

WMO QUALITY MANAGEMENT FRAMEWORK-HYDROLOGY¹

Why Quality Management Framework - Hydrology?

Reliable hydrological data and information are key inputs to the sound and wise management of water resources. Particularly under the changing paradigm of Integrated Water Resources Management, where decisions are increasingly being made through a consensual approach including relevant stakeholders, it is imperative that reliable data and information be accessible in a timely manner to facilitate informed decision making. The value of such data and information increases when they are provided through organization(s) that value and adhere to quality management principles.

Decisions in various sectors of the economy are becoming increasingly dependent on hydrological information. Depending on a particular country's circumstances it is possible that various agencies may be involved in hydrological data collection within a basin. Lack of standard procedures of obtaining measurements, storage of data, data manipulations, and protocols for data and metadata exchange, as well as acceptable analytical methodologies for transferring data into information, may often result in the generation of conflicting information, data and products being made available among various sectors, administrative regions, and diverse users. Such a situation can lead to disagreements, generate reluctance to cooperate and can undermine the importance and credibility of the work of the NHS. In transboundary basins, the equation evolves into another level of complexity requiring assurance and compatibility of the quality of data and products.

Given the uncertainties associated with the hydrological processes and the impossibility to eliminate them in the data and information production, it is useful to make the clients aware of these uncertainties. Further, research on the Global Water Cycle and impacts of increasing climate variability and potential climate change on the availability of water resources requires the sharing and use of data from many countries. It is important that in such analyses the data be compatible, comparable and of known assured quality.

Quality Management Framework and National Hydrologic Services

With a view to achieving their mission and strategic directions, the NHSs have to ensure that their core activities of hydrological data acquisition and delivery of services and products are working efficiently and effectively. It is also beneficial at the same time to have in place quality management approaches so that assurances can be given that the stated quality of the data are being attained. Implementation of quality management systems will assist NHSs in the provision of good management practices and ultimately will enhance confidence in the quality of their data, products and services (ICTT QMF, 2007)². This may build confidence in the NHS

¹ [Annex 1 to Resolution 1 of CHy-XIII, held in Geneva, Switzerland, 4-12 November 2008.](#)

² Inter-Commission Task Team on Quality Management Framework (ICTT QMF), Report of its Second Session, WMO, Geneva, 15-17 January, 2007.

with their clients, users and stakeholders, possibly resulting in the additional benefit of raising awareness on the need for financial and human resources to manage and operate the NHS.

It is worth noting that quality management is useful to a NHS even if there is no intention of the Service to enter into a formal certification process, as the adoption of quality management principles, approaches and practices facilitate the efficient and effective management and operation of a Service. Therefore, NHSs from developing or developed countries that may not have sufficient funds needed for third-party certification would still greatly benefit by adopting quality management principles.

What is the WMO Quality Management Framework (WMO QMF)?

The essence of the WMO QMF is to provide an overall strategy, advice, guidance and tools for the Member NMHS to attain quality, efficiency, and effectiveness in its functioning. The WMO QMF would enable the provision of continuing relevant advice to WMO Members on developing their individual Quality Management Systems (QMSs), thereby providing a mechanism for their further improvement. It is meant to complement and assist with the implementation of national QMSs developed/ to be developed by NMHSs. The role of the WMO QMF is, therefore, to enable and support a process of continuous quality improvement in Member countries. It would include the following distinct though related elements:

- WMO policy statement;
- WMO technical standards including Volume IV of WMO Technical Regulations;
- Catalogue of technical publications/standards as potential contributions to QMSs;
- Guide on quality management to assist NMHSs in the design and implementation of QMSs; and
- Training of quality managers, practitioners and NMHSs decision makers.

QMF-Hydrology, within the overall WMO-QMF, would mainly address the hydrological needs of the Members. It would however, adopt the elements of weather and climatic observations from the WMO QMF.

National Quality Management Framework

In the case of hydrology it is common to have multiple organizations perform similar activities with different objectives or at different geographical scales. At the same time, overall responsibility for maintaining and improving the quality of hydrological observations, products and services may rest with a central authority, typically referred to as the NHS within the country. Such a central authority should strive to establish and support the quality-related structures and processes to be adopted by the Hydrological Services (HSs) operating at various geographical and administrative levels within the country, including in the private sector, if it is possible to do so.

