CHAPTER 2

HYDROLOGICAL SERVICES

2.1 INTRODUCTION

Most Hydrological Services operate in the public sector and are therefore influenced by trends in governmental policy and practice. What is more, they work in a rapidly evolving environment characterized by the following factors:

(a) Heightened global commitment to sustainable management of natural resources and the environment, combined with efforts to improve the living conditions of the poor, who generally are the most dependent on natural resources;
(b) An expanding emphasis on the need for integrated water resources management, as pressure on the world's water and other natural resources creates a general awareness that resources must be developed and managed in a sustainable manner;
(c) A seemingly inexorable increase in the impact wrought by natural disasters, particularly floods and droughts. At the same time, risk management is becoming more widely adopted;
(d) Increased investments by Hydrological Services in capital assets and staff retraining, which is the cost of offering new or improved products;
(e) A mounting expectation that public services should be accountable not only to elected representatives, but also to the public at large. Public services should conduct their affairs with efficiency, effectiveness and economy. This expectation can culminate in the threat of litigation when the general public feels let down by government agencies;
(f) Keener competition for resources in the public sector, as governments seek to reduce taxation while meeting rising public expectations;
(g) The growing impact of globalization, which affects Hydrological Services both directly and indirectly;
(h) The impact of socio-economic trends on the day-to-day operations of Hydrological Services, such as the increasing involvement of women in professional activities and the ever-growing use of the Internet or the Web-based delivery of hydrological data and products.

Effective resource management requires accurate information as a basis for planning, implementing and monitoring resources. However, to be fully implemented, integrated water resources management demands a wide range of hydrological and related information, which may not be easily available. In order to obtain such information, a National Hydrological Service (NHS) requires proper institutional development to meet these new challenges and must develop appropriate capabilities and/or establish partnerships or strategic alliances with complementary agencies.

The general public constantly seeks higher-quality hydrological information and products. Such high-quality products and processes can provide a competitive edge for Hydrological Services that are required to compete in the marketplace. Maintenance of verifiable standards are also necessary and thus, as a general rule, a Hydrological Service should make quality management a focal point of its business, and its director should take ultimate responsibility for the quality of hydrological products.

Public agencies are continually required to do more with less, and often are obliged to recover some operating costs and seek commercially profitable projects in order to reduce the burden on the taxpayer.

As a result, the director of a Hydrological Service must constantly monitor changes in its environment so as to provide appropriate responses.

2.2 RESPONSIBILITIES AND FUNCTIONS OF HYDROLOGICAL SERVICES

[HOMS A00]

2.2.1 Nature of the products and services of a Hydrological Service

Hydrological data and information are, by and large, excludable public goods because the marginal cost of supplying the data to an additional client is practically zero, and yet access to the information can be controlled. A Hydrological Service may therefore choose to allow open access to some information, for example, making it accessible on the Internet, which places it irrevocably in the public domain, and to restrict access to other information, for example, only releasing it to selected clients, under strict contractual conditions regarding subsequent release. In this sense, services such as the

issuing of warnings to the public are pure public goods.

A National Hydrological Service can provide hydrological data and information at the national level in a cost-effective way. The implications of this are as follows:

(a) Products or public services, such as public warnings, can only be provided through public funding, because the Hydrological Service concerned cannot easily recover its costs from the beneficiaries;
(b) To obtain or sustain funding from government sources for the provision of both pure and excludable public goods, it is necessary to demonstrate their value or merit to society;
(c) Products or services that are excludable public goods can be provided on the basis of profitability or recovery of costs from the beneficiaries. Authority may be required for such operations. Proper accounting practices, financial transparency and fair charges will be expected;
(d) Boundaries between the management of pure public goods and excludable public goods may shift as a result of, for example, evolving technology, contractual arrangements and public information. A Hydrological Service may be able to influence such boundaries, if it is in the national interest;
(e) When lobbying for sources of funding, managers should review their products and services to ensure that they are in line with the mandate and pricing structure of the NHS.

2.2.2 Clients of hydrological products and services

Who are the clients of a Hydrological Service? In principle, for a National Hydrological Service, the ultimate client is the general public, represented by elected officials at the national, state/provincial and local levels. This includes the general public of the future, who will be the beneficiaries of hydrological work that is being done today.

Governmental policies and national development goals, and the information required to support them, influence an NHS fundamentally. For example, in many developing countries the beginning of the twenty-first century has seen a growing national emphasis on poverty alleviation. The management of a Hydrological Service should monitor governmental policies and analyse the implications of these policies for the individual Service. What products and services will the Hydrological Service need to provide in order to support national policies and goals? Do the Service's current products and services contribute to this? In other words, the management should ensure that the Service's products and services have the greatest possible value. This is best done objectively by means of cost-benefit, cost-effectiveness and poverty analyses, among others. The public's interest may be varied, so that a Hydrological Service may have a variety of clients, in addition to the traditional ones. A Hydrological Service may also offer private services to clients who are prepared to pay for them. The range of such clients will vary from country to country, depending on the nature of the national economy.

