Global Facility for Disaster Reduction and Recovery

Adequately financing national weather, water and climate services is a challenge as pressures to reduce public expenditures increase. This paper looks at the what kinds of services are needed

Managing and Delivering National Meteorological and Hydro-meteorological Services

WCIDS Report 2011

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Contents

Purpose

The World Bank (WB) has identified strengthening of National Meteorological and Hydrological Services (NMHSs) as a necessary component of any strategy to mitigate weather and climate related risks. A GFDRR program to help strengthen Weather and Climate Information and Decision Systems (WCIDS) was recently launched to identify gaps in national capacity and to develop financial packages to support the modernization of NMHSs in developing countries.

The means to sustain and ensure the ongoing relevance of these newly modernized services are weaknesses that haves been identified during the process and highlighted as a necessary component of any modernization program[1]. The inclusion of new capabilities, creation of new services, and operations and maintenance (O&M) require additional and ongoing budget support. While these costs may be covered by an increase in core support, this not always possible and requires careful development of financing and management plans.

Many governments have sought ways to reduce the cost of providing weather services as a part of an overall strategy to reduce public spending. Common approaches have been to transfer NMHSs from government departments to more independent government agencies or to outsource the provision of weather services to the private sector. As a result, the obligation is often on the NMHSs to increase revenue to meet the additional costs. An effective business model[2] tailored to the specific needs of a country and operating within a clear legal framework is essential.

Despite its importance, there is little documented experience in the development and implementation of business models for NMHSs. Difficulties have arisen in discussing this issue within the World Meteorological Organization (WMO), the international body responsible for meteorological and hydrological services because of the perceived competitive nature of the business and the unwillingness of NMHSs to share openly their business development strategies. Nevertheless, it is an important matter that must be addressed. This report, therefore, attempts to summarize the current practice in the management and delivery of services; assesses the strengths and weaknesses of different approaches; and proposes ways to implement new business practices as a means to sustain the production and delivery of weather and climate related services by NMHSs. It offers some guidelines for implementation of service delivery demonstrations, which will be elaborated and refined in subsequent versions of this report as more experience is gained.

[1] This has been highlighted in the recently completed Project Appraisal Document for investment in the NMHSs of Central Asia – the Central Asia Hydrometeorology Program (CAHMP).

[2] A business model describes the rationale of how an organization creates, delivers, and captures value (economic, social, or other forms of value). In theory and practice the term business model is used for a broad range of informal and formal descriptions to represent core aspects of a business, including purpose, offerings, strategies, infrastructure, organizational structures, trading practices, and operational processes and policies.

Background

The role of NMHSs

National Meteorological or Hydrometeorological Services (NMHSs) have a mandate to provide services that protect lives and livelihoods from the adverse effects of meteorological or hydrological phenomena or both. These warnings are authoritative and indiscriminate. However, while there is an unprecedented demand to reduce hydrometeorological and climate risks to the public and national economies, many NMHSs face substantial institutional challenges. These include coping with limited public sector investment, retaining qualified staff, implementing and sustaining new technologies essential to delivering the services that users need, and competition from other actors in the so called "weather and climate enterprise[3]".

In many developing countries, NMHSs lack the capacity to deliver the expected level of services. The subsequent information gaps are sometimes partially filled by other agencies, the private sector and academia. However, the approach is often disorganized and disaggregated resulting in ill-informed decisions and strained relationships between the various parties each trying to support the need for better weather and climate services using diverse approaches.

Addressing this problem requires us to assess the roles and responsibilities of each of the actors involved in the weather and climate enterprise and how to support the core functions of arguably the most important – the NMHSs – because of their responsibility to sustain the basic national hydro-meteorological and climate observing networks, deliver forecasts and analyses and issue warnings.

The dominant role of NMHSs as national weather and climate service providers creates opportunities to improve economic performance in various weather- and climate- sensitive sectors; conversely, there is also the threat that they will exploit their monopoly on weather, hydrological and climate data to limit activities and opportunities for others to develop products and services. This is a major source of tension between the various actors in the weather enterprise, particularly in developing countries. It must be thoroughly analyzed and addressed if more effective services are to be developed.

Given the financial realities within the public sector, are there opportunities in developing countries for greater cooperation between the public and private sectors and academia? Will partnerships of this kind lead to greater sharing of data and information? Can a win-win situation be created that fulfills the public sector responsibility to help the economically disadvantaged (e.g., small-holder farmers in Africa), while meeting the needs of large enterprises (e.g., insurance, agri-business, hydropower companies), and is there a sustainable financial model for NMHSs? And can business models of developed countries NMHSs be adapted for least developed ones?

[3] The Weather and Climate Enterprise consists of all of the entities contribution to production, delivery and use of weather and climate related information. It includes government, academia and the private sector; intergovernmental organizations including the World Meteorological Organization (WMO), and specialized centers such as the European Center for Medium Range Forecasting (ECMWF), satellite operators and regional climate centers.

Many donors and investment institutions recognize the importance of weather and climate information because of the increasing impact of extreme weather and the sensitivity of human activities to climate variability and change. Efforts to assist NMHSs modernize; however, often focus on the acquisition of equipment and not necessarily on the overall needs of the service. While, improving observations is an essential component of any effort to deliver effective national services, the ability to sustain this investment is crucial. This requires the means to fully integrate these upgrades into the overall weather, climate or water information production system; and, most importantly, there must be sufficient resources to hire and retain more qualified staff, to cover the likely additional O&M costs associated with expanded networks, and the new services that must be developed. Financial and economic considerations are often missing in NMHSs' modernization plans or programs supported by the governments and donors. Development of a model, which would ensure sustainability of NMHSs' operations, is a challenge for every country, with greater complexity in developing countries. Without consideration of the ongoing sustainability of operations, maintenance and service delivery, many investments have a relatively short term impact and services quickly decline or do not improve at all. Similarly training opportunities that are not linked to staff development within the NMHSs have relatively little benefit if opportunities exist outside of the NMHSs for the best qualified. The capacity to innovate is also important if NMHSs are to remain current.

Technological innovation is essential to take advantage of the benefits of the success of global atmospheric, oceanographic, and climate research, which have made huge advances in the observation and prediction of the earth system in the past two decades. Notable improvements have occurred in monitoring and predicting short-term weather hazards, climate variability and change. For example, the accuracy of global five-day forecasts is comparable with that of 2-day forecasts of 25 years ago (Shapiro et al. 2010). Significant advances have also been made on longer time scales and greater understanding of forecast uncertainties permits more useful seasonal predictions because the user can know how uncertain the forecasts are likely to be (Palmer 2004). Weather-related disasters are increasingly avoidable through early prediction, warning and action on the part of those at risk and those responsible for public safety and security.

Taking advantage of these advances requires the ability to invest in the tools needed to monitor, analyze and predict the environment, disseminate this information to users, and for users to have the capacity to act effectively.

Advances in science and technology are also driving the evolution of the weather and climate enterprise. In the past, government agencies collected nearly all of the weather, climate and hydrological data and ran nearly all of the forecast models (NRC 2003). Today, local agencies, universities and private companies can deploy their own instruments, and some run their own models or models developed by others, and provide services to users. These advances will continue and will further increase the strain between the various actors. For example tensions exist between some meteorological departments in Africa and private agricultural businesses that need weather and climate information to offer insurance and other services to their clients[4]. In the absence of government supported networks, the private sector and academia are creating their own private observing networks and using and sharing these data. These separate networks may eventually provide more capacity to the national observing network than the NMHSs could provide alone. Rather than pursuing an adversarial position, which is often the case, ways need to be found for both the government services and private sector to benefit. On the one hand, while government meteorological departments assert their authority over national networks and the dissemination of weather information, they are slow to react to the growing private sector need for weather and climate information and generally lack the capacity to meet the requirement. On the other hand, most weather- and climate-dependent businesses do not want to become private weather companies. This is an opportunity for cooperation between the private sector and NMHSs to find a cost-effective and mutually beneficial solution. The Weather Information for Development (WIND) project is one example of this kind of cooperation, which will be described in more detail in a later section on public-private partnerships.

