Artigo original

http://dx.doi.org/10.18623/rvd.v22.n6.3358

PROGRESS AND CHALLENGES RELATED TO WATER GOVERNANCE IN SOUTH AFRICA

PROGRESSOS E DESAFIOS RELACIONADOS À GOVERNANÇA DA ÁGUA NA ÁFRICA DO SUL

Article received on: 9/10/2025
Article accepted on: 11/10/2025

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The authors declare that there is no conflict of interest

Abstract
The aim of the study is to assess the status of water (focus) availability, demand and supply in South African context (locus). The rationale is that water is a human right, and every community member has a right to water accessibility. The study utilises a qualitative desktop analysis approach. The information was gathered through secondary sources that are published in the form of official documents. Journal articles, reports, etc. The information was analysed through document analysis. Findings reveal that although water management is significant to provide equal distribution of water, it has various challenges to deal with. Such challenges are linked to gaps in capacity-building, technological expertise, financial resources, to state a few. The study proposes that traditional methods and procedures may have impacted on water governance and water management. Therefore, it is suggested that the use of fourth industrial revolution (4IR) technologies in water institutions, their processes and procedures may improve the efficiency of water supply. The study contributes to the fields of public management, information technologies and water studies. The proposed suggestions may assist decision-makers, policymakers and stakeholders in improving water governance.

Keywords: Fourth Industrial Revolution (4IR). Qualitative. South Africa. Sustainable Development Goal (SDG) 6. Water.

Resumo
O objetivo deste estudo é avaliar a situação da disponibilidade, demanda e oferta de água (foco) no contexto sul-africano (local). A justificativa é que a água é um direito humano e todos os membros da comunidade têm direito ao acesso à água. O estudo utiliza uma abordagem qualitativa de análise documental. As informações foram coletadas por meio de fontes secundárias publicadas na forma de documentos oficiais, artigos de periódicos, relatórios, etc. As informações foram analisadas por meio de análise documental. Os resultados revelam que, embora a gestão da água seja fundamental para garantir a distribuição equitativa da água, ela enfrenta diversos desafios. Tais desafios estão ligados a lacunas em capacitação, conhecimento tecnológico e recursos financeiros, entre outros. O estudo propõe que os métodos e procedimentos tradicionais podem ter impactado a governança e a gestão da água. Portanto, sugere-se que o uso de tecnologias da quarta revolução industrial (4RI) nas instituições hídricas, seus processos e procedimentos, pode melhorar a eficiência do abastecimento de água. O estudo contribui para as áreas de gestão pública, tecnologias da informação e estudos hídricos. As sugestões propostas podem auxiliar tomadores de decisão, formuladores de políticas e partes interessadas na melhoria da governança da água.

