The changing water resources monitoring environment in South Africa

W. Nomquphu[a*], E. Braune[b] and S. Mitchell[c]

Fundamental reform of water law, introduced to South Africa through the enactment of the National Water Act of 1998, has major implications for monitoring water resources and information management. Previously, water resources management was highly centralized and largely supply driven. The new legislation is intended to promote equity, sustainability and economic efficiency, partly through devolved management. Monitoring, previously intended to support the development and operation of the national water infrastructure, now focuses on compliance with resource quality objectives, management targets and water use licence conditions at national, regional (catchment) and local levels. A new phase of management practice is envisaged in which water resource monitoring will require much greater attention to the interaction between the status of water resources, the effects of human activities and the response of management to the results of the monitoring process. Such integrated monitoring will need to cover the traditional fields of surface and groundwater quantity and quality, but will also include an increasing focus on the air and land phases of the hydrological cycle and the various human impacts. These new initiatives will require fresh approaches to appropriate governance for the crosscutting management of information. The Act provides for greater coordination, and various models to achieve this are emerging at local and regional level. Various partnerships and an action-learning approach are seen as essential elements of integrating different disciplines, institutions and business processes.

Introduction

South Africa is richly endowed with mineral wealth, which is responsible for most of the country's economic development. With an average annual rainfall of 500 mm, the nation's water resources are limited, with almost 60% of South Africa being categorized as semi-arid to arid. Rapid industrialization and high population growth have placed enormous pressure on the limited water resources,[1] to the extent that almost all important rivers have large and small reservoirs and interbasin transfer systems.[2] Thus, historically, the country has focused on controlling the natural water system to address the lack of water for agricultural and industrial development. Very little attention was paid to the effect of these development activities on the natural environment, including the water environment. The country's world-class hydrological monitoring programmes were focused mainly on surface water quantity and, to a lesser extent, on water quality for the purpose of water supply and infrastructure management.[3]

It is widely known that economic development has led to the gradual degradation of the nation's water resources system, but the extent and rate of water quality decline has not been consistently and systematically measured. Steps towards documenting the response of the water environment to human impacts was established through the ecosystem programmes of the Foundation for Research Development[4–6] and, later, the water quality research programmes of the Department of Water Affairs and Forestry (DWAF).[1,7,8] These programmes laid a scientific foundation for improved water resources management and also for a more systematic monitoring of these resources.

The water law reform legislation of the 1990s focused strongly on ensuring the equitable and sustainable use of this increasingly scarce resource. This entrenched the need for an integrated assessment of water resources to include often competing, human needs and environmental sustainability. The implementation of a holistic approach requires extensive revision of traditional management practices and institutions. This paper provides an overview of the steps taken by DWAF to establish appropriate monitoring programmes and governance structures. These will provide input into the coordination of environmental monitoring in South Africa envisaged by the South African Environmental Observation Network (SAEON).

The changing water management environment

With the coming of democracy in 1994 and the country becoming a signatory to several international environmental conventions, South Africa embarked on the comprehensive reform of water policies and institutions, guided by an integrated water resources management (IWRM) approach. This rests on a set of legislated instruments, including: the relevant sections of the South African Constitution[9] and the Water Services Act of 1997,[10] which sets out a regulatory framework for the provision of water. The National Water Policy of 1997[11] prescribes policy for the management of the country's limited water supplies in terms of both quantity and quality and the 'unity of the hydrological cycle'. It declares all water a 'public good' and commits the national government to serve as the public trustee of the nation's water resources.

The National Water Act (NWA) of 1998[12] was promulgated to regulate the management of the country's water resources using the IWRM approach. This takes place across several dimensions,[1] including the different components of the hydrological system (surface water, groundwater, wetlands, estuaries, etc.), the coordinated development and management of water, land and related resources, and the integration of environmental sustainability with statutory, economic, and social objectives. One of the Act's main objectives is progressively to decentralize responsibility and authority for water resources management to appropriate regional and local institutions, partly in order to assist water users and other stakeholders to participate more effectively in the management of these resources. The need for decentralization has led to the development of a three-tier water management system based on the provisions of the National Water Resource Strategy,[2] illustrated in Fig. 1, which is currently being implemented in South Africa as follows:

The national level (tier 1). This involves a national policy and regulatory framework, strategic and development planning at

[a]Department of Water Affairs and Forestry, Private Bag X313, Pretoria 0001, South Africa.
[b]Formerly with DWAF; now at Department of Earth Science, University of the Western Cape, Private Bag X17, Bellville 7535, South Africa.
[c]Water Research Commission, Private Bag X03, Pretoria 0001.
*Author for correspondence. E-mail: nomquphw@dwaf.gov.za