To this end it is expected that the NHS and each entity involved in the provision of hydrological data, products and services in a country or a basin would establish a QMS, to support continuous improvement process aimed at all activities related to the provision of hydrological data, products and services, including the quality system itself. An authorized organization, normally the NHS, should be able to guide such a process by defining the national QMF. In other words, in the case of a country with multiple hydrology-related organizations, the NHS would be responsible for the national QMF, with each HS developing and adopting its own QMS under the umbrella of the national QMF.

The National QMF has to be underpinned by an agreed upon statement articulating the objectives, policy and values of the NHS concerning the maintenance and improvement of the quality of hydrological information that it provides. It is important to ensure that policies and objectives are relevant to the stated policy of the NHS, and in consonance with the circumstances and environment of the country.

Typically, the compilation and documentation of the quality system is undertaken through a Quality Manual, which forms an important part of the process of building, consolidating and clarifying the quality management framework. Describing the framework in a single document helps reflect a coherent and integrated overall quality management strategy. The manual, in addition to the details of the specific elements of the quality system, should describe the broader content of the quality management system, including policy, objectives, organization, quality improvement, and integration and service standards. This manual may also show linkages to the WMO QMF and WMO publications. This document could also summarize what actions have been taken to satisfy the requirements of a QMS based on ISO 9000 requirements or a similar system.

What is a Quality Management System (QMS)?

“A quality management system is a management tool consisting of a set of rules to direct and control an organization with regard to quality, which is intended to assist in establishing policy and objectives and in achieving those objectives. It is a dynamic process that brings resources, activities and behaviour together to focus on the achievement of success”.

(WMO, 2006, p. 36)³

A QMS should exist in the context of the policy and structures of its QMF. The country specific QMS would reflect the current political, administrative, legal and socio-economic environment within which the HS(s) operate(s).

To support a complex professional service like a Hydrological Service, QMS must incorporate specific operational elements of quality assurance through establishing the acceptable practices and exercising control checks on these practices, which together constitutes a QMS. Such a

³ [WMO. Guidelines on the Role, Operation and Management of National Hydrological Services. Operational Hydrology Report No. 40, WMO-No. 1003, Geneva, 2006.](#)

QMS operates to control the quality and standards throughout the business process and supports the staff engaged in various activities in achieving the objectives of quality policy. To achieve this, it is necessary to define clearly the responsibility, authority, and interrelation of all staff who undertake work that affects the quality of data, products and services, as well as the approaches and verifications that are established within the system.

The quality management system guides the entire process leading to the quality of the final data, products and services. It should also be extended to include the other activities undertaken by the NHS such as accounting practices, performance appraisals and other non-technical matters. The QMS would ensure the ability of the NHS to accurately and reliably inform “clients that its data, products and services meet the standards of quality that have been defined for them” (WMO, 2006, p.36)⁴

The key principles of any quality management system should include the following:

- quality is built into the data/observation and information production process rather than relying on post-production audits or checks;
- responsibilities for each player in the process are clearly defined and properly communicated;
- existence of an efficient results-focused control process (Too many controls results in no control);
- stakeholders involvement in performance assessment; and
- participation of the practitioners in the continuous evolution of the quality management system.

Continuous improvement activities form part of every quality management system. There are many possible mechanisms for quality improvement and each HS will need to develop approaches best suited to its own circumstances. A continuous improvement process typically contains six activities that operate in an interactive manner. They are:

- formal documentation of standards and expected practices;
- development of activities that build staff awareness of standard procedures and expectations;
- assessment of product or process quality against set indicators;
- studies to propose improvements in practices;
- development of an inventory of improvement initiatives; and
- identification and documentation of lessons learned.

Role of the CHy within the WMO Quality Management Framework

The Technical Commission for Hydrology is expected to contribute to the overall WMO Quality Management Framework that is specific to NHSs, particularly with respect to further

⁴ [WMO. Guidelines on the Role, Operation and Management of National Hydrological Services. Operational Hydrology Report No. 40, WMO-No. 1003, Geneva, 2006.](#)

development of Volume IV on Quality Management within the Technical Regulations. These contributions would help address processes and procedures that are inherent to hydrological data/observations, products and services. These contributions would provide documentation (regulations, guides, and manuals on technical standards), advice and guidance to NHSs that would be of utility in the formation of their QMS within their country.