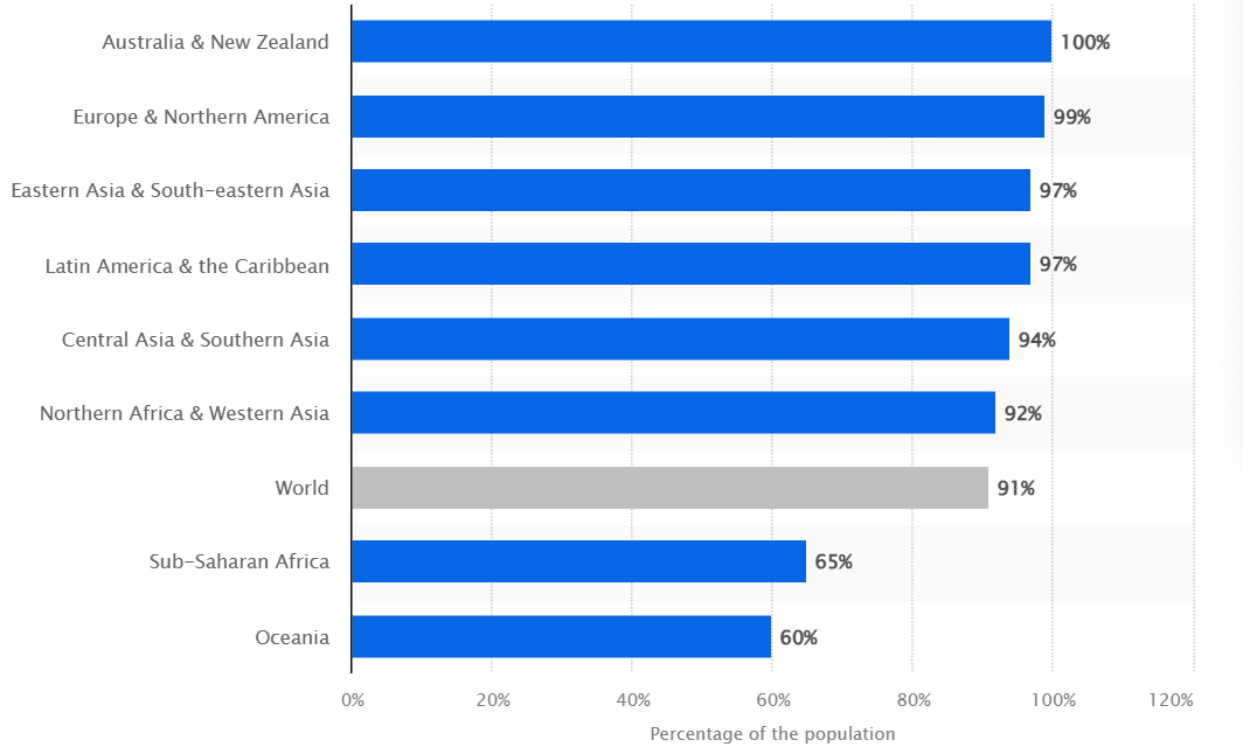
Palavras-chave: *Quarta Revolução Industrial (4RI). Qualitativo. África do Sul. Objetivo de Desenvolvimento Sustentável (ODS) 6. Água.*

1 INTRODUCTION

It is important to consider that “in most regions of the world, 90 percent of the population has access to at least basic drinking water services. However, just 65 percent of the population in sub-Saharan Africa and 60 percent of the population in Oceania had basic access in 2022” (Salas, 2025) In the context of “sub-Saharan Africa, about 16 percent of people had access to unimproved water sources and eight percent only had access to surface waters. Unimproved water sources include bottled water and tanker-trucks. Currently, eight out of ten people living in rural areas still lack even basic drinking water services. A lack of access to safe water is considered one of the top risks based on impact to global societies” (Salas, 2025), refer to Figure 1.

Figure 1

Share of population with access to at least basic drinking water services worldwide in 2022, by SDG region



Source: Statista, 2025.

To deal with water demands and water supply, it is important to have water governance in place. Water governance refers to the comprehensive array of political, social, economic, and administrative frameworks established to produce and manage water resources, as well as to provide water services across many societal levels (Jacobs-Mata et.al., 2021:1). This entails paying attention to the institutions, rules, organizations, and relationships that influence water use and management (Sehring, 2020:1). Regarding Water Service Authorities (WSA), water governance should, therefore, ensure efficiency, effectiveness, social equity and sustainability in the provision of water services at the local level. However, the state of water governance in South African local municipalities directly/indirectly affects the condition of water services and the reforms that have taken place over the decades. In terms of the state of water in the country, South Africa is considered one of the world's water-scarce countries (Alabi et.al., 2019:1).

Furthermore, the population growth, negative effects of climate change, and aging infrastructure (weighted an average of 39 years) have increased the pressure on water demand within the country (Alabi et al., 2019:1). Although the natural scarcity has posed some challenges on the level of access to water, various authors such as Sehring (2020:1), and Jacobs-Mata et al. (2021) present an opposing view on the issue. According to Sehring (2020:1), unsustainable management practices, unequal distribution, and conflicts of interest exacerbate water challenges.

While the above situation is the case presented in South Africa, the literature suggests that people living in rural areas are disproportionately affected compared to those in urban settings, resulting in unequal access to water services between rural and urban communities (Hutete, 2022:7). For example, research in Rwanda indicated that while rural inhabitants account for 82.8% of the national population, access to washing facilities equipped with water and soap was available to only about one-quarter, significantly less than one-third of the rural population (Jiwani & Antiporta, 2020:2).