The management of a particular Hydrological Service must implement frequent surveys to identify potential clients. The management should continually monitor trends in demand for water, national and provincial policies and development goals, political manifestos, trends and events in various economic sectors, as well as international agreements and agreements with donor agencies and other development partners.

Client expectations of all businesses, including those in the public sector, are rising continually and businesses must continually seek to meet or exceed those expectations. Hydrological Services are no exception. To ensure the future of the Service, managers must encourage a client focus among their staff. The single most important client is the person to whom the director reports, for instance, the Minister for the Environment. The future of a Hydrological Service depends on how successfully the director markets the Service to that person and demonstrates how the Service can be useful to the client.

A marketing strategy should meet the following aims:

(a) Identify the current and potential clients of the Hydrological Service, and maintain and update a client database;
(b) Identify the products and services required by the clients which the Service can provide;
(c) Identify the most suitable mode or place of delivery of the product or service to the client, for example, use of the Internet to provide access to real-time data, fax warnings and conventional written reports with data annexes on CD-ROM;
(d) Determine a pricing policy for different products and services, and for different clients;
(e) Specify the types of people involved in delivering the product or service;
(f) Characterize the processes of product or service delivery according to the needs of the clients;

(g) Promote the Hydrological Services where potential clients can be clearly identified and contacted directly.

2.2.3 Managing relationships with clients

A crucial element of running any business is maintaining effective relationships with clients. Good communication with clients is essential in ensuring that they be made aware of the Hydrological Service's capabilities. Good public relations and honest feedback are necessary for client satisfaction. As members of the general public constitute the bulk of the clientele of a public-sector Hydrological Service, it is essential that the public be kept informed of activities and outputs, and be provided with opportunities for feedback. A Hydrological Service should have a high profile, that is, be visible, and ensure that the public be made aware of its work. World Water Day, held on 22 March of each year, provides such an opportunity.

2.2.4 Hydrological products and services

The basic products of a Hydrological Service are water-related data and information. Data and information are of value for decision-making. Hence, a Hydrological Service might be seen as providing increased confidence or reduced risk to its clients, as they make water-related decisions. In fact, one measure of the value of these data and information is their impact on the decisions that are made.

There is a continuum in the products that a Service might provide:

(a) Water-related data and observations obtained from an observing network. Hydrological database management systems provide basic statistics such as daily, monthly, seasonal and annual means or maxima, which are useful to clients;
(b) Water-related information, such as a comprehensive assessment of national water resources, the statistics of flood events or maps of spatial/temporal trends in groundwater quality;
(c) A monitoring service, designed to provide very specific data or information at a particular location for a particular client, for example, to indicate when the dissolved oxygen concentration downstream from an outfall falls below a specified minimum value;
(d) Knowledge and understanding of water-related phenomena and water resources;
(e) Advice on decision-making, where information is developed into recommendations for responses to certain conditions, for instance, advice on an appropriate response to a contaminant spill on a major river, or on how to respond to an evolving drought.

The management of a Hydrological Service should seek to develop added-value products and services, and to move out of the "data trap", in which the Service merely provides data from which other people extract value. Capacity-building, in terms of staff skills, information management technology, quality assurance and marketing will be necessary. Other changes may have to be made to institutional arrangements as well, for example, permitting a Service to retain the revenue that it generates. The products and services offered by a Hydrological Service have value and therefore are economic goods. Hydrological Service staff should learn to package their products to meet the needs of clients. They should also realize that client needs change with the evolving climatic and economic situation.

2.2.5 Functions and activities of a Hydrological Service

The functions of a Hydrological Service should reflect the products and services required by the client. The *Technical Regulations* (WMO-No. 49) set out the core functions of a Hydrological Service in Volume III – Hydrology, D.1.1, 8.3. These include the following activities: developing standards and quality assurance programmes; designing and operating observation networks; collecting, processing and preserving data; assessing user requirements for water-related data and information; and providing such data and information, for example, hydrological forecasts and water resources assessments.

Hydrologists today need a much broader view of hydrology, including ecological, biological and human-use aspects of the aquatic system. Accordingly, the activities of many Hydrological Services are becoming increasingly diverse as they deal with different types of data and information. Hydrological Services should continually monitor changing demands for water-related data, information and advice so that they can allocate resources appropriately. An early start is always desirable, because baseline measurements and trend information will be required for many purposes in the future.

Special national circumstances might require additional basic activities, such as monitoring river channel erosion and migration, or reservoir sedimentation.

The functions and activities of a Hydrological Service are not fixed in time, but change in response to the evolving needs and expectations of society and according to technological developments. The management of a Hydrological Service should continually monitor changes in its functional environment and assess their implications for the Service. For example, in recent years, the activities of some Hydrological Services have changed significantly in response to the following developments:

(a) Recognition of the hydrological significance of climate change, bringing about a new emphasis on drought monitoring, forecasting of extreme events and time-series analysis;
(b) The near-universal adoption of computer database management systems, leading to the publication of hydrological yearbooks and dissemination of hydrological data and products in electronic form;
(c) Cooperative agreements among the riparian States in transboundary river basins;
(d) Adoption of regional political agreements, with consequent changes and adaptations of standards, regulations and directives to which participating countries must abide, such as the European Union Water Framework Directive 2000/60/EC (EC, 2000), which has brought considerable change to Hydrological Services in both the European Union and potential member States.