The Commission for Hydrology will develop guidance material to assist NHSs in the development of their QMS. This material would provide an organized system to ensure national consistency in the progressively more common cases of decentralization, partial or complete privatization and outsourcing of functions related to the acquisition of hydrological data, products and services. An initial effort would be made to further develop and document quality assurance and quality control procedures common to various NHSs. Efforts would be made to develop training materials in close cooperation with the Regional Associations' Working Groups on Hydrology.

How would the WMO QMF- Hydrology be established?

There would be three broad categories of potential focus of CHy with respect to QMF, plus one cross-cutting aspect related to training. These would include:

- documentation on approaches to QMS and guidance on its adoption and implementation, including guidance on documenting procedures used by a NHS and documentation of the attributes of the products that the NHS produces including its level of quality;
- documentation and guidance on management of NHSs (e.g., WMO Operational Hydrology Report "Guidelines on the Role, Operation and Management of National Hydrological Services")
- documentation on technical approaches for the provision of hydrological data, products and services; and
- development of training modules and materials.

CHy with its long and successful history of developing and promoting various Technical Guidance Documents (TGDs) would undertake to develop the required guidance documents. Such TGDs could form the building blocks of the QMSs of NHSs. These documents would be categorised as:

- *Technical Regulations,*
- *Guide to Hydrological Practices,*
- *Manuals,*
- *Guidance Material: Guidelines, and*
- *Technical Documents.*

Information on some of the relevant TGDs, currently under revision is given in Table 1. In the formulation of guidance for NHSs on approaching QMF and documentation of technical

approaches within the QMF, the CHy would make use of the existing “best technical practices (BTPs)” and approaches that have been developed by other organizations and take advantage of the ISO standards. The [Working Arrangement](#) with the International Organization for Standardization (ISO), which includes the subject of hydrology, would be used for the preparation of joint standards as outlined in it. CHy would keep the options open for possibility of working jointly with other organizations that promote the development of standards in hydrology.

CHy would advance the use of definitions adopted by ICTT QMF when considering activities and processes within the provision of hydrological data, products and services. The ICTT QMF defines a process as a set of interrelated activities, which transforms inputs into outputs. Each of the processes could in turn consist of sub-processes and activities or steps that are necessary to arrive at the observation. The TGD for the specific process would inherently consider and possibly articulate various approaches to sub-processes and their interactions in arriving at an “observation.”

For example, Hydrological Observations would consist of the following components and processes:

- Hydrometry: Measurements of:
 - Stage
 - Velocity
 - Water Temperature
 - Suspended sediment concentration and bed load
 - Water quality (surface water and groundwater: diverse variables)
 - Soil moisture
 - Groundwater level
 - Rate and volume of groundwater abstraction
- Climatological observations for hydrological purposes:
 - Precipitation (diverse variables)
 - Snow cover (diverse variables)
 - Snow water equivalence
 - Air temperature
 - Wind speed and direction
 - Solar radiation

Apart from observations, some hydrological processes are usually considered by practitioners to be derived using observations combined, at times, with the use of models and judgment. Some examples of these would include, but are not limited to, aspects such as the estimation of actual evaporation, rates and volumes of ground water recharge, and stream flow (discharge). The derivation of discharge data includes aspects such as data processing and storage (including the derivation of rating curves and their adjustments, and the conversion of stage into discharge).

The provision of hydrological forecasts, which includes in general stream flow forecasting and specifically flash flood forecasting, flood forecasting, low flow forecasting and flow forecasting, could be considered as hydrological products. Other commonly developed hydrological products result from “secondary data processing.” Examples of these include low and flood flow frequency analyses, and the estimation of probable maximum precipitation and probable maximum flood. These, at times, form important aspects of hydrological products and services provided by NHSs. Products of this nature could be covered by the QMS of a NHS.

Table 1: Examples of WMO Technical Guidance Documentation and their Current Status

Title	Latest edition	Form of availability	Web-link if available	Target date for update, if possible	Group overseeing up-dating of the document	Whether it contains standard procedures, standard practices
Technical Regulations Volume III - Hydrology WMO No 49	2006	Printed and electronic	N/A	-	CHy Advisory Working Group	Yes
Guide to Hydrological Practices WMO No 168	1994	Printed and electronic	http://www-cluster.bom.gov.au/hydro/wr/wmo/guide_to_hydrological_practices/WMOENG.pdf	Nov. 2008	CHy Advisory Working Group	Yes
Manual on stream gauging WMO No 519	1980	Printed	N/A	June 2009	OPACHE on Basic Systems	Yes