On the other hand, Bwalya (2018:7) contends that the Fourth Industrial Revolution (4IR) presents an opportunity to deliver new and intelligent solutions to several societal challenges, hence necessitating the adaptation of e-government to accommodate continuous innovative possibilities. The Organisation for Economic Co-operation and Development (OECD) (2016:2) noted that the Fourth Industrial Revolution, via e-government, introduces a series of technological innovations in the public sector that can potentially facilitate the transformation of governmental structures, business processes,

and culture, thereby enhancing public services to be more transparent, user-centric, and efficient. Due to its multifaceted characteristics, e-government primarily resides at the intersection of public administration and information systems. In terms of water service provision,

Alabi et al. (2019:2) argue that despite the technological efforts adopted by South Africa over the past decades, challenges in the water sector remain prevalent, with almost 36% of the bulk water being lost by municipalities, and this has been a result of aging infrastructure, water leaks, and energy-related issues. Alabi et al. (2019:2) further argue that adopting advanced water technology, digital management systems, and expedited response times can mitigate water losses and enhance reliability.

2 METHODOLOGY

Researchers must carefully choose appropriate methods that will facilitate the attainment of the intended results. In accordance with this context, a good methodological design is essential to every successful research effort and affects data collection, analysis, and interpretation. Notably, Nayak and Singh (2021:11) emphasise the need for humanities and social science academics to choose methodologies and explain their philosophical basis through research paradigms. It is also suggested by Creswell and Creswell (2018:46-54) that while these paradigms may be obscured when conducting research, they have a significant effect and can profoundly influence and impact the entire research by describing the foundation for research methodologies (Shrestha & Sharma 2024:31). As a result, they must be acknowledged as they determine the research methodologies that will be adopted by researchers (Creswell & Creswell, 2018:46-54). The methodology used in the article is qualitative desktop analysis of available documents that are in public domain. Official documents of water authorities in South Africa, journals articles and reports on water governance, internet sources are utilised and then analysed using document analysis.

3 RESULT AND FINDINGS

The realisation that water challenges are primarily associated with governance challenges has led South Africa to recognise that addressing the water crisis requires more

than just addressing technical issues but also focusing on issues of water governance. Thus, the country has been shifting from a government water system to a more governance system since 1994. New legislation, such as the Water Service Act (Act No 108 of 1997) and the National Water Act (Act No 36 of 1998) (Makaya et.al., 2020:4), among others, have been formulated and implemented, shifting the water sector from a centralised to a more inclusive and decentralised system that focuses on improving water governance. This legislation transferred responsibility for water services from the national government to the local government, designating the provision of water services as a municipal responsibility under Schedule 4 Part B of the Constitution (Hutete, 2022:157).

Nonetheless, not all municipalities qualify as Water Service Authorities (WSAs), as authorisation was exclusively granted to metropolitan municipalities. Conversely, district and local governments were required to collaboratively assume responsibility within their areas to prevent coordination challenges and redundancy (Hutete 2022:157). These regulations are established pursuant to the Municipal Structures Act (Act No. 117 of 1998) and the Municipal Systems Act (Act No. 32 of 2000).

Similarly, the the United Nations Children's Fund (UNICEF)/ World Health Organisation (WHO) (2023: VIII) opine that the rate of progress must increase sixfold to meet the Sustainable Development Goal (SDG) target of universal access by 2030. Drawing upon these reflections, this study argues that establishing efficient water governance is imperative to ensure equitable access to water services for all (Hoekstra, 2006:25; Whaley, 2022:220). However, reducing individuals lacking access to sufficient water services is contingent upon fulfilling the political, social, economic, and environmental dimensions of water governance.

Furthermore, the above data indicate a projected increase in water demand in the coming years (estimated at 70% by 2050). This can be attributed to various factors such as population growth, extreme weather patterns including droughts and floods, and the impact of climate change, which has led to hotter and drier conditions, ultimately leading to a depletion of water resources (Romano & Akhmouch, 2019:1; Kathambi et.al., 2021:1; United Nations (UN), 2022:38). These authors (Romano & Akhmouch, 2019:1; Kathambi et.al., 2021:1; United Nations (UN), 2022:38) have advanced the argument that projections have been conducted that suggest that an increased number of individuals will be susceptible to the threat of floods by the year 2050. The statements can be

contextualized within South Africa, where the Eastern Cape and KwaZulu-Natal provinces experienced floods in 2022 and 2023.