In the past, the fundamental activity of a Hydrological Service was to design and operate a basic network of observing stations. This enabled a national assessment to be made of the country's water resources, thus providing a basic set of data to meet future needs for data at all locations and for a wide range of purposes. This also called for the technical capacity to provide estimates at locations for which there were no field data at all.

It is becoming difficult to sustain the concept of a basic national network in many countries. In some countries, promotion of integrated water resources management on a river basin basis, excellent though this concept may be, has led to monitoring efforts being focused on particular applications of data at the expense of national coverage. Therefore, it is important to demonstrate the benefits of a comprehensive, integrated Hydrological Service, in which broadly based data collection is more economical, both in the operation of monitoring networks and data management, as well as in the assessment of water resources.

A Hydrological Service may also engage in the provision of private services. Examples include the following:

(a) Compulsory monitoring of incoming water quality below a wastewater outfall for a factory;
(b) Monitoring of reservoir inflows and power station outflows for a hydropower company;
(c) Water-related data required for an environmental impact assessment for private use;
(d) Provision of information for a private irrigation company;
(e) Groundwater bore monitoring for a water supply authority.

These may require the establishment of special purpose networks or project networks (or individual stations) to meet specific client needs. The client would cover the cost and own the products, which could only be archived or disseminated upon the client's request. The management of a Hydrological Service should seek such opportunities. Special projects have many benefits for a Hydrological Service, including increased revenue, spreading of overhead costs across a wider range of clients, opportunity to develop new skills, heightened profile and support, and increased innovation. The data produced by these activities could also be integrated into information generated from the basic national network.

2.2.6 Evaluation of products and services, and quality management

The final stage in marketing is to obtain feedback from clients on the products and services. There are many ways of obtaining feedback. Perhaps the simplest is a friendly telephone call a few days after the product has been delivered, to enquire whether it has met expectations. More formally, clients may be asked to complete a simple questionnaire. Possibly the ultimate evaluation tool is to arrange a client satisfaction survey. Essentially, the aim of such a survey is to determine the original expectations of the client and measure the extent to which such expectations have been met. One way of ensuring customer satisfaction is to establish a quality management framework guaranteeing the development of products according to precise, replicable and agreed procedures and standards.

Defined standards are an essential basis for quality assurance of a Hydrological Service's products and services. Increasingly, clients require knowledge of the standards that are being achieved by the Service to satisfy their clients. In general, standards may be specified for the procedures that are used by the Service, and for the attributes of the products that

the Service produces. It is important to remember that standards are needed, not only for technical activities related to hydrometric data collection and provision of metadata, but also for all other activities undertaken within the Service, such as finances, staff performance and long-term planning. A review of International Organization for Standardization (ISO) standards for metadata from a WMO perspective can be found at http://www.wmo.int/pages/prog/www/WDM/reports/ET-IDM-2001.html.

Quality management should be carried out in a systematic way. In other words, a Hydrological Service should have a quality management system in place that assures clients that its products and services meet the standards of quality that have been defined for them. A Service may find that operating a well-documented quality management system can also be of great assistance should it become involved in legal proceedings related to its data and information products.

A comprehensive quality management system is often perceived as being expensive to implement. In practice, however, a quality management system should be no different from the data/product management procedures that the Hydrological Service uses to make measurements, convey them to the office, process and archive them, and transmit them to clients. Carrying out these procedures efficiently requires the following:

(a) Documented procedures for each step of the data and information flow;
(b) Defined standards for measurement and processing procedures, the measurements (data) themselves and derived products;
(c) Staff training and overview;
(d) Assigned responsibilities;
(e) Clearly documented data.

These elements of data management are also components of quality management. A comprehensive quality management system might include additional components such as the following:

(a) Verification that standard procedures are being followed, for example, by independent checks on flow-rating curves or field work;
(b) Validation that archived data meet defined standards, for example, by cross-comparison between neighbouring stations;
(c) Documented evidence that all aspects of the system are being consistently monitored, for example, a training record for each staff member.

Although the cost of quality, implicitly high quality, is commonly perceived to be high, the cost of poor quality may well be higher. A Service may discover that observations it had made over several years were worthless because of a hitherto unrecognized fault in an instrument, or that it must completely reprocess a flow record because a weir was incorrectly rated. Such remedial measures incur a much higher cost than would have been involved in initially checking the instrument or the rating.

2.2.7 Legal basis for operations and organizational arrangements

Almost all countries have Hydrological Services that have been explicitly established by some form of legal instrument or that carry out functions that are provided for or are enabled by legislation. However, in some cases, such legislation does not establish a specific agency or even identify a government agency that is required to collect hydrological information in the process of discharging its other responsibilities. In such cases, authority may come from an annual appropriation of funds, rather than the establishment of a law to include hydrological activities.