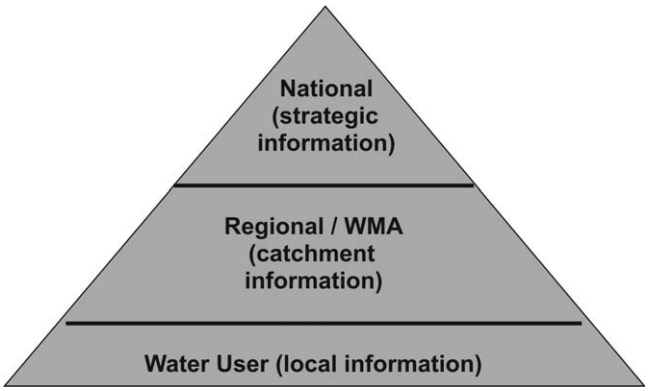

Fig. 1. Hierarchy of information requirements for management of water resources.

national and international level, reporting on the state of the environment and meeting international agreements.

A regional water management area level (tier 2). At this level the chief focus is on water management at catchment scale (e.g. authorization/licensing and coordination of water-related activities).

The local level (tier 3). The provision of water services and the management of own water use in terms of tiers 1 and 2 requirements takes place at this level. It is also responsible for meeting efficiency targets set by water services authorities and providers, including water boards, as well as all water users and water user associations.

Integrated catchment management (ICM), based on international best practice, is a key component of the institutional reform.[13] For this purpose, the country has been divided into 19 water management areas as shown in Fig. 2. These areas are a level 2 (tier 2) activity in which Catchment Management Agencies (CMAs) will be established to carry out the devolved water management responsibilities.

The institutional changes for water resources management outlined above have major implications for the monitoring of water resources. Monitoring, which, historically, was almost exclusively a DWAF function, will in future take place at each tier as part of their respective responsibilities for water resources management. The IWRM approach, however, as embodied in the National Water Act and the National Water Resources Strategy, will cut across the water management hierarchies for the purpose of implementation, coordination and integration and, where necessary, monitoring. This is elaborated upon further in the rest of the paper.

Mandate and scope of water resources monitoring

The National Water Policy[11] asserts that 'ongoing monitoring and assessment of the patterns of resource use, and the response of the resource to use, are critical for effective resource management and protection', and should be based on sound scientific and technical information and understanding. The monitoring and information management function is defined as a national government competency, specifically regarding DWAF, whose responsibilities include:

- national design and coordination of monitoring programmes;
- development of technology and methods to support monitoring, assessment and auditing;

