PREFACE

Groundwater: Our source of security in an uncertain future

S Adams, J Cobbing, I Dennis and K Riemann

This special edition of *Water SA* comprises an assemblage of scientific papers and technical notes presented at the International Conference on Groundwater: Our Source of Security in an Uncertain Future, held from 19 to 21 September 2011 in Pretoria, South Africa. A fifth of the world's population already lives in areas that are characterised by water scarcity. It is estimated that groundwater is already a primary source of drinking water for as many as 2 billion people and supports a significant part of the world's irrigated agriculture. Groundwater is an important resource for maintaining socio-economic and environmental systems. Groundwater makes up the bulk of the freshwater resources on Earth and is generally underutilised in many parts of the world. MacDonald et al. (2012) estimated that there could be 100 times more groundwater in Africa than the available surface water resources. Groundwater availability is also less sensitive to annual and inter-annual rainfall fluctuations and is considered to be an excellent buffer during dry periods.

Droughts and increased demands have triggered the search for alternative water supply options. Environmental stresses driven by the growth in population and urbanisation and the resulting energy, transport and development trends at country and global levels have further increased water shortages (World Bank, 2010), which in turn have led to more emphasis being placed on groundwater. Despite this raised profile, there are still numerous challenges. Some of the high-level challenges, not necessarily unique to groundwater, include (Adams et al., 2012):

- Global change (e.g. climate change and variability)
- (Ground)water pollution and depletion
- Rapid urbanisation with increasing supply demands and higher pollutant loads
- Coupling of the various reservoir fluxes in time and space
- Governance of (ground)water and related resources
- Data collection (monitoring) and data availability (management)
- Uncertainty quantification (e.g. model and parameter uncertainties)
- Poor land-use planning
- Scale and heterogeneity
- Capacity development
- Complete description of complex systems
- Groundwater valuation and financing

Over-utilisation and the poor management of the groundwater resource are often due to poor or non-existent management plans and governance provisions. Often described as the 'silent revolution', groundwater use, mainly by agriculture (and to a lesser extent de-watering of mines, and municipal water supply), has led to declining water levels of several aquifer systems around the world and the perception that groundwater is an unreliable resource. The proper management of the resource is thus crucial and includes an understanding of numerous factors. These factors vary from infrastructure-related issues, data collection and interpretation, to the tools (including models and frameworks) used to guide groundwater managers within the legal constraints as dictated by authorities. This special edition of *Water SA* provides useful insights on groundwater resource management and provides sound answers to many challenges facing the industry, as discussed in more detail in the papers included in this issue:

Foster et al. maintain that Sub-Saharan Africa is mainly experiencing 'economic water scarcity' due to the lack of investment in infrastructure. Information on aquifer characteristics, groundwater recharge rates, flow regimes, quality controls and use is still 'patchy' in most cases. However, considerable efforts have gone into mapping the world's aquifers at local, regional and global scales. Improved estimates of groundwater recharge are essential for the sustainable management of groundwater resources. However, sustainable groundwater development depends on increased abstraction being compensated for by increased recharge and/or reduced discharge; referred to as the 'capture principle' (Seward et al., 2006). **Stone and Edmunds** estimated the rate of groundwater recharge through the dune-sands of the Kalahari overlying the Stampriet Basin in Namibia. They used the chloride mass balance method for a first estimate of the direct recharge rate through the dune-sands. This is an example of the application of proven techniques in the search for better groundwater management. **Holland** provides an assessment for the factors responsible for improved groundwater yields within geologically-complex hard-rock terrains. **Du Toit et al.** show the value of re-interpreting existing datasets to show that groundwater resources in the Limpopo Province of South Africa can be utilised as a bulk water supply option. **Pavelic et al.** present a simple analytical framework that can be used to assist with decision making for irrigation from groundwater, and to determine the potential areal extent under different cropping patterns. However, limited data availability and uncertainties associated with certain parameters hamper the expansion of the approach to other areas. Whilst in some instances excellent data gathering and management is taking place, in most other places limited data gathering and management occurs. Groundwater resource

Available on website http://www.wrc.org.za
ISSN 0378-4738 (Print) = Water SA Vol. 38 No. 3 International Conference on Groundwater Special Edition 2012
ISSN 1816-7950 (On-line) = Water SA Vol. 38 No. 3 International Conference on Groundwater Special Edition 2012

planning should be brought into the realm of surface-water resource planning by applying the concepts of assured yields. **Murray et al.** developed these concepts into 2 models; the Aquifer Assured Yield and the Aquifer Firm Yield Models, and demonstrated the successful application of these within the Karoo aquifer system of South Africa. Murray et al. also show that with proper planning tools favourable groundwater potential areas can be identified for bulk use. However, groundwater systems are more complex, and thus inherently more difficult to manage, than surface water. Also, groundwater availability is less sensitive to annual and inter-annual rainfall fluctuations than surface water (Giordano, 2009); though over time the overall impact of these fluctuations will be negative. The role that groundwater can play in minimising the impact of climate change threats is significant but would require careful management. **Dennis and Dennis** have developed the DART (Depth to water-level change, Aquifer type (storativity), Recharge and Transmissivity) index, which can be used to identify areas that could potentially experience changes in their groundwater resources as a result of climate change.