Another well-documented example is the Oklahoma Mesonet (Mesoscale[5] Network), which is a meteorological observing network developed by scientists at the University of Oklahoma (OU) and Oklahoma State University (OSU) (Box 1). This network complements and extends the national surface observing network providing higher resolution measurements needed for many applications in the State of Oklahoma. Tools are developed for public safety, agriculture, wildfire management, and K-12 education, among other applications.

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[4] See for example, Kilimo Salama, a "pay as you plant" insurance designed for Kenyan Farmers so they can insure their farm inputs against drought and excess rain developed by Syngenta Foundation for Sustainable Agriculture (SFSA). This project requires a basic meteorological observing network with high spatial resolution that required the company to invest in meteorological observations since the national meteorological service does not presently have the capacity.

[5] In meteorology, "mesoscale" refers to weather events that range in size from about one km to about 200 km. Mesoscale events last from several minutes to several hours. Therefore, mesoscale weather events are phenomenon that might go undetected without densely spaced weather observations. Thunderstorms, wind gusts, heatbursts, and drylines, are examples of mesoscale events (http://www.mesonet.org). A"dryline" separates a moist air mass and a dry air mass.

Box 1: Oklahoma Mesonet

The Oklahoma Mesonet consists of 120 automated weather stations, which provide data the Oklahoma Climatological Survey (OCS). There is at least one station for each of Oklahoma's 77 counties. At each site, the environment is measured by a set of instruments located on or near a 10-meter-tall tower. The measurements are packaged into "observations" every 5 minutes, and then the observations are transmitted to a central facility every 5 minutes, 24 hours per day year-round.

The Oklahoma Climatological Survey (OCS) at OU receives the observations, verifies the quality of the data and provides the data to Mesonet customers. It only takes 5 to 10 minutes from the time the measurements are acquired until they become available to the public.

OK-First is an outreach project of the Oklahoma Climatological Survey (OCS) and Oklahoma Mesonet. It provides training and real-time weather data to public safety officials for use in weather-impacted situations. OK-First training and data are provided at no cost to qualified applicants in Oklahoma.

As of March 2011, more than 190 agencies in and around Oklahoma participate in the program, including the local Weather Forecast Offices (WFOs) of the National Weather Service. OK-First operates with substantial funding support from the Oklahoma Department of Public Safety. Costs are recovered according to the following data policy:

OFFICIAL POLICY ON ACCESS TO DATA ARCHIVES OF THE OKLAHOMA MESONET:
(Adopted by the Mesonet Steering Committee, September 17, 1996; Amended August 27, 2003)

Category I - Direct Sales

- Annual Mesonet CDs will be produced on a three-year lag and will be available for $1000 per CD-ROM;
- Data costs for other requests will be assessed according to Mesonet Steering Committee policy (below);
- A data handling fee of $50 per hour will be assessed for data tailored to special needs, with a minimum charge of $20;
- All data are copyrighted; no redistribution is allowed - penalty is termination of access to data archives and possible legal action to recover lost revenue;
- Approval of the Director of the Oklahoma Climatological Survey or designee is required before data will be delivered;
- All direct sales shall consist of Mesonet data with quality-assurance pre-applied; Special requests, including fee waivers, non-standard data, or data without quality-assurance pre-applied shall be subject to review of the Mesonet Steering Committee.

Category II - Mesonet Partners

- Partners shall pay an annual fee of $50,000 for access to standard Mesonet data (defined below); Annual fee includes:
- One copy of annual Mesonet standard data on CD-ROMs, which may be copied and distributed to researchers sponsored by the Partner;
- Access to all archives of standard Mesonet data (since commissioning of the network) via a self-serve web-based interface (when available);
- Access to observed data accompanied by separate quality-assurance flags (i.e., not pre- applied quality-assurance as on the annual CD-ROMs).
- Partnership includes a site license for redistribution within a group specified in the terms of the contract;
- Data can be used in collaborative projects among other Partners with the written authorization of the Mesonet Steering Committee or designee;
- All data are copyrighted; no redistribution is allowed to non-contracted users - penalty is termination of access to archives and possible legal action to recover lost revenue;
- Contract and funds must be received before data access will begin.

Category III - State and Academic Institutions

- State-funded institutions, including Oklahoma academic institutions and state agencies, shall have identical access as Mesonet Partners, subject to the following additional restrictions:
- Data may be used only for projects within qualifying Oklahoma institutions;
- Any collaboration with individuals or entities external to the institution requires advance written approval of the Mesonet Steering Committee or designee;
- Mesonet acknowledgement is required on all publications which utilize Mesonet data and/or derived products (see below for an example);
- Funded research projects are strongly encouraged to include funds for acquiring Mesonet data according to the Mesonet's Fee Structure;
- The Director of each unit acquiring Mesonet data shall sign a statement agreeing to these provisions prior to the release of data;

Annual fee shall be waived as long as the State of Oklahoma provides core funding, as determined by the Mesonet Steering Committee.

Category IV - Fee Waivers

- Waiver or reduction of Mesonet fees may be provided at the discretion of the Director of the Oklahoma Climatological Survey, subject to consultation with the Mesonet Steering Committee; Waivers will be recommended for projects engaged in unfunded, exploratory research or small- dollar grants where regular Mesonet costs would be prohibitive;
- The Mesonet data provider will make a recommendation to the Steering Committee outlining the waiver request, including the individual and institution requesting the data, purposes of use of Mesonet data, the value of Mesonet data being waived, and a recommendation on whether to grant or deny the request;
- If no official response from the OCS Director either (1) altering the recommendation, or (2) postponing the recommendation is given within ten (10) business days, the recommendation will be accepted;

Anz granted waiver will be accompanied by a letter stating the terms of use of the data, including prohibitions on redistribution and requiring acknowledgement on any publication From http://www.mesonet.org/

As has been demonstrated by the agricultural sector, new kinds of services are needed. The growing importance of climate change and longer term variability for economic planning, adaptation and development requires greater emphasis on the delivery of climate services. Strategies to achieve this vary from country to country. However, there are several key elements: they must be inclusive of many different communities with expertise in different sectors; they should include hydrometeorological services and their expertise in monitoring and prediction, and they should connect to the appropriate parts of government and civil society tasked with responsibilities for adaption and mitigation of climate-related hazards. Defining the role of the NMHSs' climate services is an important component of the NMHS's strategic development and will have financial and human resource implications. Success without extensive partnerships is unlikely (Rogers et al. 2007).

International relations are universal components of NMHSs' strategies. From the beginning, advances in weather forecasting depended on the sharing of observations across political boundaries. This is still true today. Restrictions on access to data limit the capacity to analyze and predict environmental changes, which occur across national boundaries. The interconnected global economy requires hydrometeorological and related information to support decisions that connect goods and services and public safety everywhere. Therefore it is important to have national strategies that link to and support a regional and global strategy for the development of national hydrometeorological services. The development of regional warning services that link national warnings in a coherent and consistent way is an important practical step.

Recruiting and retaining qualified staff is a growing challenge for NMHSs everywhere. With technical innovation comes the need for highly skilled technicians. This is often not the case and many small NMHSs are unable to sustain modernized observation and production systems because of a lack of expertise. Working in a socially responsible organization may no longer be sufficient incentive; even larger services have difficulty competing for staff attracted to higher paying private sector employment.