Following numerous debates, the statistical analysis conducted using the Joint Monitoring Programmes (JMP) indicated that the Millennium Development Goals (MDGs) have led to significant advancements. According to the United Nations MDG Monitor (2017), JMP figures indicate that the targets for clean water accessibility were met in 2010, five years before the set deadline. From 1990 to 2015, there was an increase of 2.1 billion individuals who obtained access to 'better' sanitation and 2.6 billion individuals who gained access to 'improved' drinking water sources. Since 1990, there has been a nearly 50% reduction in the prevalence of open defecation among individuals. Similarly, Larionova (2020:14) and Anderson (2016:1) further opine that the MDGs for water were surpassed; however, there were implications with regard to water scarcity and inequities. The aforementioned statistics were corroborated by country-specific reports, such as that of South Africa.

4 DISCUSSION

Socio-economic inequalities and location-based disadvantages exacerbate these disparities, as rural communities often lack the necessary infrastructure and resources to ensure equitable access. The persistence of these challenges is evident even eight years after the MDGs concluded in 2015 (United NationsWater, 2018:16; Mattos et. al., 2021:855).

The inadequacy of current strategies further hampers progress toward SDG 6. Weststrate et al. (2018:800) and Chitonge et. al. (2020:217) argue that maintaining the status quo is unlikely to achieve the desired outcomes by 2030. While Public-Private Partnerships (PPPs) have been employed to advance water and sanitation goals, Stephens et.al. (2023:557) highlight their limitations, noting that the profit-oriented goals of private entities often conflict with the principles of social equity. These limitations underline the need for alternative approaches that prioritise equity over profit. The commercialised approach to water services further deepens disparities, as profit-driven private providers prioritise returns overextending services to marginalised communities (Song & González, 2022:79). Consequently, water distribution decisions are dictated by economic motives

rather than the principles of equity and public welfare, hindering the achievement of the SDGs.

The observation was made in the report by the United Nations Water (2018:11), stating that projected estimates suggest that if the natural environment continues to deteriorate. Unsustainable pressures are placed on the world's water resources; by 2050, approximately 45% of the world's gross domestic product, 52% of the world's population, and 40% of grain output will be vulnerable to risk. The situation's impact will be more significant on economically disadvantaged and socially excluded populations, aggravating existing inequalities (Rahaman et.al., 2021:472).

Data acquisition and monitoring represent critical challenges to realizing SDG 6, as they underpin governance pillars such as accountability, transparency, and participation. Effective monitoring mechanisms are essential for tracking progress, holding service providers, governments, and development partners accountable, and ensuring alignment with global SDG targets (Ortigara et. al. 2018:7). However, many countries, particularly in sub-Saharan Africa, face significant barriers due to limited economic, organisational, and human resource capacities needed for robust data collection and evaluation. In the context of water sector, one of the major barriers identified is an accountability gap, discussed below.

A study by Moyo and When (2017:98) on the implementation of the water sector skills plan in South Africa revealed the policy gaps, and the authors attributed it to factors such as actors' motivation, capacity, and information-sharing as contributors to the slow progression of water sector strategic planning (WSSP), all of which negatively affect policy implementation. More so, a study by Weaver et.al. (2019:8) on the civil society organisation response to water service delivery issues in South Africa underscored the importance of civil society participation in water governance, as emphasised by the National Water Act (1998).

With regards to the Department of Water and Sanitation (DWS), it is noted that beyond policy formulation, the department is also responsible for continuous policy review and evaluation to ensure alignment with evolving socio-economic and environmental imperatives (Water Research Commission, 2022:16). This dynamic approach to policy governance enables the department to address emerging challenges in water security, climate change resilience, and service provision inequities, thereby

reinforcing its commitment to sustainable and inclusive water resource management (Dini et.al., 2021:7).

Additionally, the department undertakes various programs that are essential for municipalities and supports municipalities in performing their role effectively regarding their water service provision (Local Government Sector Education and Training Authority (LGSETA), 2024:15). This can be exemplified by the War on Leaks Programme, which underscores the department's role in mitigating water losses through infrastructure maintenance and skills development (Parliamentary Monitoring Group [PMG], 2019:1; Energy & Water Sector Education Training Authority [EWSETA], 2020:13). Although the objective of this chapter is not to discuss the effectiveness of such initiatives, it is worth noting the scholarly debate which revealed deficiencies in the implementation of the project. Various scholars, such as Muller (2020:23) and Phillip (2022:1), argue that the program did not achieve its objectives of reducing water losses or creating jobs.