A great variety of legal or quasi-legal instruments giving varying degrees of authority is possible, for example, a national water policy, statute or law, water code, decree, order or inter-ministerial agreement, depending on the system of government. WMO (1994) provides a number of case studies that show the diverse arrangements that are possible. In many countries, water resources are now managed under the authority of a water law, a law establishing a water sector head office such as the National Water Resources Council, a law on environmental protection, a law on natural resources management, or similar statute. In these cases, the emphasis of the law is on aspects of resource management, such as allocation, resource pricing, or administration of permits. Hydrology may receive only passing reference, perhaps by being granted the authority to collect appropriate information.

There is a marked trend towards establishing river basin agencies that have comprehensive responsibilities for water management, including the provision of water-related information. Such agencies can now be found on every continent. In many cases, these river basins and their agencies are transnational, such as the Zambezi River Authority in Southern Africa. In some countries, there is complete coverage by river basin agencies, whereas in others only the principal rivers are covered. Management of water resources by river basin agencies or by subnational civil administrations introduces a need to harmonize standards,

coordinate data exchange, avoid duplication and assure national interests, for example. These tasks may be assigned to a national head office and carried out by its secretariat, which may be provided by the NHS or be completely separate. Inter-agency coordination and liaison are absolutely necessary in such cases.

The increasing complexity of decision-making in the water sector with a variety of stakeholders and actors, often with conflicting interests, necessitates a clear definition of the roles and responsibilities of each player. Furthering the main aim of integrated water resources management requires that data and information be available to all participants. Therefore, an appropriate legal framework and some form of legal instrument are desirable to provide a basis for a Hydrological Service's operations. In particular, such a legal framework may be needed to provide authority for activities or functions such as traversing private property as part of maintaining a monitoring station; charging fees for the delivery of products or services; requiring other organizations, including those of the private sector, to provide copies of their data for addition to the national archives; or transnational activities or liaison.

When laws related to water are being revised, managers should seek to participate in the drafting process. In particular, they should try to implement measures that have been successful in other countries and attempt to introduce these into their national legislation. Contacts with other organizations, such as WMO and its regional association working groups, will provide useful ideas. WMO publications also provide practical guidance (see WMO, 1994, 2001*a*).

The functions of a National Hydrological Service may be undertaken by a National Hydrometeorological Service, by one main sectoral Hydrological Service or by federal Hydrological Service overseeing various state or regional Hydrological Services.

In a survey of 67 countries carried out in 1991 (WMO, 2001*a*), four principal models were found for organizing Hydrological Services at the national level. Some 51 per cent of those surveyed had national hydrological or hydrometeorological agencies ; 1 per cent, regional (subnational) hydrological or hydrometeorological agencies; 42 per cent, both national and regional hydrological or hydrometeorological agencies; 6 per cent had neither national nor regional hydrological or hydrometeorological agencies.

The organizational arrangements of Hydrological Service are very diverse. Much depends on the legal system, governmental structure and stage of economic development, and successful examples suggest that effective operational hydrology can be conducted under a variety of circumstances. Although managers of a Hydrological Service may have limited influence on organizational arrangements at the national level, they should take every opportunity to participate in organizational restructuring. They should draw on the experience of Hydrological Service managers in other countries in order to propose changes that will help improve the performance of their Service.

At the level of an individual Hydrological Service, the organizational structure will largely depend on the Service's functions, products and activities. As these are always evolving, so too, should the structure evolve.

Managers of a Hydrological Service should draw on the experience of other Services when considering appropriate organizational structures. Extensive information on the relative merits of different organizational models, such as pyramidal structures or flat structures, is always useful.

In a country with several Hydrological Services, defined standards are of particular importance in ensuring comparability of hydrological data and products. A key role of the NHS or lead Hydrological Service is to establish national standards. The same could be said of an international river basin in which there are several NHSs. In this case, a key role for a river basin organization would be to establish standards for the whole basin and assist NHSs in achieving them.

The *Technical Regulations*, Volume III – Hydrology (WMO-No. 49) provides a set of long-established technical standards, as does the ISO Handbook 16 – Measurement of Liquid Flow in Open Channels (ISO, 1983).

The technical standards adopted by a Hydrological Service provide an objective basis for performance monitoring and appraisal. These standards should be incorporated into a Service's objectives.

2.2.8 Managing relationships with other institutions

Water is vital to many sectors of the economy, and many governmental as well as non-governmental organizations are likely to have an interest in water. Indeed, most countries have several organizations

engaged in different aspects of hydrology, with monitoring of surface water, groundwater and water quality commonly the responsibility of different agencies. Even if there is a designated NHS or a National Meteorological or Hydrological Service (NMHS), there are likely to be complex interrelationships among hydrological agencies. As integrated water resources management and river basin management principles become more widely adopted, relationships among water-related agencies will be consolidated.