Demand-Driven Services – Realizing the Social and Economic Benefits of NMHSs

What drives NMHSs are the services they provide

Today, weather and climate affect society more than at any other time, with different sectors vulnerable to even small changes in environmental conditions. At the same time, societies are becoming more capable of mitigating the adverse consequences of weather and climate phenomena providing the information is timely and relevant (Rogers and Tsirkunov 2011).

Economic growth is changing the requirements for energy, manufacturing and transportation. For example, electrical power generation, which is fundamental for economic security and sustainable development, is vulnerable to a range of weather and climate hazards including changing rainfall patterns affecting hydropower generation, availability of wind energy, solar and the impact of extreme heat and cold affecting network stability and demand. The growth in global trade exposes more goods and services to potential delays. Today, manufacturers generally maintain low inventories of goods to minimize costs. The result is that supply chains are more susceptible to transport network disruptions, which can seriously impact the availability of essential commodities from food to heating-oil supplies. Conversely, if provided with adequate lead-time, such agencies can increase stock and resources in anticipation of requirements. Climate services are increasingly important to better manage adaptation to cope with increasing risks of droughts, floods, inundation and other weather-related extremes exacerbated by climate variability and change.

The blending of social, economic and environmental information is central to sound planning and decision-making. Timely and accurate weather, climate and water information and forecasts have many applications but the utility of these services is often poorly understood, resulting in low demand and lack of public investment in NMHSs. Unless demand-driven services can be created, new societal and economic benefits, which could be provided by NMHSs, will always be viewed as a low priority for government spending amidst the needs and costs of other public goods and services.

This emphasis on demand-driven services is a departure from the traditional role of a National Meteorological or Hydrometeorological Service (NMS), which emphasized the production and dissemination of meteorological and hydrological forecasts and related products only. Now there is a need to understand how these products and services are utilized and what can be done to increase the benefit to the user. In other words it is no longer sufficient to produce a good forecast of severe weather, the forecast must be used properly and the benefit in terms of improved safety and security must be realized. This is critical to developing an effective business model.

Most of the value of weather, climate and water information added or lost in the so-called value chain between the weather and its impact occurs in communicating the information to users and in the behavior of users in response to that information and ultimately the effect of their decisions on the societal or economic outcome. If the user cannot make changes or if there is no effect on the outcome, the information has no direct value (Lazo 2007).

There are three areas where value could be increased; namely by improving the forecast, by improving communication or by improving the decision-making process. If currently available information is underutilized, added value will likely accrue if the communication or decision-making process is improved. If the information available is insufficient to influence decisions, then value will be added by improving the weather, climate and water information, itself (Rogers et al. 2007).

Clearly this end-to-end process is not entirely the responsibility of the meteorological services, but requires an active partnership between the producer and consumer of meteorological products and services. Different strategies may be employed depending on specific country applications. It is clear, however, that reliance on simply providing the best weather forecast or climate outlook is not sufficient. A lot more effort is needed on the part of the provider and user to understand each other's capabilities and constraints in order to optimize the use of weather and climate information to improve economic performance.

In the US, the emphasis is on building better partnerships with other government departments which utilize the National Weather Service products and services (NRC 2003). In France, collaboration with health services, for example, has created an early warning system for health and both participate in a National Heat Wave Plan designed to minimize loss of life during a major heath wave and air pollution episode (Pascal et al, 2006). In China, the concept of a public service platform has been created to strengthen collaboration between the China Meteorological Administration and many other organizations (Tang 2009, unpublished)[6]. The aim has been to realize tangible and quantifiable benefits to the community by exploiting new operating partnerships between user and provider to share responsibility for the effective delivery of services. This has included the development of new tools and methods to strengthen dialog and collaboration between provider and user.

In the UK, the Public Weather Services Customer Group (PWSCG) exercises a high degree of control over the core budget of the Met Office for the services, which are free-at- point-of-use. PWSCG is responsible for funding the underpinning operational capability of the Met Office, and the research and development needed progressively to improve the utility of its forecasts over time. This helps ensure that products and services are focused directly on specific public sector needs and that representatives of the public's interest collectively influence the research and development of the organization to achieve optimum benefit (Met Office 2007).

Many other examples exist, but these few illustrate the different ways that providers and consumers of hydrometeorological and related services can interact effectively.

The greater emphasis on decision-support requires different capabilities than those found traditionally in NMHSs. Cross-sectoral training is needed to increase the capacity and capability of the producer and consumer of hydrometeorological information to work together. For example, WMO cooperating organizations, such as the International Research Institute for Climate and Society (IRI) are now teaching courses aimed at employees of health, climate and hydrometeorological and related services[7]. This new capability, at the interface of hydrometeorological and user sectors, will lead to better decision tools and more effective outcomes for society and the economy.

This type of training is relatively new in sectors, such as energy, health and planning, but more common in agriculture, aviation and marine transportation. There are opportunities to find best practices in current training efforts that may be universally applicable to cross-sectoral training (Rogers et al. 2007).

A service-oriented or customer focus implies good communication skills. The trend in many advanced NMHSs is to trade the cost of increased technological innovation with a decrease in staffing, often closing offices and consolidating capacity in central facilities. This approach tends to reinforce the ability to provide forecast products, but may reduce the capacity of the NMHS to work directly with the user sector. In this case, the capability to exploit modern information technologies is essential.

[6] The Shanghai Meteorological Bureau (SMB) created a Multi Hazard early Warning System (MHEWS) in partnership with many other municipal agencies at risk from weather and climate related phenomena. Building on this success, SMB now houses Shanghai's Early Warning System, which is a more comprehensive warning system involving many government departments and is not only limited to weather and climate phenomena.

[7] http://portal.iri.columbia.edu/portal/server.pt?open=512&objID=1094&mode=2

Those NMHSs which effectively embed their employees within their key customer organizations generally develop a more effective producer and consumer relationship leading to greater innovation in the customer's sector and closer alignment of the NMS with the expected outcomes of that provided service. There are many examples of this approach from many NMHSs, including road weather services, support for military operations, and agricultural services. This is also an area where there is considerable capacity within private weather service providers and a major area of tension between the public and private sector, which may be in direct competition. Some countries, such as the US restrict the activities of their National Weather Services to avoid competing with the private sector, others governments require their NMHSs to offer commercial services and rely on competition laws to engender fair competition between the public and private sectors. In practice, this is very hard to achieve.

Implicit in the provision of impact-specific services is that many of these are bespoke services for specific economic sectors with a clear commercial value to that sector. Balancing the provision of public services and potential commercial services is a challenge.

Common Business Models for NMHSs' Services

Managing a modern NMS with limited public sector investment

Nearly everywhere, governments are striving to improve the well-being of their citizens at a time of mounting public debt and demands to reduce public spending.

Population dynamics, reducing poverty, water security, food security, increasing prosperity and improving public health and safety are key social and economic drivers. The natural environment is a challenge, made worse by changes in the climate, which threatens development through extreme weather events causing disasters, reduced food security, reduced availability of uncontaminated freshwater, and the rise and spread of diseases. The safety of life and property is paramount for all countries.

NMHSs are constituted as the authoritative voice on weather warnings in their respective countries, and in many they are responsible for climate, air quality, water resources, land-slides, seismic and tsunami warnings. NMHSs help their governments make better decisions to mitigate natural hazards, to adapt to climate change and to increase the overall security of society and the economy. NMHSs should be a fundamental component of the crisis management or risk reduction infrastructure of their countries. This is an inherently governmental role.