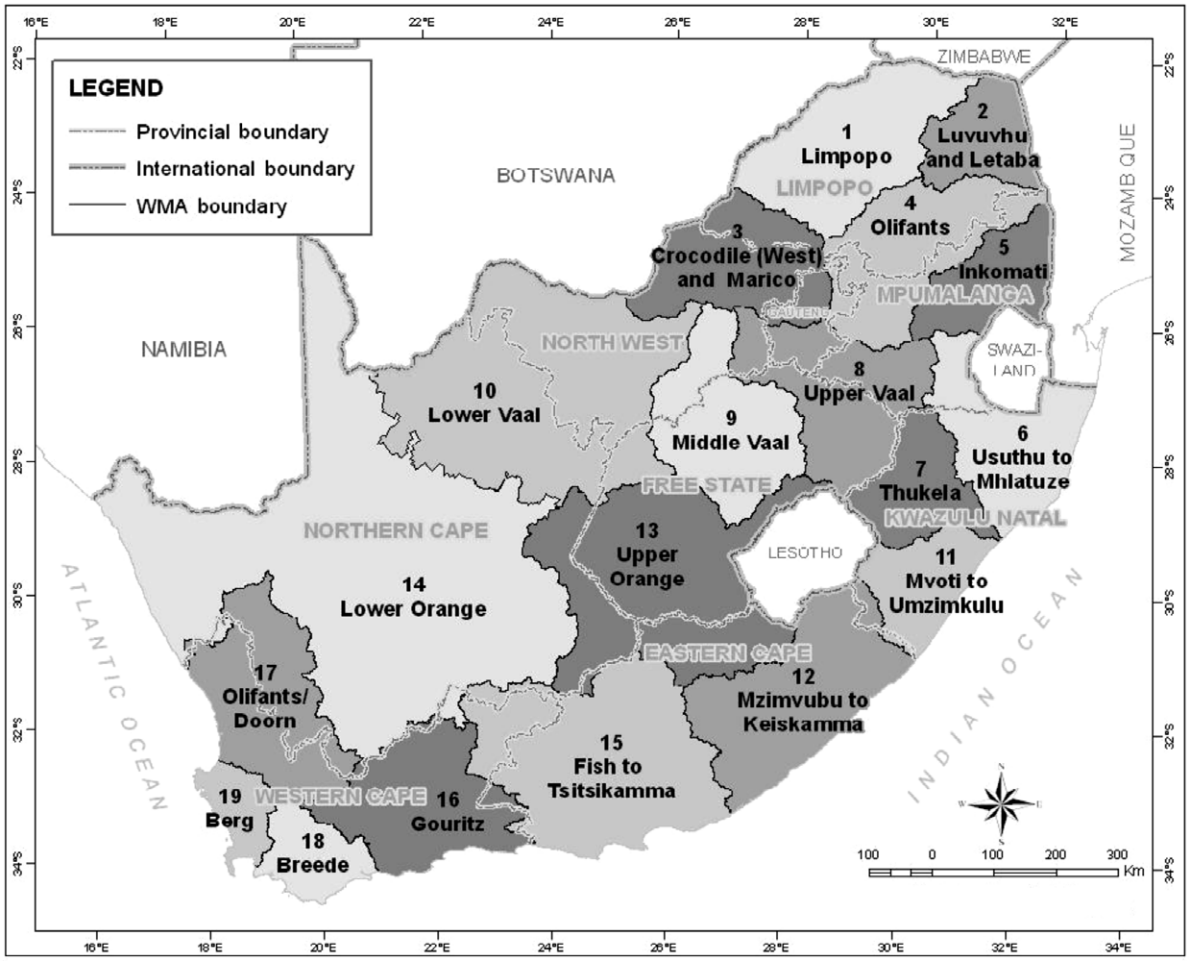

Fig. 2. Map of water management areas (numbered 1–19) in South Africa.

- standardization of approved methods and techniques for monitoring, analysis and assessment;
- regular review of regulations, standards, methods and accreditation requirements;
- design, establishment and maintenance of national monitoring networks;
- development and maintenance of information management systems.

However, the minister (of DWAF) can 'delegate all or any monitoring and assessment, information management and reporting functions to any other Government department, provincial administration, local authority or competent body, where capacity exists.' Additionally, DWAF is required to report to Parliament regularly on the status of the country's water resources.

Chapter 14 of the National Water Act of 1998[12] is dedicated to the integration and coordination of monitoring systems by the minister. It states that the minister must:

- establish national monitoring systems (in order to assess the quantity, quality and use of water resources and health of aquatic ecosystems as well as changing atmospheric conditions);
- establish national information systems on water resources for the above information (including a national register of all water use authorizations);
- ensure access to this information; and
- establish mechanisms to coordinate monitoring.

Based on national considerations and international best practice,[14–16] the strategic framework introduced to harmonize the monitoring systems[17] has induced a fundamental rethink of the purpose and definition of monitoring. The framework adopted the 'user-centric approach', which requires a monitoring programme to be defined according to specific information required by users to perform a stated water management function. This has implications for an integrated approach to the execution of core functions of a monitoring programme, namely data acquisition, data management and storage, and information generation and dissemination.

Whereas the existing national programmes have previously focused largely on monitoring the resource status and trends, there is an emerging paradigm towards assessing water and land-based impacts on the resources as well as managing these influences.[8] This management-related monitoring will have to take place at the levels at which the particular resource management itself is taking place, as illustrated in Fig. 1.[18] In the future, the main emphasis will be on water-use monitoring undertaken by many different stakeholders, which will make national direction and coordination critical.

The scientific challenges of monitoring for IWRM

With its historical focus on point-source control and the construction of major water resources infrastructure, South Africa previously provided limited incentives for comprehensive assessment of water resources.[7] With increased focus on demand management and the optimization of resource conservation and use for a variety of societal needs, a much stronger, science-led water resources management approach will be needed.

This shift in emphasis was broadly influenced by the United Nations' Agenda 21,[19] which defines water resources assessment as the continuing determination of sources, extent, dependability and quality of water resources, and of the human activities that affect those resources. Görgens[20] argues that strategies promoting sustainable utilization of a resource would fail if they did not recognize that the resource resides in, or comprises, an input–transference–response system with many components, qualities and links. Görgens declares that 'systems', by definition, implies a focus on the integration of different components operating at different levels.