Key areas of cooperation for Hydrological Services include the following:

(a) Data and information exchange among Hydrological Services under different parent organizations, and with the NHS if one exists;
(b) Cooperative arrangements that avoid duplication and facilitate sharing of technology, for example, through the joint operation of monitoring networks, shared facilities such as instrument calibration laboratories, joint purchasing arrangements for hydrological software or instrumentation, or joint field exercises for quality assurance;
(c) Data and information transfer to client organizations that require hydrological information for resource management or other purposes;
(d) Collaboration with national disaster management agencies and the NMS, so as to provide forecasts and warnings of extreme hydrological events;
(e) Joint projects in research and development with universities or research institutes, where the Service benefits from research and development, and the research establishment benefits from, among others, accessible data, field installations and opportunities for research students;
(f) Cooperation and liaison between Hydrological Services and the NMS for the exchange of water-related and climate data and shared technology for data management.

In most countries, cooperation in the water sector is deemed to be so important for the national interest that a central organization such as a National Water Resources Council is established. The position and authority of such bodies vary widely. In some cases they are largely advisory, with limited power. In others, they are chaired by or report directly to the Prime Minister, and have considerable authority. Hydrological Services always benefit from such arrangements.

Many riparian countries share river basins with others, and the downstream countries, such as Bangladesh, Cambodia, Egypt and the Gambia, are heavily dependent on upstream flows. Ideally, their NHSs should collaborate closely with those of the upstream countries so as to have the ability to forecast flows and issue warnings. River basin organizations, such as the Mekong River Commission (www.mrcmekong.org) and the International Commission for the Protection of the Rhine (http://www.iksr.org/), facilitate such relationships in some river basins, although this is not always so. Unquestionably, a key responsibility of the director of a Hydrological Service in a riparian State is to maintain close working relationships with those holding equivalent positions in the other countries concerned, either bilaterally, or in the framework of river basin agreements administered through multilateral river basin organizations.

A number of international organizations provide considerable assistance to national water resources agencies and Hydrological Services, and directors of Hydrological Services should be aware of the mandates and interests of those organizations.

2.2.9 **Data exchange**

Arrangements for data exchange are of considerable importance to Hydrological Services, including:

(a) The NHS, NMS and sectoral Hydrological Services in a single country;
(b) NHSs in a transboundary river basin;
(c) NHSs in neighbouring countries, with which water resources are not shared, but where data access would facilitate hydrological modelling or analysis;
(d) NHSs and international organizations concerned with global water resources assessment and international data archives;
(e) Hydrological Services working for national projects and to assist the private sector.

In the early 1990s, new technological developments and governmental policies posed a threat to the long-standing free and open exchange of meteorological data. Therefore, in 1995, the WMO Congress adopted 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 – which explicitly excluded hydrological data. Four years later, in 1999, Congress adopted Resolution 25 (Cg-XIII) – Exchange of hydrological data and products (WMO, 2001*b*). This Resolution specifically relates to the international exchange of hydrological data and information products, but the basic principles are applicable at the national level. As discussed in 2.5.2, it is economically efficient to transfer or exchange data under a charging

regime in which only the transfer costs are levied, and this is essentially the principle expressed in Resolution 25 (Cg-XIII). A number of Hydrological Services have experimented with financial arrangements for data transfer in recent years, and the general consensus seems to be that the approach advocated by Resolution 25 (Cg-XIII) is preferred. In practice, the situation is more difficult in transboundary river basins, where issues of national sovereignty and national development outweigh all others. In these circumstances, NHSs can only insist that Resolution 25 (Cg-XIII) be followed.

Many Hydrological Services consider it useful to provide data to educational institutions and international scientific projects at no charge. On the other hand, if the data are to be used for consulting work, there is no reason why a Hydrological Service cannot require payment of a charge based on the cost of obtaining, verifying, storing and transferring the data concerned.

2.3 PLANNING AND STRATEGY [HOMS A00]

Perhaps a director's most important responsibility is to implement the Hydrological Service's planning and strategy development. To successfully respond to changing conditions and demands, a Service needs a director with vision and the ability to implement actions. Planning and strategy development imply change. Few people like change, especially when it is imposed on them, and the managers of a Hydrological Service need skill in managing change. In particular, the organizational culture of many Services may need to shift from one that has a technical focus to one that focuses first and foremost on clients.

Managers of a Hydrological Service need plans and strategies that ensure the Service allocates its resources to achieve its most important goals. Diverse plans of different duration should be formulated to match identifiable goals. A strategic plan will provide a view of the overall direction of the Service, for example, for a period of five years. In times of rapid change, it is difficult to look ahead even five years; therefore the plan would need to be updated regularly. An annual plan sets out the specific intentions and desired results to be achieved during a single year of operation; it is usually associated with a budget. A development plan focuses on the process of building a Service's capacity to carry on its business, and may consider a time period of 10 years or more for this purpose. In addition, there may be plans that focus on particular aspects of the Service's operations, such as a staff training plan.

A comprehensive plan is likely to include some or most of the following elements:

(a) Vision – how we want our world to be;
(b) Mission – the reason for which the Hydrological Service exists;
(c) Principles or values – the fundamental and unchanging beliefs that relate to the work of the Service;
(d) Review of achievements during the last planning period;
(e) Analysis of strengths, weaknesses, opportunities and threats (SWOT);
(f) Goals and desired outcomes – broad statements of what is to be achieved;
(g) Objectives and desired outputs – specific targets: measurable results and standards, together with a time frame;
(h) Actions – specific actions that will be used to achieve objectives and outputs;
(i) Financial budget;
(j) Performance criteria and indicators – measures that will be used to check progress.