At the same time, governments are seeking ways to improve efficiency and reduce the costs of public services. Methods have varied from the outsourcing of public services to the transfer of public functions to more independent government entities that operate at arm's length from their originating departments. Services associated with public safety have remained largely within the control of central, regional or local government departments. One exception has been the NMS, which despite having responsibility for the protection of lives and livelihoods has become a target for quasi-commercialization in many countries.

We have identified four, interrelated models for the management and delivery of hydrometeorological services. In general, many NMHSs combine some of the elements of each adapted to their unique circumstances.

Model I - The Government Supported Public Service (Government Model)

This approach provides only public services at government expense. A good example is the United States National Weather Service (NWS), which is core funded in order to provide all of its products and services at public expense for the public good. It has been shown that this approach has helped to develop a relatively strong private sector that is not in direct competition with the NWS, maintaining a balance between the public sector's role in providing basic information for public safety and economic security and sustaining specialized, value-added private-sector services (NRC 2003). This permits a clear distinction between public goods, private goods and mixed goods. In the case of the United States, the three parts of the Weather Enterprise are: the public sector in the form of the National Weather Service, which is responsible for protecting life and property and enhancing the national economy; Academia, which is responsible for advancing the science and educating; and the private sector made up of weather companies, meteorologists working for private companies or as private consultants and broadcast meteorologists, which is responsible for creating tailored products and services for individual clients and for working with the NWS to communicate forecasts and warnings that may affect public safety (NRC 2003).

This might be considered the ideal model if public sector financing is sufficient. The risk of this approach is that services will be reduced if public spending is reduced since there are no alternative sources of revenue. In many countries, reductions in public sector financing means that the NMS is competing with other government priorities such as primary and secondary education, public health and national security. Poor public financing creates a downward spiral for NMHSs resulting in reduced staffing, inability to maintain observing networks, limited capacity to innovate, and poor service delivery, which leads to further neglect and inability to meet the need for adequate warnings of extreme events.

As pointed out by the NRC (2003), there is also an inherent tension between the public, private and academic sectors because

- each sector contributes in varying degrees to the same activities – data collection, modeling and analysis, product development, and information dissemination – making it difficult to clearly differentiate their roles.
- the sectors also have different philosophies of sharing data and models with the other sectors and the general public;
- advances in scientific understanding and technology permit new user communities to emerge and change what the sectors are capable of doing and want to do; and
- all members do not share the same expectations and understanding of the proper roles and responsibilities of the three sectors.

Reducing friction between each of these sectors is important for the ongoing functioning of the Weather Enterprise in the United States. Very few countries outside of the United States continue to use this model and, of those that do, many are in transition to one of the other models.

Model II – Core & Discretionary Funded (Agency Model)

This second approach retains the responsibility of the Government Model to provide a public service, but is required to compete for the additional funds needed to run the entire service, usually through short-term contracts to address the specific needs of a government department or state-owned enterprise. These additional, discretionary, funding mechanisms are usually referred to as commercial by government, although they lack the exclusivity normally associated with commercial activities. European NMHSs have over the past twenty-five years or so experimented with one form of commercialization or another. The enthusiasm for the development of commercial services has been strongest in Scandinavia, UK, France and the Netherlands with varying degrees of success.

The Met Office's business model distinguishes between two types of customer: central government bodies requiring services which cannot sensibly be competed; and services provided on a commercial (usually competed) basis to customers both inside and outside government. This distinction helps the Met Office demonstrate its compliance with competition law in relation to possible cross-subsidy (Met Office 2007).

The main customers for non-competed services to central government are the Ministry of Defence (MOD), Department of Environment, Food and Rural Affairs (DEFRA), and the PWSCG. In these cases, prices are to be set at a level consistent with Treasury guidance on the cost of capital for inter-departmental services. The Met Office maintains Customer Supplier Agreements with all relevant customers which clearly define the outputs and associated costs, and where possible provide incentives for cost-reduction and/or service-enhancement. In contrast, profit margins for business which is either competed or capable of being competed are dictated by market conditions. This also applies to competed services to Government departments (Met Office 2007). Developing the appropriate policy and legal framework is essential. In the UK, the Met Office's activities are defined within the Government Trading Funds Act 1973 as amended, and the Meteorological Office Trading Fund Order 1996[8] and subsequent amendments. A trading fund is expected to make a return on capital employed (ROCE), which is a dividend for the Treasury. If this practice is employed elsewhere, it is recommended that any ROCE be used within the NMS as an investment in new services or as incentives for staff rather than returned to the finance ministry.

[8] The financial expectations of the government for the Met Office are laid out in a treasury minute. The treasuring minute dated March 2003 states that the, "the Secretary of State for Defence, being the responsible Minister, has determined (with Treasury concurrence) that a further financial objective desirable of achievement by the Meteorological Office Trading Fund for the period from 1 April 2002 to 31 March 2007 shall be to achieve a return, averaged over the period as a whole, of at least 3.5 per cent in the form of a surplus on ordinary activities before interest (payable and receivable) and dividends expressed as a percentage of average capital employed. Capital employed shall equate to the total assets from which shall be deducted the total of the current liabilities." Thus in addition to cover costs, there is an expectation of a return on investment.

The potential to reduce the cost of public services by offsetting investment against commercial revenue has also attracted the attention of governments in other regions. Many countries in Africa are in the process of transforming meteorological departments into agencies with the aim of creating more flexible organizations with the capacity to make strategic and tactical decisions on their own, particularly with regard to budgeted resources.

One consequence of this approach can be an overall reduction in core spending on infrastructure with the aim that shortfalls will be made up from contract funding. The problem with this tactic is that the latter type of funding is usually short-term and ongoing basic infrastructure costs may not be met. There is also a need to dedicate a lot of staff to solicit and manage contract work with greater emphasis on development, sales and marketing rather than forecasting, which in a small NMS may be difficult to achieve.

In the transition from government department to agency or even before this step, one major problem emerges and that is the only asset that most NMHSs consider is their observing system database, which they perceive to have intrinsic financial value. Consequently, there is a tendency to restrict access to these data, which if not considered essential data, as defined by WMO Resolution 40[9], can be withheld with impunity. The net effect is that fundamental questions about climate adaptation may go unanswered for fear that this asset will be exploited by others at the expense of the NMS.

Practices which restrict data are increasingly at odds with various international and national directives. For example, European governments are increasingly recognizing the benefits of making their data open and reusable. The wide availability of Public Sector Information (PSI) can be a key driver to develop content markets in Europe, which can generate new businesses and jobs and provide consumers with more choice and value for money[10]. One objective of the Digital Agenda for Europe (DAE) is to facilitate the wider deployment and more effective use of digital technologies to enable Europe to address its key challenges and provide Europeans with a better quality of life, for example, by opening up access to content. One element of this is INSPIRE, the European directive to create a European Union (EU) spatial data infrastructure to share environmental spatial information among public sector organizations and better facilitate public access to spatial information across Europe. The regulations of the European Inspire program[11] encourage data sharing. Thus, at least in Europe, it is increasingly difficult for national

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[9] Resolution 40 of the 12th World Meteorological Congress defines the WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities (See Annex II)

[10] This goes well beyond what was envisaged in Cg XII Resolution 40 by actively encouraging the commercial exploitation of public data.

[11] The main points of the Regulation are the following:

- Metadata must include the conditions applying to access and use for Community institutions and bodies; this will facilitate their evaluation of the available specific conditions already at the discovery stage.
- Member States are requested to provide access to spatial data sets and services without delay and at the latest within 20 days after receipt of a written request; mutual agreements may allow an extension of this standard deadline.
- If data or services can be accessed under payment, Community institutions and bodies have the possibility to request Member States to provide information on how charges have been calculated.

meteorological services to restrict access to their weather and climate data sets and should engender higher value-chain service development. For example, in 2007, the Norwegian Meteorological Institute instituted a free data policy[12].