The use of indicators to gauge the sustainability and efficiency of a systems approach to water resources management is invaluable. A commonly used framework for organizing and presenting physical data from various subject areas and sources is the driving forces, pressures, state, impacts and responses framework, developed by the Organisation for Economic Cooperation and Development (OECD) in the late 1980s.[21] In South Africa, this approach is applied in the 'State of the Environment' reporting[22] and it is also considered to be appropriate for the analysis of catchment systems.[23]

A practical application of science-led management of water resources in South Africa is provided by the River Health Programme (RHP), a major component of the National Aquatic Ecosystem Health Monitoring Programme. The RHP was established in 1994 in response to the need to monitor, assess and report on the ecological status of river ecosystems based on their biological condition in relation to all the human-induced disturbances affecting them. It uses monitoring to progressively improve river management.[24]

The first step requires assessment of the current ecological status of a river, using biomonitoring indices as ecological indicators, to identify problem areas where corrective measures are required. Following this, the ecological status of a river reach is expressed as a river health category (that is, a level of ecosystem health), which relates to a management class in terms of the water resource classification system in the National Water Resources Strategy.[14] A number of management programmes (such as controlling sources of pollution, removal of alien vegetation, etc.), based on this assessment, can be introduced to improve the health status of a river/catchment. Such management decisions are supported by status and compliance monitoring programmes, which are designed following detailed surveys to understand the river system.

To determine the priority of other issues for more systematic science-led monitoring, DWAF is presently undertaking a first country-wide, comprehensive assessment of the state of water resources (T. Zokufa, pers. comm.). This assessment should eventually lead to the integrated monitoring of reference conditions and impact–response indications at every scale, from regional to local.

Emerging monitoring governance model

According to Ashton,[25] the scope of governance in the water and environmental context includes the full suite of mechanisms for managing water or other natural resources according to objectives that reflect the goals of society. This should include all three sectors of society: government, non-governmental organizations, and community or civil society (including the private and the commercial sectors). These are then stratified into different levels, from international, regional and national down to local.[25] Cooperative governance between and among sectors is essential because of the interactions between different ecosystem components.

The South African water resources management model[2] is conceptualized along similar lines and this, in turn, has provided perspective on the nature of the future governance of the country's monitoring activities. The key to the successful implementation of water resources management is the systematic flow of relevant information generated throughout the hydrological

