WATER RESEARCH COMMISSION
WORKING PAPER

# IDEAS FOR MAINSTREAMING GROUNDWATER

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## 1. Introduction

It has taken just eight months for the combined water levels of the Cape Town dams to climb from less than 15% of capacity to almost three-quarters full. As it stands, the combined levels for Cape Town now sits at 65%(PIJOOS, 2019). This is a great turnaround of events from the imminent approach of day zero. Groundwater, a critical resource that South Africans often treat as 'out of sight, out of mind,' has since gained widespread attention. However, the precious time and resources invested in groundwater drought relief projects over the last few months will become meaningless, unless a concerted effort is made to use the data generated for future planning purposes. It is an easy task to address our water issues during a drought, but it's just as important, if not more so, that we transform our water system during wet years. South Africa needs to incorporate lessons learnt and develop better mechanisms that will allow for the proper management and use of groundwater systems in their sustainability plans. A case in point is the drought the City of Cape Town has been experiencing over the past few years. Notwithstanding the importance record low rainfall events had on triggering the water crises, the severity of the drought could have been alleviated by good governance(Olivier and Xu, 2019). The Eastern Cape has also been affected by the drought with the Coega Development Corporation (CDC) increasing its water conservation efforts in a bid to tackle the water crisis as it reached dire straits in the Nelson Mandela Bay Metro. A number of artesian boreholes were drilled in the CDC area and will be used as part of the of the future water supply of the town (Figure 1). In addition, innovative ways of capturing surface water runoff and injecting into aquifers need to be engineered to prevent losses due to evaporation and further degradation by mixing with seawater. This is critical if groundwater is to be considered as a conjunctive water supply option well into the future. Groundwater, being the largest active source of freshwater, has a strong resilience to droughts as it reacts slowly to seasonal changes and therefore is able to provide a continuous water supply if managed properly.

This paper aims to put a spotlight on the role of groundwater as a strategic resource, on the one hand for actual coping with inadequate drinking water services, and on the other hand to provide water of an acceptable quality to augment water shortages during periods of drought as a result of climate change, population growth and urbanization.

Figure 1 150l/s borehole to supply Coega Industrial Development zone.

## 2. Regulatory and Institutional Context – South Africa

The National Water Resource Strategy 2 (NWRS 2), incorporates groundwater in a meaningful way, enabled by the National Groundwater Strategy(DWA, 2013). South Africa has some of the best legislation, policies, regulations, guidelines and strategies at its disposal. However, efficient management of groundwater relies on the effectiveness of applicable legislation and institutional arrangements, as well as good understanding of the behaviour of an aquifer or wellfield being managed. There is generally a lack of skilled technicians and other operation and management specialists, particularly in small towns needed to make informed decisions at the local wellfield scale. A recent research study conducted by researchers at the University of the Free State's Institute for Groundwater Studies (IGS), where they developed a training manual for groundwater resource management & governance for municipalities, showed that all municipalities rated groundwater as a critical resource, yet there is no planning nor capacity, available to do the actual work(Kotze et al., 2017). While skills and capacity building are key building blocks to the implementation of the NWRS 2, recent reforms within government have placed the responsibility for the coordination of education, training and skills development across sectors in the Department of Higher Education through the various Sector Education and Training Authorities (SETA's). For the water sector, the Energy and Water Sector Education and Training Authority (EWSETA) is charged with the responsibility of coordinating and facilitating skills development and capacity building in accordance with the Skills Development Strategy III, Human Resource Development Strategy II (2010-2030) and the New Growth Path National Skills Accord (NSA) between government, business and labour. The SETA's should therefore be seen as the main drivers that can address the skills gap by funding relevant workplace based training and mentoring strategies, but also coordinate training activities already taking place in the region and aligning it with sector needs(EWSETA, 2016).

Ever-increasing pressures on the groundwater resource base mean that groundwater governance is a critical issue requiring worldwide attention. It is assumed that good groundwater governance embodies technical, economical, judicial, social, institutional and administrative structures and an adequate policy field that ensures the responsible use and maintenance of groundwater systems and related ecosystems services(DWS, 2016). In the context of groundwater management, good governance needs to involve both issues of resource quantity and quality. Nevertheless, most legal frameworks treat these 2 aspects separately. However, since the dawn of our new democracy and the promulgation of the National Water Act (36 of 1998) there still remains clear weaknesses with regards to South Africa's institutional framework. Groundwater management often lacks the financial and human capacity needed for the investigation of the resource characteristics and functions, especially in developing countries, and as a consequence there are shortcomings in terms of reasonable legal provisions and pricing systems. The dynamic nature of both socio-economic development and predictions of global climate change makes groundwater management complex, uncertain and often unpredictable.