Groundwater sustainability is considered to be a value-driven process, based on intra- and inter-generational equity, which balances the needs of the environment, society and economy (Gleeson et al., 2011). However, the social aspects of groundwater development projects are often neglected. **Myburgh and Hugo** developed a groundwater–community compatibility index that can be used in the initial stages of groundwater development projects. It is crucial to understand community preferences and perceptions to ensure the sustainability of the developed water supply schemes as well as to develop appropriate operation and maintenance programmes. **Hay et al.** reinforce the notion that poor operation and maintenance of water supply, treatment and reticulation infrastructure are the cause of significant water losses. The authors also maintain that it is these operational issues, and not the groundwater resources, which are the main reason why decision makers view groundwater as an unreliable resource or option. Skills development and training is crucial at all levels within municipal structures to ensure proper management of their well-fields. **Riemann et al.** developed the 'Groundwater Management Framework' that can allow authorities to acquire groundwater management tools and the required capacity to improve their management capabilities.

In assessing the groundwater governance provisions in South Africa, **Pietersen et al.** found that the technical, legal, institutional and operational provisions were reasonable at the national level but weak with regard to cross-sector policy coordination. At the local level, basic technical provisions such as hydrogeological maps and aquifer delineation with classified typology are in place, but governance provisions such as institutional capacity, provisions to control groundwater abstraction and pollution, cross-sector policy coordination and the implementation of a groundwater-management action plan are weak or non-existent. Management of the resources should be backed by strong governance provisions. The low awareness levels and negative perceptions of groundwater, by the public and policy-makers, represent a major challenge for the sustainable development of this resource. Groundwater valuations create an understanding of the economic value of groundwater under different uses and management options and help to allocate water to its highest value use (**Bann and Wood**). These valuations also create the required awareness and the basis for improved decision making.

It is heartening to see how hydrogeology is evolving from a science of how to find and exploit groundwater into one that addresses the integrated management of this valuable resource. The discipline-specific approach to solving specific research questions will remain very important, but this cannot, on its own, address current environmental and social problems (Adams, 2012). The business-as-usual approach to water management and planning is no longer feasible and groundwater's role in closing the water supply–demand gap must be recognised and afforded the same level of commitment as that of surface water resources.

References

ADAMS S, DIMKIĆ M, GARDUÑO H and KAVANAUGH MC (2012) Groundwater: perspectives, challenges and trends. In: Li H (ed.). *IWA Specialist Group Directory. Global Trends & Challenges in Water Science, Research and Management: A Compendium of Hot Topics and Features from IWA Specialist Groups*. International Water Association, London.

GIORDANO M (2009) Global groundwater? Issues and solutions. *Ann. Rev. Environ. Resour.* **34** (7) 7.1-7.26.

GLEESON T, ALLEY WM, ALLEN DM, SOPHOCLEOUS MA, ZHOU Y, TANIGUCHI M and VAN DER STEEN J (2011) Towards sustainable groundwater use: Setting long-term goals, backcasting, and managing adaptively. *Ground Water* **50** (1) 19-26.

MACDONALD AM, BONSOR HC and DOCHARTAIGH BÉÓ (2012) Quantitative maps of groundwater resources in Africa. *Environ. Res. Lett.* **7** (024009) 1-7.

SEWARD P, XU Y AND BRENDONCK L (2006) Sustainable groundwater use, the capture principle, and adaptive management. *Water SA* **32** (4) 473-482.

WORLD BANK (2010) Monitoring Environmental Sustainability: Trends, Challenges and the Way forward. In: 2010 Environmental Strategy: Analytical Background Papers. The World Bank Group. URL: http://siteresources.worldbank.org/EXTENVSTRATEGY/Resources/6975692-1289855310673/20101209-Monitoring-Environmental-Sustainability.pdf (Accessed 11 June 2011).

Available on website http://www.wrc.org.za
ISSN 0378-4738 (Print) = Water SA Vol. 38 No. 3 International Conference on Groundwater Special Edition 2012
ISSN 1816-7950 (On-line) = Water SA Vol. 38 No. 3 International Conference on Groundwater Special Edition 2012