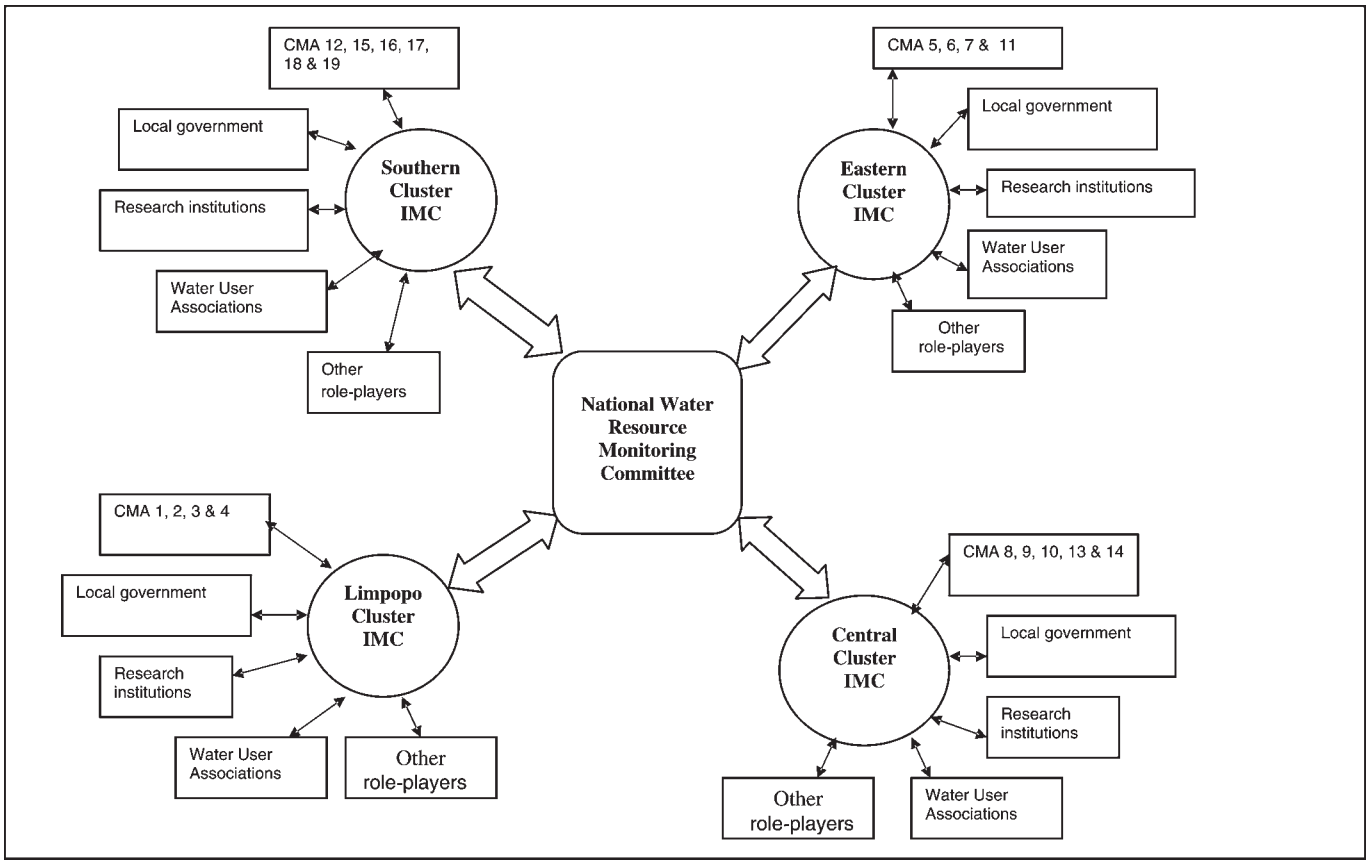

Fig. 3. Proposed monitoring governance concept model.

cycle. However, there are various governmental sectors with specific legislative responsibilities for certain components of the hydrological cycle. For instance, DWAF has legal jurisdiction over what Ashton[25] referred to as 'blue water' in aquatic ecosystems, whereas atmospheric water and 'green water' is legislated and regulated in the environment, agricultural and land-use planning sectors. Clearly, such a jurisdictional set-up demands cooperative government among government agencies and cooperative governance, or co-management, with other role-players and interest groups, given the 'unity' of the hydrological processes.

The co-management concept is aptly defined as 'a situation in which two or more social actors negotiate, define and guarantee amongst others themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources.'[26] This concept embraces a pluralistic management approach based on the principle of subsidiarity, in which negotiated agreements on management roles, rights, and responsibilities are brought about, in which the conditions and institutions of sound decentralized governance are made explicit.

This type of voluntary cooperation or partnership is starting to happen, as exemplified by the RHP, in which social actors drawn from all levels of government, the science community and civil society are already involved. The public–private partnership, demonstrated in the RHP, provides an approach to governance which allows the industry to monitor itself and be accountable for its own performance, while the regulating authority focuses on auditing and penalty action where necessary.

An emerging conceptual model for the coordination of water resources monitoring activities in South Africa is illustrated in Fig. 3, with the following components:

- Centrally (at national level), the proposed advisory committee on water information will determine high-level strategic information needs and formulate policy for water resources information management.
- The National Water Resource Quality Monitoring Committee will be a forum where all monitoring programmes, national and local, are coordinated and integrated in terms of a national monitoring framework. The committee will be supported by sub-committees dealing with issues such as quality assurance, technical standards and capacity building.
- The regional nodes of coordination, built around DWAF clusters or regional offices (Fig. 3) to coordinate the management of their portion of the national programmes, facilitate cooperation between various monitoring networks (e.g. those of CMAs, local authorities and other social actors), and promote the sharing of information among all organizations involved in the monitoring of water resources.

Conclusion

South Africa has been operating an excellent river flow monitoring network since the early 20th century, when the focus was on supply-driven water development, also known as the point-source control approach. Groundwater and water quality monitoring was introduced more recently, based largely on research and voluntary action. The advent of the National Water Act of 1998 has shifted the focus from supply-driven water development to managing a scarce resource in which ongoing, integrated monitoring and assessment are critical for the management and protection of water resources. In this approach, the design of monitoring programmes is driven by sound scientific information in which the relationship between water resource status and the impact of human activity and the

management responses are key considerations. The RHP is the first example of this science-led management of water resources in South Africa.

Integrated Water Resources Management, as advocated by the National Water Act, is leading to a decentralization of management, in particular to the creation of Catchment Management Agencies and Water User Associations. The involvement of different actors in the hydrological cycle necessitates building and strengthening partnerships to co-manage the water resource through appropriate governance structures. The proposed conceptual model of monitoring governance is based on changing objectives of water resources management. Its purpose is to introduce a marked shift in focus from individual data collection programmes to integrated, client-focused water resources monitoring.

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