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POLICY BRIEF

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Understanding groundwater governance systems challenges: A need for adaptive integrated water management approach for efficiency in South Africa considering poor groundwater quality, delayed policy implementation, and challenges in adopting new water treatment technologies.

Executive Summary

It is estimated that about 94% of freshwater resource is made up of groundwater which in many ways is essential resource for socioeconomic development and environmental sustainability for most communities. Despite its intensive harvest and use, over the years, there's been continuous fragmentation of groundwater and surface water policy which has created some instability in the related operations of groundwater governance and security. As a hidden public resource (sometimes neglected resource), groundwater lacks the immediate financial reward or effect, there's has been less investment in improving its management for efficiency. In a range of context this has caused perpetual water security and access conflicts amongst stakeholders, such as water managers, water authorities, private land owners and communities. Given that South Africa is a water stressed and semi-arid country, the groundwater allocation and protection becomes essential as it's a source of freshwater, hence effectively managed for the achievement of the long-term outcomes of integrated water resource systems. An adoption of the adaptive water management approach may include some of the following:

- Enforcing frequent groundwater monitoring and adhering to stringent standards is necessary to protect public health and maintain water quality.
- Investing in new integrated infrastructure for water treatment technologies will help ensure the prevention of water-related diseases and deaths by eliminating water pollutants.
- The development of active membrane filters as a method for treating polluted water is essential for water re-utilisation and overcoming water scarcity and achieving sustainable water access for all.
- Continuous evaluation of the integrity of the groundwater ecosystem for improving outcomes mapping, resource planning and guiding deployment of strategic resources (diagnostic data and information to support effective decision-making).

Introduction

The access to clean and safe drinking water has been regarded as a human right and also a global imperative by various water councils and the United Nations Sustainable Development Goals (SDGs) [1].

Most rural areas and peri-urban areas in South Africa (SA) still lack access to clean water, mainly due to a lack of proper distribution of water channels from the water treatment plants [2]. These communities ultimately rely on groundwater for consumption, irrigation, and all other domestic purposes. The groundwater is provided through wells, communal boreholes provided by the municipalities as well as private boreholes as the sole supply of drinking water in the communities with stringent measures to limit excessive use of groundwater [2].

The users and some municipalities in these remote areas consider groundwater as a naturally clean water source for consumption without purification. However, various scientific researchers in SA have shown alarmingly increasing groundwater pollution by anthropogenic activities including heavy metals, pesticides, personal care products, pharmaceuticals, nitrates, sulfates, and various micro-organisms such as viruses, bacteria, and algae, which may lead to new strains of diseases and infections [2]. These pollutants and their metabolites are frequently detected in groundwater at high levels due to improper and continuous disposal of waste into the environment, which ultimately ends up in water bodies including groundwater [3].

The policy and strategy for Groundwater Quality Management in South Africa specify that the remedial action will take place in a case where there is a need when contamination of groundwater is occurring or has already occurred, and where the law cannot be applied to enforce clean-up of groundwater, and the implantation strategy will be implemented on a site-specific needs basis, which will include prioritisation and evaluation of priorities for remedial action, clean-up of abandoned sites, and emergency action procedures or plans for accidental spills [4]. However, this policy and its strategies fail to address the procedure and methods to combat poor-quality groundwater, aging infrastructure, lack of integrated water treatment technologies into the current water treatment processes, and how the closure of disposal sites will stop the pollutants from leaching into the water bodies.

Therefore, it is imperative to develop and employ cheap and effective membrane filters for the removal of harmful pollutants from groundwater, since the DWS has specified in their national water and sanitation master plan that low funding investment and insufficient partnerships hampered the implementation of improving the infrastructure and thus, the quality of the distributed water.

Instead of observing crumbling infrastructure and poor-quality water being distributed, cheaper technologies such as membrane filters can be incorporated into the existing infrastructure with low financial investment as compared to building a new infrastructure.

Alternative water treatment processes such as light-activated membrane filters emerged as potent techniques for the eradication of toxic pollutants from water due to their ability to degrade various organic pollutants into carbon dioxide, water, and other harmless by-products. The membrane filters rely on added materials to harvest light and to degrade and remove pollutants from water. These membrane filters can also assist the DWS in addressing its challenges relating to their short and long-term interventions which include purification of desalination, and water re-usability such as grey water re-utilisation. Therefore, the policy requires to be modified and include the integration of modified membrane filters into their infrastructure to improve water and groundwater quality. Through this brief, we aim to:

- Identify the presence of toxic pollutants in various boreholes or groundwater systems.
- Develop cheap and sustainable membrane filters that can utilised by communal and private groundwater users and establish ways to integrate them into the existing infrastructure.
- Prioritise frequent onsite detection (on a daily basis) to ensure the safe drinking of groundwater.
- Train individuals and staff on groundwater management and the importance of water purification.

Policy Context

The Department of Water and Sanitation (DWS) has a mandate to develop effective water policies, implement and enforce compliance, and monitor water standards to protect water quality. However, slow implementation strategies, lack of funding, deteriorating infrastructure, and current water treatment policies—including processes such as coagulation, flocculation, sedimentation, adsorption, and disinfection—still fail to completely remove various pollutants from groundwater. Furthermore, local municipalities struggle to manage and refurbish their water treatment infrastructure, making it difficult to implement new water treatment technologies. On the other hand, private water suppliers can contribute to maintaining water quality by investing in advanced treatment solutions that enable the removal of toxic contaminants from water. The policy further relies on the "self-regulation" principle, meaning that the municipalities and the communities (with boreholes) can set their quality standards, provide their own pollution prevention strategies and the polluter pays.