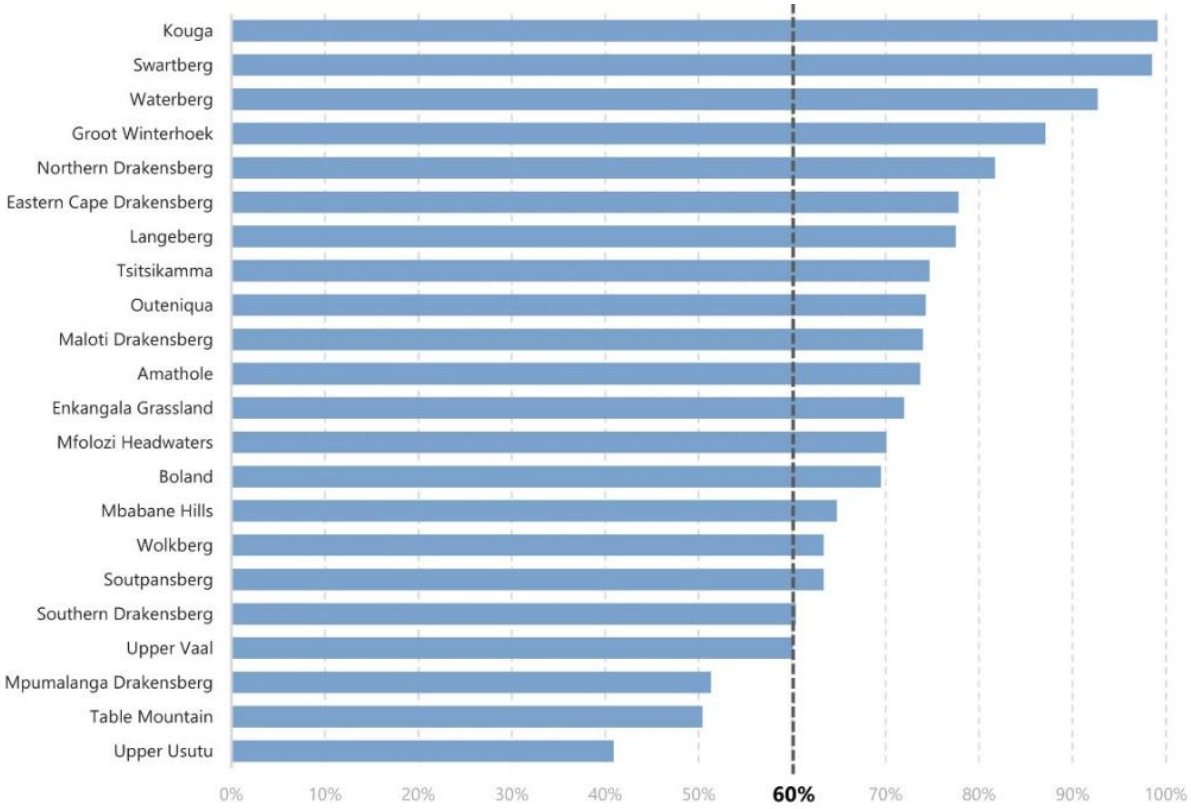
Other examples include Youth Development and National Water Week, which are commitments to ensure an integrated approach towards job creation, skills development, and entrepreneurship. National Water Week helps raise awareness about the importance of saving water. It encourages communities to join in the endeavors to ensure that every drop counts through responsible water management in communities (Government Communication and Information System [GCIS], 2022:10).

An appropriate strategy is required to enhance research and promote the creation of novel technology solutions, while concurrently cultivating future leaders in water management across governmental, industrial, and research domains (World Economic Forum, 2018:19). Resolving all forms of difficulties (financial, administrative, infrastructure, etc.) would empower the Water Research Commission to facilitate the advancement and execution of technologies that satisfy the requirements of both present and future generations in municipal water administration.