This model or some variation of it will be represented in most NMHSs. It is arguably very difficult to implement unless it is part of a government-wide reform since agencies not used to paying for services from other government departments will likely refuse to pay for meteorological and hydrological information, even though it may be essential for their operations. It will be essential for the NMS to have in place good accounting methods to properly monitor and demonstrate the cost-effectiveness of these services. Guidelines on accounting, cost centers and management practices are needed and could be developed with WMO.

Model III – Commercially Funded (State-Enterprise)

The third approach builds on the second model. This applies to NMHSs, which are encouraged or required to compete directly in commercial, competitive markets. In turn this raises a number of issues regarding the monopoly that NMHSs hold on basic hydrometeorological and related data and fair competition. NMHSs are data monopolies that enable the effective reuse of public information by individuals and the private sector. However, without a clear separation of their public sector tasks from their commercial interests, it is easy to see how NMHSs may inadvertently, or otherwise, misuse their dominant position in the commercial market for hydrometeorological and related information. The Met Office Framework Document 2007 is explicit about this[13]. A case brought to the attention of the Norwegian Competition Agency in 2001 by the private company Storm Center argued that the Norwegian Meteorological Institute was using its monopolistic position to compete unfairly (Box 2). This led to the formation of a spin-off state-owned commercial service that operated at arm's length from the public service to openly compete in commercial markets. This approach, if successful, could have provided a profitable revenue stream without distorting the core public sector business of the NMS. In the case of Norway, however, the subsequent policy change to make all data free limited the value of a separate company and the Norwegian Meteorological Institute refocused its attention on activities that strengthened its core public responsibilities. This approach also helps to retain image of the NMS as a public service.

- While fully safe-guarding the right of Member States to limit sharing when this would compromise the course of justice, public security, national defence or international relations Member States are encouraged to find the means to still give access to sensitive data under restricted conditions, (e.g. providing generalized datasets) Upon request, Member States should give reasons for these limitations to sharing.

[12] http://met.no/English/Commercial_Services/

[13] In competing with other organizations in order to maximize profitable revenue from commercial activities, the Met Office must ensure that it is – and is seen to be – fully compliant with competition legislation, including the need to avoid misusing its position as a dominant provider in certain sectors. Transparent processes are to be put in place to ensure that there is no cross-subsidy between services delivered (Met Office Framework Document 2007, p. 14

Box 2: **Storm Weather Centre AS and the Norwegian Meteorological Institute (2000/2001)**

The case. In 2000 and 2001 Storm Weather Centre AS (Storm) approached the Norwegian Competition Authority (NCA) and requested the Authority to consider the competitive situation between the Storm and the Norwegian Meteorological Institute (Norsk Meteorologisk institutt - MI), which is the Norwegian national institute for weather forecasts.

MI is a state administrative agency under the Ministry of Education and Research and has responsibility for the public meteorological services for civil and military purposes in Norway. MI also sold special services to the public and private companies.

Storm is a weather forecasting company that sells products and alert services to the media. The company also operates within markets like hydropower, offshore and agriculture. Storm sells products that are processed meteorological raw data. These raw data Storm are mainly bought from MI.

Storm was of the opinion that MI was not exposed to the same competitive conditions as Storm. Storm pointed to three factors it considered of significance in this regard. First, it argued that the MI partially could transfer the cost of its commercial production to the activities the company exercised by virtue of being a state agency. Second, it argued that the marketing department of MI did not face the same risks as Storm, because MI with the state in the back could cover any deficit. Finally, Storm argued that there was cooperation on the price of the data that Storm was dependent on in its production. According to Storm, this cooperation took place between the MI and other meteorological institutes in Europe, through the organization ECOMET.

NCA concerns. MI and Storm both operated on the supply side of the market for processed weather and climate services in Norway. MI was the largest company, and at the time Storm was the only competitor. The NCA considered it important to protect competition on equal terms in this market, and concluded that MI's activities created, or could easily create competition distortions.

The main reason for this point of view was that MI had the ability to finance its commercial activities with grants the agency got over the national budget. Thus, it was a risk that MI could operate with lower prices than those reflecting actual production costs. Another factor that could create competitive barriers in the NCA's opinion was the incentive to provide MI's commercial activity access to raw data on different terms than the competitors.

On this basis, it was the NCA's assessment that the MI's commercial activities should be separated out into a separate company, for example, a state corporation. The new company should not have access to raw data from MI on different terms than those offered to competitors. Moreover, the NCA also pointed out that a new company should be able to take advantage of the MI's other resources, such as marketing on the MI's homepage on better terms than its competitors.

However, the NCA also underlined that before any separation took place, an assessment had to be made whether any economies of scope between MIs agency activities and the commercial activities suggested that such a separation should not be made.

The current situation. Traditionally, the sale of basic meteorological products in the form of automated sales of meteorological data to commercial institutions had been an important source of revenue for the MI's market department. The decision to release all meteorological data for free made in 2007 limited the market potential for commercial activities at the MI. Thus, the same year, the board of MI decided that the Institute's paid activities should be restricted to projects contributing to the development of the Institute's expertise, thus improving the fulfillment of the state assignment. The market department in its current form should be phased out. The board underlined that any remaining market activities should be administered in accordance with state aid rules and competition legislation, ensuring that any cross-subsidization not take place.

Taken from: *OECD DIRECTORATE FOR FINANCIAL AND ENTERPRISE AFFAIRS, COMPETITION COMMITTEE Working Party No. 3 on Co-operation and Enforcement, Discussion on corporate governance and the principle of competitive neutrality for State-Owned Enterprises – Norway – 20 October 2009.*

Whichever model or variant is employed, reselling basic data should be avoided in favor of adding real value to the information. This model implies that that NMHSs acts as a wholesaler of basic meteorological and hydrological data and products that can be purchased by the retail commercial or discretionary funded service. All, but the core public service, would pay and transfer the costs to their customers.

This model is also applicable to those countries that have decided to contract out the provision of public weather services to the private sector or have created a government-owned commercial enterprise. In this case, the government has defined its requirements for a weather service and the private enterprise fulfill their contractual obligations to discharge this public responsibility in the same way that a public body would. The leadership of this enterprise would participate on behalf of the country within international bodies, such as the WMO.

New Zealand was one of the first to adopt this approach. MetService provides New Zealand's National Weather Service. In addition, it provides commercial services and has a wholly-owned subsidiary Metra, which provides international commercial services (http://www.metservice.nz). While there was considerable mistrust of MetService when it was first created, it has proven that a private enterprise can provide public services and can discharge the nations international obligations, if vested by government to do so.

Model IV – Public-Private Partnership (PPP) or Build-Operate-Transfer (BOT)

A fourth approach is for the NMS to partner with commercial sector or non-profit sector to create an entity, which can serve as a means to broker information and data exchange between the NMS and the private sector. It may also be a conduit for acquisition of observing stations to strengthen national networks while enhancing observations of highest value to the commercial sector.

Build-Operate-Transfer

This approach has been pioneered for NMHSs in Africa by NetHope[14] and Accenture Development Partnerships[15] with support from the Bill and Melinda Gates Foundation and Rockefeller Foundation (Box 3). The basic premise of the Build-Operate-Transfer (BOT) model is the delegation by the public sector to a private sector (possibly, but not necessarily non-profit) to design, build, operate and maintain infrastructure or facilities for a certain period. During this period the private entity has the responsibility to raise the finance for the project and retain revenues generated by the project but is not the owner of the infrastructure or facilities. At the end of the concession agreement, the infrastructure or facilities are transferred to the public sector without any remuneration of the private entity. Various parties can be involved in any BOT project: the host government, which is normally the initiator of the project and decides if the BOT model is appropriate for its needs. Political and economic circumstances are the main factors for this decision. The government normally provides some support for the project, changed laws, sharing of data, etc. The project sponsors who act as concessionaire create a special entity which is capitalized through their financial contributions. The entity will have only a limited workforce so it will subcontract to a third party to perform some of its obligations under the agreement.