A strategic or long-term plan would not specify actions and might include only an indicative budget. An annual plan, however, might briefly summarize many sections from an existing strategic plan and place more emphasis on defining the proposed actions and associated budget.

The above-mentioned list commences with the high-level vision and mission statement, continues with an appraisal of how the Service has performed, an honest evaluation of its condition (the strengths and weaknesses of the Service) and of its business environment (opportunities for new business and threats from competitors or adverse changes in the environment), and then moves on to the specification of actions and the means of measuring whether these have been successful. It is easy to obtain plans from other agencies to develop ideas on appropriate approaches and formats. The *WMO Strategic Plan* (WMO-No. 1028) should, for example, be available to a Hydrological Service director and may be obtained from the WMO Secretariat. Other services in the WMO group are an obvious source of guidance; for instance, the Australian Bureau of Meteorology (1995, 2005, 2006) has plans on a range of timescales, which might provide useful examples for other services.

A Hydrological Service that is a component of a parent organization may have a strictly defined

planning and budgeting format and process to which managers would adhere. However, where there is more freedom, managers should take planning seriously. At times, where resources are lacking and it appears as though the Service receives no recognition or encouragement, planning may seem to be a pointless exercise. However, it is perhaps under these conditions that planning is most necessary to set a positive course for the future and provide an impetus for change.

A plan is not solely an internal document, but is commonly used to promote the Service and as the basis for a performance agreement or contract between the director and the senior official to whom the director reports. In this case, the plan will be negotiated with the senior official, as well as the Service's staff.

Planning procedures are an essential component of management and are dealt with in many textbooks and all tertiary-level business management programmes. Hydrological Service managers should make planning a basic part of their business management studies.

Planning need not be technical or time-consuming, although techniques such as discounted cash flow analysis to select the most promising of several alternative courses of action can be used. It is, perhaps, most important to effectively involve stakeholders in the process, that is, not only senior management, but all the Service's staff, clients and potential collaborators. A mix of a top-down and bottom-up generation of ideas is desirable, facilitated by consultation with clients and other stakeholders. The director and senior management should set the overall direction of the Service, on the basis of their understanding of the wider business and political environment. Other staff may have a more hands-on perspective on strengths and weaknesses, and personal links with clients and collaborators. Commonly, individual departments will make proposals for components of the plan, which will be incorporated, modified or omitted according to the chosen selection procedure.

A useful starting point for appraising the present condition of a Hydrological Service is the *Water Resources Assessment: Handbook for Review of National Capabilities* (WMO/UNESCO, 1997).

Before a Hydrological Service's strategic, annual or other plan is implemented, managers must develop a clear link between the Service's plan and the responsibilities and duties of its staff. It is essential that managers focus the attention of their staff on the results that they are expected to achieve, and not simply on the tasks that they are to carry out.

An essential aspect of planning is appraisal of past performance. In many countries, government agencies are required to provide an annual report to the national assembly of elected representatives, and this provides the ultimate in performance appraisal. Even where they are not required to do so, directors of Hydrological Services should review at least annually their Services' activities, achievements and changing environment. The findings might be presented in different ways and degrees of detail for various audiences: for elected representatives and clients, brief, focusing on contributions to national life; for staff, detailed, highlighting technical and product/service matters; and for management and planning staff, comprehensive, including an analysis of deficiencies and adverse changes in the environment.

Appraisal of the performance of the entire Hydrological Service provides the basis for identifying its strengths and weaknesses, and for developing a plan that builds on these strengths and eliminates any weaknesses. Managers should appraise the Service's performance in terms of the performance criteria and indicators previously defined by the plan, and should consider how successfully the Service is achieving its vision and mission and governmental policies and goals. Feedback from public- and private-sector clients alike is an invaluable element of performance appraisal. A Service that delivers products that are technically first class but contribute little towards achieving governmental goals or meeting commercial clients' needs is unlikely to receive consistent support or funding for future planning periods.

2.4 HUMAN RESOURCES MANAGEMENT AND CAPACITY-BUILDING

[HOMS A00, Y00]

2.4.1 Management

Most organizations consider their most important resource to be their staff. This is true and managers of successful Hydrological Services know this well. As the role and functions of a Hydrological Service evolve, the staffing requirements and management style of the Service may need to change as well. Hence, a Service that is modernizing or developing value-added products, for instance, is likely to require more staff skilled

in information technology. Such staff will perform their tasks differently from staff with traditional field skills and will require different levels and styles of supervision.