Additionally, it is important to consider that "South Africa is a semi-arid country, with only a few natural source areas for water. These areas, referred to as Strategic Water Source Areas (SWSAs), provide much of the water that flows from the taps" (Statistics South Africa, 2023), see Figure 2.

Figure 2

Proportion of natural or semi-natural land cover per SWSA, 2020 in relation to an ecological function threshold of 60%



Source: Statista, 2023.

The significance and challenges of SWSA may form part of future publications.

Hoekstra (2010:24) suggests that effective water governance requires coordinating various factors, including land and energy, and the marine environment in certain cases. Thus, the environmental dimension necessitates the implementation of sustainable water usage practices and preserving associated ecosystem services. Only with sustainable water practices can the water industry develop with stability (Huang & Peng, 2023:1).

Effective water governance will also guarantee that institutions can withstand and surmount challenges encountered in the delivery of water services. In instances where water governance is inadequate, adverse outcomes are likely to occur. The occurrence of Day Zero during the Cape Town, South Africa, water crisis in 2018 (Enqvist & Ziervogel, 2019:2) is a prime example of the idea in question, which led to severe water scarcity in the area. Academic discourse suggests that although Cape Town experienced a drought, poor water governance contributed to the delay of emergency measures and ultimately

intensified the consequences of the situation. Moreover, this phenomenon can be linked to the present situation of the Nelson Mandela Bay Municipality in Port Elizabeth, which came close to announcing Day Zero in 2023 (Mbiza & Sinha, 2022:1).

The Millenium Declaration presented an ambitious perspective that combined the notions of 'enhanced liberty' and human development (Larionova, 2020:10). The driving force behind this initiative stemmed from the recognition that although personal autonomy holds significant value, individuals face limitations in exercising their freedom when they are marginalized, unwell, lacking in literacy, subjected to prejudice, exposed to violent conflict, or deprived of political participation (Poku & Whitman, 2011:3).

According to Adenle (2017:1), several areas required strengthening, including democracy, infrastructure, industry, science and technology, and a robust implementation process. Other critics of the MDGs noted that their main weakness was the lack of a clear plan and enforcement mechanism, making it uncertain that their goals would be achieved (Hoekstra, 2010:37).

Chaudhuri and Roy (2017:37) echoed similar concerns in their study in India, criticising government reports claiming the MDGs were achieved, as households often relied on groundwater sources contaminated by multiple pollutants. Similarly, Marten (2018:585) argued that turning the goals into numbers made them too simple and abstract, leading to a shift in some of their original principles. Consequently, it is reasonable to question whether those who posited the infeasibility of attaining the Millennium Development Goals were accurate in their assessment and how this may impact the forthcoming Sustainable Development Goals. Hence, it is a query that remains unresolved in the scholarly discourse.

Additionally, capacity development, weak institutional capacity, limited human resources, and inadequate community participation impede effective water governance and accountability (Dinka & Nyika, 2024:15; Ortigara et. al., 2018:7) are some obstacles hindering SDG 6 progress. More so, the inadequate management and utilization of water resources represent significant obstacles to attaining Sustainable Development Goal 6 (SDG 6) in Africa. Key challenges include poor administration, corruption, high transactional costs, and ineffective cost recovery mechanisms, all of which exacerbate inequalities in water access and utilisation (Horne, 2020:901; Murwirapachena & Nyamazunzu, 2024:612).

Climate change poses a significant threat to the achievement of the SDGs for water and sanitation (Horne, 2020:888; Annisa et. al., 2023:1). The impacts of climate change, such as rising air temperatures, shifts in precipitation patterns, and increased vulnerability of economically disadvantaged populations highlight the need for water resource management to be contextualised within broader climate adaptation strategies (Moghayedi, 2024:285). Climate change threatens to aggravate water scarcity, with projections indicating that by 2050, up to 52% of the global population will face water stress, disproportionately affecting marginalized communities (Rahaman et. al., 2021:472; Stephens et. al., 2023:570).

Clarke and Feeny (2011:513) identified capability, geography, and various challenges as key factors. The disputes hold significant importance, particularly within the Sustainable Development Goal 6 framework, which aims to guarantee universal access to water. The challenges related to water governance and the water sector are contingent upon the context and vary across countries and regions. Therefore, utilising a uniform baseline to evaluate performance may lead to biased outcomes. It is imperative to exercise prudence with respect to contextual variations as they have a direct or indirect impact on the execution process, which has previously impacted the MDGs.