In general, a project is financially viable for the private entity if the revenues generated cover its costs and provide sufficient return on investment. For the host government, viability depends on its efficiency

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[14] NetHope is a unique collaboration of 33 of the world's leading international humanitarian organizations working together to solve common problems in the developing world.

[15] ADP is a pioneering 'corporate social enterprise' that employs a not-for-profit business model that makes the core skills of Accenture accessible to the international development sector to help strengthen organizations and build emerging markets from within.

in comparison with the economics of financing the project with public funds, and considering the expertise that the private entity is expected to bring and the transfer of risk to the private entity.

Applied to the expansion, maintenance and operation of weather, climate and hydrological observing networks for NMHSs, a BOT would be responsible for building a sustainable business model for weather and climate information. Donor grants would purchase and maintain observing stations, and help build business capacity by creating a neutral governance and administrative business unit that has business acumen and commercial networks. For example, there are many commercial networks implemented in countries to provide data for specific applications, such as weather risk insurance. In many instances, a BOT could be used to bring together the public sector and private sector data and create a revenue stream that is advantageous to all parties. In this example, the insurance company can focus on its core business and the NMS can take responsibility for the maintenance of the network with financial support provided by the private sector through the BOT. The BOT could also develop new products and services which would also provide revenue to all of the BOT shareholders, both public and private. Since the BOT is a neutral entity, it can act as an information broker helping guarantee fair pricing and commitment from all parties, both public and private.

Box 3: BOT – The Weather Information for Development (WIND) Initiative in Kenya

Building on an idea initiated by Kofi Annan at the Global Humanitarian Forum with WMO and other partners, the Bill and Melinda Gates Foundation and Rockefeller Foundation are supporting WIND to improve the delivery of weather and climate related products and services to farmers. Starting in Kenya, the project aims to bring together all of the various actors in the agricultural sector – government, private sector, small holder farmers, agricultural business, etc. – to improve the network of meteorological observations relevant to agricultural activities – input insurance, irrigation, planting, harvesting, etc. Kilimo Salama and similar projects in Kenya have demonstrated the value of input insurance (seed and fertilizer) to small-holder farmers based on meteorological data collected from a network of automated weather stations and access to long-term climate records. During the initial trials some of these networks were implemented by private companies alone (e.g., Syngenta Foundation for Sustainable Agriculture) and some in collaboration with the Kenya Meteorological Department (KMD). Expanding these networks and increasing the capacity of KMD to provide a more comprehensive network that could improve geographically specific climate forecasts and outlooks was considered highly desirable for all parties, both government and private sector.

However mutual mistrust on the part of all parties has to be overcome for the correct business model to be implemented. On one side, the government department believes that it should be the only operator of observing networks and on the other the private sector does not believe that they will have the necessary access to data if the networks are operated by the government. While this is not a good premise to establish a partnership between the public and private sector, a third, neutral party was proposed as compromise and the idea of a separate organization, a so-called data steward, to manage the WIND related observing networks financially supported by the private sector and operated on behalf of the consortium by KMD. This is a version of version of the Built-Operate-Transfer model with the new entity responsible for managing agreements with the private sector, developing new revenue generating products and services, and acting as arbiter for access to these data. The revenue generated by this entity would pay for the operations and maintenance costs of the networks. The perceived benefit is that the data are quality controlled by the national authority and independently maintained from insurance and other service providers increasing the veracity of the network; KMD enhances its basic observing network enabling it to improve its weather and climate forecasts increasing opportunities for improved services; the private sector can concentrate on its core business, and a revenue stream can support the KMD O&M costs for the network.

This is a new departure for government operated meteorological departments and the learning curve is likely to be steep with a reluctance to commit to a model where the government organization does not outright control the entire network. Nevertheless, it is clear that something similar to the BOT approach is needed if networks are to be expanded quickly to meet the growing demand for high-resolution information. At the end of the grant period, the BOT entity would be transferred to government.

For a typical NMS, the observing network would consist of three parts: the existing public NMS network, the new donated components, and private networks. The NMS would have control over all three parts with a portion of the total extracted to form a shared database managed by the BOT. This BOT would be set up as non-profit entity, initially with donor grants and subsequent revenues to maintain the observing network. The goal would be to create a business model to generate revenues to maintain the network and augment the data collection, operations and maintenance capabilities of the NMS. At the end of the agreed concession period the BOT would be transferred to the NMS. The BOT's shareholders would include both government and private sector parties, and it would be responsible for managing relationships between the public and private sectors through MOUs and similar agreements.

Public-Private Partnerships

Other PPPs have been tried or are in the process of development. It is informative to look at some of the ones that have worked and some that have not been so successful both in the fields of Meteorology and elsewhere to distill some good practices that may help in the future development of PPPs.

PPPs involve institutional cooperation between government and private enterprises for the joint management of complex projects in which there is an exchange of know-how between the public and private sector, and a sharing of risk by the government and private enterprise in the fulfillment of public tasks. PPPs have inherent risks – asymmetrical dissemination of information, opportunist behavior of private enterprises, lack of transparency, financial and other risks, uncertainty in task fulfillment, control deficiencies, and a lack of democratic participation and responsibility. There are also many legal issues, such as those related to laws governing competition, awarding of contracts, taxation, employment and contracts (Lienhard 2006). Special challenges exist in the inclusion of private enterprises in fulfilling sovereign tasks – in the case of the NMS, the issuing of weather warnings would be considered a sovereign task, and would likely not be seen as appropriate for a PPP; how the warnings are delivered, however, might be included in a PPP.

The aim of a PPP should be to provide services that are more economical and qualitatively better. Liehard (2006) describes the following key features:

- at least one public and one private partner;
- mutually compatible (or complementary) goals;
- complexity/great need for coordination;
- procurement or task fulfillment;
- long-term orientation ('life-cycle');
- bundling, utilization and synergies of public and private resources;
- risk-sharing;
- gains in efficiency and effectiveness.

In all PPPs, the responsible actors require a new culture, a culture of trust, mutual understanding, and learning from each other aimed towards a common public welfare oriented goal, and not simply an economic one. Partners working together in traditional project delivery models tend to pursue more or less conflict and confrontational habits, cooperation management needs special arrangements to prevent opportunist behavior (Box 4).

Box 4: Stormy weather - The Met Office caught a cold over WeatherXchange but remains optimistic about future ventures

Some of the pitfalls of Public-Private Partnerships are captured in the following abstracted article written by S. Mathieson for the Guardian Newspaper on June 1 2006. He describes the failure of WeatherXchange, Joint Venture between the Met Office and the private sector.

The Met Office is looking to expand its commercial work, its chief executive Mark Hutchinson said last week, despite losing £4.5m in the failure of WeatherXchange, a joint-venture established in 2001 with private-sector partners to serve the financial derivatives market. It went into receivership last summer.

The episode demonstrates the risks public-sector data providers run when entering the commercial world. The Met Office, which, as a government trading fund, is supposed to generate a return for its owner, the Ministry of Defence, invested £1.5m, and spent a further £3m in staff time and other costs, on the joint-venture.

The WeatherXchange name, along with its data and forecasting business, was purchased from the receivers in April by Speedwell Weather Derivatives, to which the Met Office supplies paid-for data, but in which it has no investment.