The long-term success and health of a Hydrological Service rests in the hands of the director and managers. To discharge their responsibilities effectively, they require skills in a number of areas. The director should ensure that the entire management team has the following assets:

(a) Diplomatic and administrative skills to function successfully in the public service environment or as a State-owned company;
(b) The ability to monitor and understand the business environment and translate it into planning the Service's programmes;
(c) Skills in all areas of business management – human resources, finances, capital assets, product quality, information technology – as appropriate to the Service;
(d) Leadership skills and motivation;
(e) Marketing and communication skills that are needed to develop effective relationships with clients, the public and elected representatives, investors/donor agencies and the "owner";
(f) Technical and scientific knowledge required to ensure that the Service has the technology it needs;
(g) The ability to represent the Service and the national interest at an international level.

The director should place as much emphasis on management training as on technical capacity-building.

If indeed staff are the most important resource, managers should select staff with great care. They should appoint or reassign staff to meet the demands of the Service's strategic and annual plans so that work groups have the human resources needed to achieve their assigned objectives. A director should take staff succession seriously, that is, identification and preparation of junior staff to advance to more responsible levels as senior staff retire. A combination of experience and training will be needed to suitably prepare such staff.

A contract between the Hydrological Service and an employee is an essential basis for effective and fair human resources management. Legal requirements with regard to employment contracts vary from country to country, and managers of Hydrological Services should be familiar with the employment-related legislation under which they operate. For a Hydrological Service that is a parastatal or state body, the form of contractual arrangements for employees is normally specified by national civil service regulations.

The Director of a Hydrological Service that lacks closely specified arrangements for employee contracts should seriously consider developing them. The main benefit of a contractual agreement, for both employer and employee, is that the relationship is specific and transparent, allowing any shortcomings on either side to be addressed in an objective manner.

A job description for every staff member is an essential management tool. It provides both a clear statement of what the Service expects of the individual and a basis for setting personal objectives, implementing performance appraisals and identifying training and personal development opportunities.

Job descriptions and objectives provide the basis for the appraisal of staff performance, which is on a par with planning and strategy development in terms of importance to the managers and staff of a Hydrological Service. In many organizations, performance appraisal is linked to preparation of staff development plans for individual staff members, for work groups – for example, a work group that is expected to take on new responsibilities – or for the entire Service. Staff development plans will be used for future performance appraisals, in part to ensure that proposals have been implemented and to evaluate their success as tools for enhancing performance.

When human resources management tools such as job descriptions, setting of objectives and performance appraisal are introduced, staff members can be resistant and sceptical. However, a manager will find that they will be more likely to cooperate if tools to enhance their prospects are used sensibly, constructively and persistently over a period of one or two years. It cannot be overemphasized that management tools must be used with understanding; if not, they are likely to be of little value, and even counter-productive. This implies that the director and managers of a Hydrological Service should ensure that their own performance meets the Service's needs.

2.4.2 Training and continuing education

Training and continuing education are of critical importance to both management and staff, the collective goal being to enable staff members make the greatest possible contribution to achieving the Service's mission. Training and education should

be managed in a structured way, possibly by preparing a training plan for the Service or for individual staff members. It should correspond to training needs analyses that are part of the performance appraisal process. These analyses may also be carried out independently, for example, when managers are considering new procedures, products or services, organizational restructuring or some other response to the changing business environment, and when there is a need to match current competence with that of the past.

2.5 FINANCIAL AND ASSET MANAGEMENT [HOMS A00]

Financial management has become a basic aspect of a director's work, as governments worldwide impose more stringent financial disciplines. Normally, financial management procedures are defined by a Hydrological Service's parent organization, and the director and/or selected management staff receive appropriate training in these procedures. Nevertheless, a director should make every effort to develop a much more sophisticated grasp of financial management than the basic minimum.

Accounting procedures in the public sector are generally prescribed by government and a Hydrological Service that is part of a government department or State-owned enterprise will have to follow these scrupulously. This is to ensure transparency and accountability, that is, to make sure that the Service's financial accounts are clear and comprehensible, resources are spent for the designated purpose, responsibilities for financial transactions can be identified and funds are not siphoned off through corruption – unfortunately a fact of life in developed as well as developing countries.

2.5.1 Sources of revenue

A major concern of managers of a Hydrological Service – indeed, of any organization – is the source of income or revenue required to maintain the Service's operations and assets. In most countries, the government has been and will continue to be the predominant source.

The recent trend worldwide is for governments to require or enable public sector agencies to find sources of commercial revenue in addition to allocations from the national budget. Some Services have made significant progress in identifying non-governmental clients or willing clients within the public sector. Value-added products and services are the most profitable. A Service should focus its energy on seeking new sources of revenue only in areas that are consistent with its primary mandate and where a good, that is, profitable, business case can be made.

Commercial work requires a legal mandate, and the managers of Hydrological Services that engage in commercial activities should be familiar with national laws and regulations relating to commerce.

In most countries, there are relatively few non-governmental clients for value-added products that are potential sources of considerable commercial revenue. This is especially the case in developing countries where the pressure on a Hydrological Service to find supplementary sources of revenue is also likely to be greatest. Most of the products and services of a Hydrological Service, and the databases and other assets that are needed to provide those products and services, are, however, public goods for which the government is the logical purchaser. A Hydrological Service may nevertheless be required to recover some of the costs of its public services and products.