Infrastructure is mentioned as one of the main gaps in capacity within municipal water governance. The conducted literature review showed that water service authorities are faced with infrastructural challenges stemming from maintenance demands, upgrading, backlogs, decaying and outdated infrastructure, amidst the threats of population demand and climate change (Ndeketeya & Dundu, 2019:167; Department of Cooperative Governance (DoCG), 2022:23). A lack of financing has worsened this problem (Mbana & Sinthumule, 2024:9).

Current infrastructural challenges in South Africa appear to persist, aligning with global projections that estimate $90 trillion will be needed over the next decade to achieve sustainable infrastructure. As of the 2018 projection, South Africa is required to have an estimate of around ZAR840 billion over the next ten years that would need to be spent for adding new infrastructure, maintaining existing infrastructure, and upgrading old infrastructure (Department of Water and Sanitation [DWS], 2018a:47; Mandiriza & Fourie, 2023:2). Additionally, urbanisation, which concentrates on infrastructure demands, is expected to double these requirements (Adshead et. al., 2019:1).

On the other hand, Dithebe et.al. (2019:13) revealed that the structural weakness of the municipalities deepens the funding gap. The study highlighted several aspects, such as the lack of creditworthiness, non-transparent financial management, insufficient municipal revenues, inadequate investment laws, and corruption.

Internationally, OECD countries also face pervasive funding gaps in the water sector. The financial crisis constrained utilities' ability to raise tariffs due to affordability concerns and political resistance, while borrowing became more difficult (OECD, 2016:84). Similarly, in South Africa, municipalities rely on a mix of transfers, tariffs, and taxes ("3T") to fund water services (OECD, 2021:81; Muller 2023:1369). However, adjustments to the 3T model are necessary to secure stable revenues amidst declining water consumption and collection inefficiencies (OECD, 2016:83; OECD, 2021:81). The assertion follows the observations that with the current funding model, most water services are failing to collect revenues and are reliant on grant funding. This scenario is not healthy or sustainable.

Another study by Kroukamp & Cloete (2018:72) revealed that service delivery improvement plans and annual reports often lack clarity, with vague information making it difficult to measure performance accurately or establish reliable baseline data. More so, Naidoo et.al. (2016:463) identified knowledge gaps in the Green Drop and Blue Drop Programmes, noting deficiencies in public understanding and municipal obligations tied to these critical water quality initiatives. Aiding to this point, Rivett et.al. (2013:409) contend that this is particularly an issue in rural municipalities which are considered difficult to manage due to their dispersed population, historical setup, and other governance challenges such as under-resourcing and funding issues.

Hutete et. al. (2023:16) identified an imbalance between administrative and operational staff, with municipalities employing more administrative personnel while operational competencies remain lacking. This imbalance results in excessive consultations and delayed service delivery. Dhitebe et. al. (2019:103) point to unreliable planning, inefficient procurement processes, and insufficient technical capacities, leading to operational failures. Similarly, Bazaanah and Mothapo (2023:14245) highlight poor responsiveness to municipal complaints, lack of coordination among stakeholders, and rising water tariffs, which raise affordability concerns for rural residents.

Other studies that relate to the accountability gap in municipal water governance include a study by Mbana and Sinthumule (2024:9) which revealed financial

mismanagement in district municipalities, such as poor interventions during COVID-19, and corruption in the implementation of the Municipal Infrastructure Grant (MIG). Another study by Mabadahanye et. al. (2024:8) noted the lack of transparency and standardisation in municipal governance, stressing the need for improved transparency, accountability, and stakeholder engagement.

Additional challenges regarding policy implementation noted included excessive government involvement, administrative control, outdated institutional arrangements, fragmentation, poorly coordinated water administration, over-reliance on consultants, and deficiencies in capacity, funding, information, and accountability (Molobela & Sinha, 2011; OECD, 2015; Anderson & Guppy, 2017 as cited in Adom & Simatele, 2024:69). These factors collectively hinder the realisation of the intended outcomes of South Africa's water policies

Similarly, Hutete, Sibanda, and Maramura (2023:14), in their study of water governance and social equity in South African rural municipalities, revealed that some policies were partially implemented, highlighting the Rural Household Connection Policy and the consequence management policies as examples. The study further attributed these policy gaps to political interference and a lack of commitment to addressing rural disparities. Similarly, a study by Muller (2023:1377) cites the Free Basic Water Policy as having been weak in implementation.

