The imperative of water resources assessment

by Harry F. Lins*

Introduction

As populations grow and economies expand, competition for water to meet household, municipal, agricultural and industrial needs continuously increases. Moreover, laws and regulations aimed at keeping water in rivers and streams to meet environmental and recreational objectives are similarly increasing. Meeting the fundamental needs for water and reconciling the frequently opposing requirements and interests associated with it, necessitates stable and extensive water-monitoring operations and a commitment to water resources assessment. Indeed, water resources assessment is a prerequisite for the sustainable development and management of water resources throughout the world.

The term “water resources assessment” refers to the continuing determination of the location, extent, dependability and quality of water resources, and of the human activities that affect those resources (Young et al., 1994). Batchelor et al. (2005) describe it further as “a systematic study of the current status and future trends in both water resources and water supply services, with a particular focus on issues relating to availability, accessibility and demand”. Whether one is concerned with irrigation, flood loss mitigation, urban and suburban drainage, energy production, industrial and domestic water supply, health, drought mitigation or preservation of aquatic ecosystems, water resources assessment is essential to the planning, design, construction, operation and maintenance of reliable water systems.

Although the concept of water resources assessment appears relatively straightforward, its comprehensive implementation is complex and difficult to achieve. Young et al. (1994) identify several conditions that are requisite to the establishment of a sound basis for water resources assessment, including: a supportive institutional framework; an effective and efficient system for monitoring water quantity and quality, both on the surface and in the ground; a modern and flexible system for storing, retrieving and disseminating the monitored data; a coordinated and hierarchical approach to research and development; and the establishment and support of a cadre of well-trained water resources professionals.

Supportive institutional framework

Although national assessment of water resources is the responsibility of the national government, many elements of such an assessment are undertaken at the provincial (state), and local government level. In most countries, responsibility for water resources assessment tends to be divided among several national ministries and departments and provincial agencies. This segmentation of roles complicates the assessment process and highlights the need for close coordination among the various organizations involved in the monitoring, storage and analysis of the various assessment data. A successful strategy for conducting water resources assessment will generally involve a governing regulatory framework, as well as appropriate administrative and fiscal decision making processes.

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If there is magic on the planet, it is contained in the water.

Loren Eiseley
Ideally, and for optimal national implementation, the framework should consider the following activities (ICWE, 1992): establishment of a national policy, a legislative framework, economic instruments and regulatory arrangements; establishment of institutional arrangements necessary for effective and efficient collection, processing, storage, retrieval and dissemination of surface- and ground-water quantity and quality and water-use data; establishment and maintenance of effective cooperation among the various agencies responsible for collecting, storing and analysing hydrological data; and verification that the assessment information is utilized in the development of water-planning and management activities.

**Water data collection and storage**

Monitoring of the quantity and quality of surface- and groundwater, at an appropriate frequency and for a suitable period of time is the most fundamental component of water resources assessment. Yet, as pointed out by Lins (2008), the development and maintenance of high-quality national hydrological data collection networks are being undermined by widespread declines in monitoring stations, particularly long-record stations. In addition, disparities in the characteristics of how water information is stored and made available can confound assessment efforts.

The need exists for integrated monitoring and information systems to be established and for data to be collected and stored on all aspects of water resources. These include, in addition to hydrological data, geological, climatological, hydrobiological, hydrochemical and topographic data, soil, land- and water-use data, as well as sewage discharges, point and non-point sources of pollution and constituent loads discharged into coastal oceans.

The capability of collecting and storing hydrological data varies considerably from country to country and no country has a perfect arrangement. Some problems, however, are pervasive: observing networks that are too sparse, too few hydrological variables being measured or record lengths too short for many assessment tasks. In some instances, the lack of data is so acute that the planning of long-term sustainable development is severely compromised.

**Data and information dissemination**

No less important than the collection of water data for water resources assessment is the archiving and dissemination of water data. Those preparing assessments must be able to access the wide array of hydrological and related data needed to evaluate water availability and trends and to do so in such a way as to simplify the data-analysis process.

Increasingly, National Hydrological Services and related organizations are developing water information systems to meet these needs. To be most useful, water information systems should be geo-referenced; composed of subsystems associated with surface- and groundwater and water quality and use; enable information retrieval via the Internet; and have free and open distribution. In most countries, however, the broad
array of water data is not stored within a single database and maintained by a single agency. Where multiple organizations maintain the required data, the goal should be to develop a water information portal to provide a single point of entry for quickly assessing and accessing the data needed for the assessment.

Water science research and development

Water science and related technology has been essential to the development of national infrastructures that provide safe drinking-water, agricultural irrigation, hydropower, flood control and navigable waterways, as well as improved water quality through waste-treatment technology, protecting and enhancing habitat for aquatic organisms and enhanced recreational opportunities.

Scientific concepts and technological tools are used to measure the water supply, expand choices for water use and reduce the uncertainty in water availability and quality. New measurement techniques, innovative observational network design, improved means for data access and improved water-supply forecasting are helpful developments. So, too, are predictions of water availability over time, particularly when accompanied by estimates of their reliability. Advances in biotechnology and nanotechnology and creative uses of low-quality water increase water-management options.

New frameworks for conceptualizing and dealing with the complexity of water availability, quality and management issues consider the interactions of various physical, chemical, biological and societal elements. Effective strategies for accommodating multiple competing demands require quantitative methods to compare options and assess the trade-offs among them. With adequate tools to model these complex systems, decision-makers will be able to assess consequences of specific policies and decisions under a broad range of potential conditions. This will help countries use existing infrastructure more effectively, and focus on expanding engineered and natural infrastructure where it is most needed.

Some important principles for guiding the development of the science and technology needed to support water resources assessment

- Advances in water science and technology should be applied at national, provincial (state) and local levels; inform and be informed by private sector developments; and be used to provide safe, reliable water supplies;
- Scientists and managers must employ a systems approach to freshwater withdrawals, use and disposal that considers physical, chemical, biological, social, behavioural and cultural aspects;
- Water law, economic incentives, public awareness, public education and sensitivity to differences in value systems are cornerstones of effective water resources management.

Human resources development

Water resources assessment is predicated on the existence of a cadre of well-trained and motivated professionals in sufficient numbers to undertake the activities described earlier in this report. To this end, the need exists to establish and strengthen education and training programmes on water-related topics, within an environmental and developmental context, for all categories of staff involved in water resources assessment activities, using advanced...
educational technology. National and local water agencies must also develop sound recruitment, personnel and salary policies. Similarly, water-use efficiency at the local level can be improved by strengthening the managerial capabilities of water user groups, including women, youth, indigenous people and local communities. Importantly, the conduct of water resources assessment requires an enabling environment at all levels.

Conclusion

Water resources assessment is a prerequisite for sustainable development and management of water resources worldwide. It provides a basis for the sound and proper planning, design, construction, operation and maintenance of projects associated with irrigation and drainage; mitigating flood losses; industrial and domestic water supply; urban and suburban drainage; energy production; health; agriculture; fisheries; drought mitigation; and the preservation of aquatic ecosystems. Water resources assessment, under various names (e.g. water accounting, water resource audits, water census) are being increasingly promoted as a key component of integrated water resources management.

References


Lins, H.F., 2008: Challenges to hydrological observations, WMO Bulletin, 57 (1), 55-58