Economic theory indicates that the appropriate approach to cost recovery is to charge for the direct and associated overhead costs of providing the product or service, including the administrative cost of recovering costs, as well as depreciation of the assets used. Where the product or service uses a hydrological database or other asset provided at public expense, it is economically inefficient to attempt to charge part of the cost of providing that asset. Potential clients strongly object to such charges and refuse to use the service at all. This results in underutilization of the public asset, the use of inferior alternatives such as guesswork and hence economic inefficiency. The experience of Hydrological Services that have attempted to charge for data generally confirms this. Increasingly, it is regarded as preferable to provide unrestricted public access to data via the Internet at no charge. This reduces the cost of meeting data requests and can help enhance the Service's reputation.

As a means of imposing financial discipline and achieving maximum transparency, a government may choose to administer funds in ways other than making an allocation in the national budget. These include:

(a) Providing funds through a non-governmental organization such as a National Research Council, which allocates funds on a competitive basis and/or in terms of defined national needs for information;

(b) Establishing the Hydrological Service as a State-owned enterprise and administering public funds on the basis of a contract for defined outputs and services. In the extreme, the contract could be awarded on a competitive basis, potentially to another provider;
(c) Introducing a government contract between the appropriate Minister and/or the Minister for Finance and the director of the Hydrological Service, to provide defined outputs and services.

The director of a Hydrological Service is unlikely to have much influence on such a decision, which will reflect overall government policy. However, the director should seek guidance from other directors in similar circumstances, either in other organizations in the same country or Hydrological Services in other countries, and attempt to negotiate contractual arrangements that provide the most favourable conditions for future work.

Lastly, it is worth recalling that a way of increasing effective revenue is to reduce costs, for example, by moving from paper-based to Internet-based dissemination of information. Of course, the Service should ensure that the quality of the product or service does not suffer, but is preferably enhanced from the user's perspective.

2.5.2 Budgeting and monitoring financial performance

Budgeting should be an integral part of annual planning. As the Hydrological Service defines its proposed programme of objectives and activities, it will need to define the associated costs and, through an iterative process, revise the proposed programme so that its cost is consistent with likely revenue. Just as it is desirable for operational staff to be involved in annual planning, so too should they be involved in setting the budget. They will, after all, have to work with and within it.

As a rule, Hydrological Services that are parastatal or state bodies, budgeting procedures and timetables are strictly defined. The annual planning process must therefore be timed accordingly. The Hydrological Service is likely to be required to submit its budget in a defined format to its parent organization, in terms of specified line items in a chart of accounts. The managers of the Service should ensure that the internal process of preparing a budget provides an end result that can readily be converted into the required format, but may prefer to use a format that is more appropriate to the Service's business or simpler to use.

The completed budget should be a key component of the annual plan and a means of monitoring performance against the plan.

2.5.3 Asset management

In simple terms, the purpose of asset management is to ensure that the value of the organization's assets is maintained, and therefore that the organization continues to be a going concern that has the resources to do business. Therefore, it is of considerable importance to all managers and staff of a Hydrological Service. Asset management basically involves acquisition, replacement, maintenance, protection and disposal of assets.

2.5.4 Database security

A Hydrological Service's single most important asset is its database. Means of protecting this asset will depend on the data storage media that are used, but there is no doubt that the director of a Service must ensure that it is protected. In a number of countries, data rescue projects have been necessary to gather together all data – original records, usually on paper – place them in a secure location and convert them into an electronic format that is more manageable on a long-term basis. Such projects, admirable though they may be, should become necessary only under circumstances completely beyond the control of the Hydrological Service. There can be few excuses for a director who allows his Service's basic asset to be degraded.

Paper media, for example, observers' notebooks, recorder charts and machine-punched tapes, are invaluable because they usually provide the original record that must be consulted if questions arise about data validity, or if data reprocessing is required for some reason. They should be stored in such a way that they will be subject to the smallest possible degree of damage by insects, water, rot, sunlight, fire, earthquake or simple loss. Original records should be the responsibility of a single office; if such an arrangement is not possible, however, the same person in each office in which the records are stored should be responsible for them. Whatever the case, the location of original documents should be carefully tracked, for example, if they are released for reprocessing. If a Hydrological Service does not have the facilities or expertise to permanently archive its paper media, the national archive, museum or library may be able to assist.

As paper media are subject to deterioration, copies should be made. Commonly, microfilm or

microfiche copies are made, but the obsolescence of this technology presents difficulties for the future. Electronic storage of scanned images is now an economical alternative, using CD-ROMs or other even higher density media. In this case, technological obsolescence is perhaps an even greater concern than microfilm; thus the Hydrological Service will need a procedure for regular migration of electronic archives onto successive generations of storage media.

The secure long-term storage of original and processed records in electronic form, for example, incoming telemetered data, or an entire computer database, requires procedures that are not so much sophisticated as disciplined. It is essential to make regular, frequent backups of data, following rigorously defined procedures so that data are not lost before they reach the archive, and to make liberal comments on archived data so that subsequent users can understand any changes that have been made.

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