Another study by Khunoethe et.al (2021:1–5) revealed a similar scenario in Msunduzi Local Municipality. Their study identified flaws in performance management systems, particularly the absence of alignment between Key Performance Areas and performance indicators for top management, which affected the municipality's objectives. Additionally, vague and conflicting objectives further hindered the municipality's ability to achieve its set goals.

Moreover, the Department of Water and Sanitation provides municipalities access to critical planning and management tools via its Water Services Systems Menu. This digital platform offers regulatory documents, technical guidelines, and strategic resources (Internet source: https://ws.DepartmentofWaterandSanitation.gov.za/wsmenu/default.aspx?dr=la).

Two examples of such tools are the Water Services Development Plan (WSDP) Support Tool and the Municipal Strategic Self-Assessment (MuSSA) system. The WSDP tool aids municipalities in structuring their water service plans by integrating knowledge

systems, automating planning frameworks, and aligning municipal strategies with regulatory requirements (Jalisa, 2024:2). The system provides situation assessments, infrastructure investment requirements, and Medium-Term Expenditure Framework (MTEF) projections to guide both municipal planning and the department's regulatory oversight (Haigh et. al., 2010:477; DWS, 2015:10).

Meanwhile, the MuSSA system, established in 2006, is a digital repository for evaluating municipal capacity and performance in water and sanitation service delivery. By identifying institutional vulnerabilities and informing Municipal Priority Action Plans, MuSSA is an internal monitoring mechanism for Water Services Authorities (WSAs) and a strategic performance assessment tool for the department and its sector partners (Jalisa, 2024:7).

Data-driven decisions through 4IR technologies have the potential to enhance and transform planning in Water Service Authorities by making it more transparent and inclusive (Krammers et. al. 2014:299). Therefore, this study contends that data-driven decisions and informed planning can enable water governance stakeholders and municipalities to be more proactive than reactive to changing patterns and help mitigate the risks associated with water scarcity and climate variability, as they will have accurate, accessible, real-time, and up-to-date data to make more informed decisions and address service delivery challenges (Nel & Masilela, 2020:35; Wanyama et.al., Oluk, 2024:10). These efforts may contribute to the achievement of sustainable and resilient water service institutions which are critical components of water governance.

More notably, the Water Research Commission (2024:11) recognises that although technology cannot address all water-related issues, the Fourth Industrial Revolution can foster innovation in water resource management and profoundly influence water governance. However, Montmasson-Clair et.al. (2022:19) emphasise additional research and investment in efficient water supply and sanitation services in South Africa. The authors (Montmasson-Clair et. al., 2022:19) further highlighted the difficulties in commercialising local water and sanitation technology due to insufficient support for skill development. Given the above discussions, the current study emphasises the importance of the Water Research Commission as a key player in adopting and implementing 4IR technologies to improve water governance through research and innovation.

5 CONCLUSION

The study noted that ageing staff, the absence of a replacement plan, turnover and vacancies at the Department of Water and Sanitation had detrimental implications on its mandate to perform its duties towards the local government. Notably, these deficiencies force municipalities to be reactive rather than proactive, impede proper community engagement, and, in some cases, limit participation as the capacity to do so may need to be improved. Additionally, the administrative deficiencies in South Africa's water sector are intensified by ineffective billing and revenue collection, operational inefficiencies, workforce shortages, and insufficient reporting and transparency. These issues result in financial losses, service interruptions, public demonstrations, and a decline in trust in local governance, perpetuating a cycle of inefficiency and inadequate service delivery.

The lack of empirical data is considered as a limitation to the study. The future studies may conduct interviews with personnel of water authorities, water institutions, water ministry. This may to some extent may fill the gap between theory and practice of water governance.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

How to cite this article (APA)

Vyas-Doorgapersad, S. (2025). PROGRESS AND CHALLENGES RELATED TO WATER GOVERNANCE IN SOUTH AFRICA. *Veredas Do Direito*, 22(6), e223358. https://doi.org/10.18623/rvd.v22.n6.3358