As a lead, DWS has taken the initiative to identify future water sources, such as groundwater, and is currently assessing development options, operational and maintenance costs of infrastructure, water supply services, and the adequate management of water quality. Local communities and non-governmental organizations will have a responsibility to ensure high water quality standards are maintained and protected by advocating for the minimization of water pollution, creating awareness campaigns and community engagement initiatives related to water protection, adopting water conservation practices, and assisting law enforcement by reporting individuals who do not comply with the Environmental Practices Act.

Research method and approach

This policy brief was informed by the study conducted by Masindi and Foteinis [2], Olley et al. [5], Seyler et al. [6], Verlicchi, and Grillini [7], Pietersen and Beekman [8], in which they analyzed data on South African groundwater and surface water from 2016 to 2024.

Results and Policy Implications

Infographic 1. A schematic representation of sources of groundwater pollution [9], followed by a membrane filtration setup for eradicating groundwater pollutants to obtain clean water.

Key Findings

- It was discovered that almost all borehole samples contained harmful microbes, making them unsafe to drink.
- Seven of 42 borehole samples met some national water quality standards.
- Only 13.3% of groundwater was drinkable; most was brackish.
- Household, industrial, and agricultural effluents introduce contaminants into groundwater.
- Untreated pollutants degrade water quality over time, causing environmental harm.
- Chlorination could help reduce microbial contamination in groundwater sources.
- Nickel, nitrates, and calcium exceeded standards due to acid-mine drainage.
- Further assessment is needed for clean water access and action plans.

Conclusion

	It was found that high levels of various groundwater pollutants caused all the boreholes in North West to not be suitable for human consumption.
	Furthermore, the main source for microbial groundwater contamination was feces due to the lack of sewage systems, hence, the infiltration of microbes through the soil.
	Effective pre-treatment steps that combine multiple steps are essential and should be investigated in rural communities for groundwater treatment before consumption.
	Integration of oxidation processes into the existing process could be a viable solution.

Policy Recommendations

We recommend that water bodies, municipalities, and private water suppliers refrain from the passive assimilation of groundwater and begin implementing effective processes for more frequent monitoring of groundwater quality. In cases where there is a shortage of expert personnel, these entities should consider outsourcing qualified experts to assist with monitoring and remediation processes.

It is also advisable that all active boreholes be registered with the nearest municipalities to facilitate regular groundwater monitoring. Furthermore, the responsible municipalities should establish regional monitoring networks.

- We recommend encouraging water bodies, municipalities, and private water suppliers to adopt, implement, and execute new water treatment technologies involving highly active membrane filters.
- These technologies will enhance water treatment efficiency in their current infrastructure.
- Later, they can be rewarded with regulatory incentives such as tax holidays, subsidies, tax exemptions, lower municipal rates, or other special grants.
- On the other hand, strict penalties, fines, or prosecution should be imposed on individuals or sources contaminating groundwater.
- Clear and stringent guidelines for remediation measures should be provided for those who fail to comply with water contamination policies.
- These recommendations will help protect environmental practices, maintain high-quality groundwater, and deter groundwater pollution.
- Based on previous scientific reports, it is necessary to integrate multiple water treatment technologies into the existing infrastructure at different points to specifically address each contaminant (heavy metals, inorganics, organics, and microbes).
- The benefit of membrane filters is that they can remove a variety of water contaminants, including heavy metals, inorganics, organics, and microbes.
- These membrane filters have high water permeability and can be reused several times before being discarded. Their precursor is typically cellulose, which is environmentally friendly.
- Training water technicians and operators will be crucial for the new operational processes and maintenance.

Table 1. Dissemination Plan

Policy brief Title	Targeted audience/s	Preferred Dissemination methods	Potential Dissemination stakeholders	Preferred dissemination date
Understanding groundwater governance systems challenges: A need for adaptive integrated water management approach for efficiency in South Africa considering poor groundwater quality, delayed policy implementation, and challenges in adopting new water treatment technologies.	Department of Water & Cooperate governance and traditional affairs	Share and distribute the policy brief via email with the Department of Water and other government departments, including their policymakers. Send the policy brief to the communications department for online publication in their digital magazines, newsletters, and website.	Department of Water & Cooperate governance and traditional affairs	31 May 2025
	Water boards and private water suppliers (Water Research Commission, Rand water, Sedibeng Water)	Attend workshops and conferences organized by water boards, such as the Water Institute of Southern Africa and WRC Workshops. Send the policy brief to the water boards' communications department for online publication in their digital magazines and on their website.	Water boards and private water suppliers (Water Research Commission, Rand water, Sedibeng Water)	15 June 2025
	Local Municipalities	Share and distribute the policy brief via email with the Department of Water and other government departments, including their policymakers. Send the policy brief to the communications department for online publication in their digital magazines, newsletters, and website.	Municipalities	25 June 2025
	Non-Government Organisation (Mvula Trust, Water.org, & Tsogang Water and Sanitation)	Be part of NGO's public Forums and community engagement and school visits and distribute pamphlets Share and distribute the policy brief via email with the NGOs	Non-Government Organisation	30 June 2025
	Civil society / Local Communities	Organize community engagement events and school visits to distribute pamphlets. Visit community radio stations to present the policy brief. Post the policy brief on social media platforms such as LinkedIn, Facebook, Twitter, WhatsApp, and Instagram.	Civil society / Local Communities	15 July 2025
	Agricultural Farmers	Share and distribute the policy brief through email with the farmers and small-holder farmers. Do local farm visits and distribute pamphlets	Agricultural Farmers	30 July 2025

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