Hutchinson told the Commons defence select committee on May 23 that his organization was dominated by public-service civil servants, and will need to bring in relevant expertise in order to build its commercial activities. "We don't have an awful lot of hard, private-sector commercial experience," he said.

The day before, Peter Ewins, the chief executive of the Met Office from 1997 to 2004, told the committee he did not believe other participants in WeatherXchange made initial investments but had instead provided credibility and expertise. "That sounds incredibly naive and amateurish," said Kevan Jones, a Labour MP. "If you had done that in local government, you'd have been shot."

Ewins, who remained chairman of WeatherXchange after leaving the Met Office, says the joint-venture was hit by poor European growth in weather derivatives. But he added: "After I left the Met Office, there was in my view not the champion of that relationship that was so necessary to its success."

According to Jones, "the reason why the relationship broke down was the fact that the Met Office realized how lucrative this venture was, and was selling information directly to the market, rather than going through WeatherXchange."

The next day, Hutchinson said: "Did we undermine WeatherXchange during 2004? The answer is categorically not," adding he had "spent many months" trying to keep the joint-venture going.

But WeatherXchange had wanted to expand the areas of Met Office data over which it held exclusivity. "We simply couldn't respond in the way in which the company wished us to respond, as we are not allowed to put exclusivity on generic weather data," Hutchinson said, adding that the Met Office was already selling data in some of the areas to which WeatherXchange wanted exclusive access.

Box 3 describes a reporter's view of a joint venture between the Met Office and the private sector to provide brokerage, , data and services to the global weather derivatives market. There are several lessons to be learned (House of Commons 2006):

- Joint ventures must work with well-defined governance structures established by the parent bodies;
- Good management information flow to ensure proper oversight
- The public body needs good commercial experience and conversely the private sector needs to understand the governmental processes to ensure due diligence

- Examine PPP feasibility including feasibility tests, economic feasibility tests, risk assessment and implement ongoing risk management throughout the venture
- Well defined contract and dispute resolution processes
- Ensure no conflicts of interest

Thus a PPP must be based on a win-win situation with the advantages and risks to all of the parties carefully weighed. Table 1 summarizes the advantages and risks of PPPs.

Table 1 Advantages and Risks of PPP projects (Liehard 2006)

Advantages	**Risks**
For Public authorities	
Financial relief/gain in efficiency	Selection of partner
More rapid realization of projects	Long-term commitment
Optimized task fulfillment/relief	Complexity
Image enhancement	Conflict of interest / political risks
For the private partner	
Opening of new markets	Long-term commitment/stability
Attractiveness of public business partner	Long path to decision
Improvement in the chances of success	Pseudo competition
Anticipation of yields	Diverging interests

A PPP can be viewed as a third path between administrative reforms and total privatization. This is linked to a cultural change that is characterized by a relationship of mutual trust between the public and private sectors, as well as by a better economic understanding of government on the one hand and a stronger orientation toward the common good by private enterprise on the other (Liehard 2006).

There is considerable scope for the development of PPPs for the delivery of weather and climate services, which requires testing and evaluation.

Practical Steps toward Implementing a Service Delivery Strategy

Given that there is relatively little experience in the application of some business models and missteps are likely as new ideas are developed and tested, it is proposed that a series of demonstration projects be setup to test and evaluate new business models under a variety of conditions using the following roadmap:

- Evaluation of the existing NMS structure and current methods of producing and delivering services to the public and other sectors
- Review of legal instruments governing the NMS operations, identify issues that will affect choice of business model

- Survey of user needs in both public and private sectors and an assessment of how these needs are being met currently by the NMS and other actors (private sector, other government agencies, etc.), opportunities for partnership within and outside government
- Identification of gaps in services
- Systematic evaluation of business models; what changes, if any, are needed to improve service delivery? What services are needed?
- Evaluation of the cost of providing new services and the human resources required
- Selection and implementation of a model to test and evaluate
    - Model 1 – emphasis will likely be on improving interaction with users, improving communication and dissemination of user-relevant information
    - Model 2 – distinguish between public sector services (e.g., Public Weather Services) and services provided using commercial mechanisms (e.g., other government departments that pay directly for special services)
    - Model 3 – Structure a commercial business unit within the NMS focusing on high value services, not data sales
    - Model 4 – Develop Public Private Partnerships that adhere to the principles described here.
- Evaluation of service improvement – ensure from the outset that the impact of the new strategy can be properly measured and evaluated against the existing business models in terms of cost-effectiveness, efficiency and impact.

Summary and Conclusions

Information and knowledge of the weather, hydrology and climate is critical for economic development and disaster risk reduction. Today, this statement is axiomatic. Extreme weather threatens the lives and livelihoods of millions of people on a daily basis: climate change is increasingly shaping all of our lives as we learn to cope to with new temperature and precipitation patterns, increasing the risk of drought, flooding, heat waves and cold. Many weather-related, human disasters could be avoided if the current capability to forecast was utilized fully and warning issued and heeded.

Advances in observing systems, numerical modeling, data assimilation, visualization and the means of information dissemination could provide the world with an unprecedented level of advanced knowledge about avoidable disasters almost anywhere on Earth. How we deliver this information for social and economic good has been the focus of this report.

A core issue is how to sustain service improvements beyond the initial capital investment. The report describes several different business models that can be adapted to the different government circumstances and regulations. In some instances, it is recognized that new laws would be required to implement some of these approaches. Finally a roadmap for the implementation of a business demonstration project is outlined. A separate more detailed plan will be developed on a case-by-case basis tailored to the specific circumstances of the NMS involved.

There are important strategic consequences resulting from the choice of service model.

True commercial services are about exclusivity, confidentiality and competition; in contrast, public weather services are about the provision of information to everyone to make timely decisions to protect lives and livelihoods. The latter depends on the free and open exchange of data and information; profitability of the former depends on restricting information to paying customers.

A data policy that is restrictive on the one hand and open on the other will be in conflict if the commercial and public services are operated within a management structure that permits decisions from the commercial sector to influence the public sector. The commercial service will have the upper hand in those services, whose governments are reducing public expenditures. The experience of Norway suggests that an open data policy will inevitably reduce the opportunities for the development of the relatively low value services that are high dependent on marketing data, but should encourage opportunities to develop more sophisticated decision-support systems that are closely connected to users.

As more NMHSs operate within competitive markets, there are implications for the way they view each other. Traditionally, NMHSs have been partners with even the least capable providing a valuable contribution to the global network of observations, and the more capable sharing and exchanging numerical weather predictions. Increasingly, however, NMHSs see each other as potential competitors and their information as proprietary. The net effect is restrictions on access to even basic hydrometeorological data because of the perceived commercial value of the data as an excluded product.

The shift away from a fully core-funded NMHS, to one that depends increasingly on discretionary funding, has often the unfortunate and sometimes unforeseen consequence that other government entities view NMHSs in the same way that they may view a private, commercial contractor. This can make it difficult to create effective partnerships to deliver even the basic desired social and economic outcomes. This can also undermine the leadership of the NMHS in national policy issues for the same reasons. From another perspective, however, a PPP approach might work here. In this case, a more developed a commercially successful NMS could fulfill the role as the private sector partner to a whole-government focused agency or even to another NMS.

There must also be a clear legal framework, ideally a “meteorological law” that governs what NMHSs can and cannot do.

Since knowledge in this area is evolving quickly, this report will be followed by revisions that expand on some of the key ideas.