The administration tasked with the interlinked responsibilities of ensuring water quality and availability face a need to improve system resilience based on interdisciplinary knowledge of water shortage risks and adaptation possibilities. With increasing pressure and impacts from population growth, urbanization, climate change, etc., the ecosystem services that aquifers in (peri-) urban areas provide are fundamental. Among those services are how aquifers function as water reservoirs and buffers. Key planners and decision makers have for some time looked at river basins in efforts to secure freshwater for cities, and to varying degrees implemented

Integrated Water Resources Management. They are now increasingly taking Nature-Based Solutions into account for urban areas, such as through investments in physical structures that can double as water retention zones during flooding events(Shivakoti et al., 2019). The invisible nature and complexity of aquifers has meant that groundwater resources do not easily lend themselves to inform policy for the necessary building of resilience. This suggests that groundwater can only gain a role as a strategic resource where an integrated approach to urban water management and governance acknowledges the importance of all available resources and move away from the focus on large infrastructure and centralized water supply solutions. Fundamentally, in the pursuit of reducing vulnerability the resilience lens tells us to expect the unexpected. In the ever-more stressed urban water scenario, diversification is vital to spread risks and improve preparedness. The future management of our water resources requires that decisions concerning resource allocation and use are made transparent through informed public participation and by fully considering ecosystem requirements, inter-generational equity and precautionary principles.

## 3. Managed Aquifer Recharge

When considering issues of changing climate and rising intensity of climate extremes, Managed Aquifer Recharge (MAR) can become an increasingly important water management strategy, alongside demand management, to maintain, enhance and secure stressed groundwater systems and to protect and improve water quality. Managed aquifer recharge (MAR) or artificial recharge of groundwater is the intentional storage of water underground to reduce evaporative losses and utilize the porous aquifer media for water conservation and decontamination(Dillon et al., 2019). MAR has been practiced in South Africa since the mid 1970’s at the Atlantis aquifer, however much more work is needed to document the costs and benefits of MAR. This will include doing work in relation to alternative water supplies or places of storage and in identifying scenarios where MAR is likely to produce the least-cost water supply and greatest benefit accounting for all objectives, including current economic externalities such as resource and environmental benefits. The relevance of these strategies for a water scarce country like SA has been recognized by the Department of Water and Sanitation (DWS) in pursuing the “Artificial Recharge Strategy” for groundwater resources more than a decade ago(DWAF, 2007). One particular sector that has a huge role to play in recharging aquifers for the benefit of all stakeholders are the mining industry in South Africa. MAR and Aquifer Storage and Recovery (ASR) are potential strategies that could enhance their positive water impact while improving operational efficiencies. Mines can extract water from an aquifer before it enters the underground workings and re-injecting it further downstream(Megdal et al., 2014). This will inevitably reduce the volumes being contaminated in mine workings, lowering the pumping and treatment costs that are normally associated with wastewater before it can be legally discharged from the mining site. Another benefit is the ease with which water can be stored underground in aquifers, compared to building and maintaining surface infrastructure. Aquifers also minimise evaporation, which can be significant in dams. More regulatory effort in building water security through MAR for longer-term water banking, and in conjunctive use of dams and groundwater could create extra value out of existing dams. Furthering the knowledge of downstream impacts of MAR operations in catchments is also needed. South Africa needs governance frameworks to be strengthened to ensure that MAR is sustainable and protects groundwater quality and generates benefits for all members of groundwater-dependent communities, particularly during drought.

## 4. Groundwater Water Quality and its Uses

Knowledge of groundwater's chemical and microbial quality is critical when attempting to predict its use. In general very little is known about the microbial quality of groundwater especially in the case of privately owned wells or boreholes in rural areas (Abia et al., 2017). Groundwater might not be suitable for drinking and other uses without prior treatment in these areas. In urban areas microbial groundwater quality is increasingly compromised due to rapid expansion of informal settlements and inadequate waste management practices from various anthropogenic activities that result in the contamination of ground water (Wang et al. 2012) Climate change and weather extremes also lead to increase flooding in some areas which compromises the quality of groundwater (McMichael et al., 2006; Howard et al., 2016). As with microbiological characteristics, understanding the chemical characteristics of water will ensure its use appropriately. Chemical ground water quality is affected by the interaction of water and the minerals found in the aquifer (Lapworth et al., 2017).

In South Africa saline groundwater resources are not well-understood but could present significant sources of water for both industrial and mining applications. Saline groundwater are often termed a nuisance, however given the current drought situation this water could potentially become an important source to the water supply-mix in the future coupled with desalination or other emerging water treatment technologies (Burger et al., 2006). Saline groundwater can be classified as either brackish, saline or brines. Saline groundwater, in the South African context, is defined based on the Total Dissolved Solids (TDS) levels and SANS 2412 drinking water quality standard as ≥ 1,200 milligrams per liter (mg/ℓ) (SANS, 2015). Saline groundwater is typically used for irrigation/agricultural purposes, however highly mineralised water should be included in the water supply mix. South Africa has a legacy of gold and coal mining and this impacted mine water should be considered a resource and be treated using innovative techniques to potable standards. Reclaimed mine water and re-use provides an opportunity to augment water supplies in areas of chronic water shortage.

## 5. Conclusion and Recommendations

In conclusion, then there appears to be plenty of opportunities for groundwater to be considered a mainstream resource if managed in a holistic manner. This paper recognizes the strategic role of groundwater resources for the effective management and mitigation during periods of drought. Fundamental to its application is generating a sense of urgency in order to rally the political will to secure effective groundwater governance at all levels. Hydrogeologists, and other professionals involved in groundwater, are a key component in creating such a sense of urgency by raising public awareness in terms of opportunities and threats. The appropriate appraisal of groundwater resources, with which diverse stakeholders can identify, should be considered as a vital precursor to its sustainable management. Last but not least, good policy design alone is insufficient for effective groundwater governance. Rather, implementation requires sufficient investments, reliable science, accurate data, good leadership, and equitable decision-making.

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