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Annex I

Resolution 40 (Cg-XII)

WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities

THE CONGRESS,

Noting:

(1) Resolution 23 (EC-XLII) — Guidelines on international aspects of provision of basic and special meteorological services,

(2) Resolution 20 (EC-XLVI) — WMO policy on the exchange of meteorological and related data and products,

(3) Resolution 21 (EC-XLVI) — Proposed new practice for the exchange of meteorological and related data and products,

(4) Resolution 22 (EC-XLVI) — WMO guidelines on commercial activities,

(5) The report to Twelfth Congress of the chairman of the Executive Council Working Group on the Commercialization of Meteorological and Hydrological Services, established at the request of Eleventh Congress by the Executive Council in Resolution 2 (EC-XLIII) — Working Group on the Commercialization of Meteorological and Hydrological Services,

Recalling:

(1) The general policies of the Organization, as set down in the Third WMO Long-term Plan (1992–2001) adopted by Eleventh Congress, which include, inter alia, that Members should reaffirm their commitment to the free and unrestricted international exchange of basic meteorological data and products, as defined in WMO Programmes (Third WMO Long-term Plan, Part I, Chapter 4, paragraph 127),

(2) The concern expressed by Eleventh Congress that commercial meteorological activities had the potential to undermine the free exchange of meteorological data and products between national Meteorological Services,

Considering:

(1) The continuing fundamental importance, for the provision of meteorological services in all countries, of the exchange of meteorological data and products between WMO Members' national Meteorological or Hydrometeorological Services (NMSs), WMCs, and RSMCs of the WWW Programme,

(2) Other programmes of world importance such as GCOS, GOOS, WCRP, and IGOSS, which are sponsored and implemented in cooperation with other international organizations,

(3) The basic role of WMO Members' NMSs in furthering applications of meteorology to all human activities,

(4) The call by the world leaders at UNCED (Brazil, 1992) for increasing global commitment to exchange scientific data and analysis and for promoting access to strengthened systematic observations,

(5) The provision in the UN/FCCC committing all Parties to the Convention to promote and cooperate in the full, open, and prompt exchange of information related to the climate system and climate change,

Recognizing:

(1) The increasing requirement for the global exchange of all types of environmental data in addition to the established ongoing exchange of meteorological data and products under the auspices of the WWW,

(2) The basic responsibility of Members and their NMSs to provide universal services in support of safety, security and economic benefits for the peoples of their countries,

(3) The dependence of Members and their NMSs on the stable, cooperative international exchange of meteorological and related data and products for discharging their responsibilities,

(4) The continuing requirement for Governments to provide for the meteorological infrastructure of their countries,

(5) The continuing need for, and benefits from, strengthening the capabilities of NMSs, in particular in developing countries, to improve the provision of services,

(6) The dependence of the research and education communities on access to meteorological and related data and products,

(7) The right of Governments to choose the manner by, and the extent to, which they make data and products available domestically or for international exchange,

Recognizing further:

(1) The existence of a trend towards the commercialization of many meteorological and hydrological activities,

(2) The requirement by some Members that their NMSs initiate or increase their commercial activities,

(3) The risk arising from commercialization to the established system of free and unrestricted exchange of data and products, which forms the basis for the WWW, and to global cooperation in meteorology,

(4) Both positive and negative impacts on the capacities, expertise and development of NMSs, and particularly those of developing countries, from commercial operations within their territories by the commercial sector including the commercial activities of other NMSs,

Reminds Members of their obligations under Article 2 of the WMO Convention to facilitate worldwide cooperation in the establishment of observing networks and to promote the exchange of meteorological and related information; and of the need to ensure stable ongoing commitment of resources to meet this obligation in the common interest of all nations;

Adopts the following policy on the international exchange of meteorological and related data and products:

As a fundamental principle of the World Meteorological Organization (WMO), and in consonance with the expanding requirements for its scientific and technical expertise, WMO commits itself to broadening and enhancing the free and unrestricted1 international exchange of meteorological and related data and products;

Adopts the following practice on the international exchange of meteorological and related data and products2:

(1) Members shall provide on a free and unrestricted basis essential data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations, particularly those basic data and products, as, at a minimum, described in Annex 1 to this resolution, required to describe and forecast accurately weather and climate, and support WMO Programmes;

(2) Members should also provide the additional data and products which are required to sustain WMO Programmes at the global, regional, and national levels and, further, as agreed, to assist other Members in the provision of meteorological services in their countries. While increasing the volume of data and products available to all Members by providing these additional data and products, it is understood that WMO Members may be justified in placing conditions on their re-export for commercial purposes outside of the receiving country or group of countries forming a single economic group, for reasons such as national laws or costs of production;

(3) Members should provide to the research and education communities, for their non-commercial activities, free and unrestricted access to all data and products exchanged under the auspices of WMO with the understanding that their commercial activities are subject to the same conditions identified in Adopts (2) above;

Stresses that all meteorological and related data and products required to fulfil Members' obligations under WMO Programmes will be encompassed by the combination of essential and additional data and products exchanged by Members;

Urges Members to:

(1) Strengthen their commitment to the free and unrestricted exchange of meteorological and related data and products;

(2) Increase the volume of data and products exchanged to meet the needs of WMO Programmes;

(3) Assist other Members, to the extent possible, and as agreed, by providing additional data and products in support of time-sensitive operations regarding severe weather warnings;

(4) Strengthen their commitments to the WMO and ICSU WDCs in their collection and supply of meteorological and related data and products on a free and unrestricted basis;

(5) Implement the practice on the international exchange of meteorological and related data and products, as described in Adopts (1) to (3) above;

(6) Make known to all Members, through the WMO Secretariat, those meteorological and related data and products which have conditions related to their re-export for commercial purposes outside of the receiving country or group of countries forming a single economic group;

(7) Make their best efforts to ensure that the conditions which have been applied by the originator of additional data and products are made known to initial and subsequent recipients;

Further urges Members to comply with:

(1) The Guidelines for Relations among National Meteorological or Hydrometeorological Services Regarding Commercial Activities as given in Annex 2 to this resolution;

(2) The Guidelines for Relations between National Meteorological or Hydrometeorological Services and the Commercial Sector as given in Annex 3 to this resolution;

Invites Members to provide explanation of the WMO policy, practice, and guidelines to the commercial sector and other appropriate agencies and organizations;

Requests the Executive Council to:

(1) Invite the president of CBS, in collaboration with the other technical commissions as appropriate, to provide advice and assistance on the technical aspects of implementation of the practice;

(2) Invite the president of CHy to continue his work on the issue of commercialization and the international exchange of hydrological data and products;

(3) Keep the implementation of this resolution under review and report to Thirteenth Congress;

Requests the Secretary-General to:

(1) Keep Members informed on the impacts of commercialization on WMO Programmes and to facilitate the exchange of relevant information on commercialization among NMSs;

(2) Report on a timely basis to all Members on those meteorological and related data and products on which Members have placed conditions related to their re-export for commercial purposes;

(3) Maintain effective coordination with IOC and other involved international organizations in respect of joint programmes during WMO's implementation of the practice;

Decides to review the implementation of this resolution at Thirteenth Congress.

1 "Free and unrestricted" means non-discriminatory and without charge [Resolution 23 (EC-XLII) — Guidelines on international aspects of provision of basic and special meteorological services]. "Without charge", in the context of this resolution means at no more than the cost of reproduction and delivery, without charge for the data and products themselves.

2 See Annex 4 to this resolution for definitions.

Annex I Data and products to be exchanged without charge and with no conditions on use

Annex II Guidelines for relations among National Meteorological or Hydrometeorological Services (NMSs) regarding commercial activities

Annex III Guidelines for relations between National Meteorological or Hydrometeorological Services (NMSs) and the commercial sector

Annex IV Definitions of terms in the practice and guidelines