

AYÍKÁ

ISSN: 2664-3030 (Print)
2664-3022 (Online)

**JOURNAL OF ENVIRONMENT AND
POLITICS IN AFRICA**

AYIKA: JOURNAL OF ENVIRONMENT AND POLITICS IN AFRICA

DOI: <https://doi.org/10.69778/2664-3022/2026/8.1/EN>

Editorial Note

This issue of *AYIKA* brings together a rich and timely collection of scholarship that underscores a central truth: in Africa, environmental questions are deeply political, and political realities are increasingly shaped by environmental change. The contributions in this volume reflect the growing complexity of this relationship, engaging themes that span governance, technology, security, sustainability, and identity across diverse African contexts and beyond.

A defining feature of this issue is its strong engagement with the role of digitalisation in advancing sustainability. From the systematic review on how digitalisation enables decarbonisation, to analyses of agri-tech adoption in Nigeria and South Africa, the volume highlights the transformative potential of technology in addressing environmental challenges. These contributions move beyond optimism, carefully examining the mechanisms and constraints that shape technological uptake. They remind us that digital solutions are not neutral; their effectiveness depends on policy frameworks, institutional capacity, and socio-economic conditions.

Equally prominent is the question of governance, particularly in relation to service delivery and institutional performance. The examination of water service failures in Gauteng Province offers a sobering account of how governance lapses can translate into environmental and public health crises. Similarly, the discussions on public service reform and parliamentary oversight reveal the persistent challenges of accountability and administrative effectiveness across the continent. Together, these studies point to a critical insight: sustainable environmental outcomes are contingent on capable, transparent, and responsive institutions.

The issue also engages deeply with questions of political order, security, and regional cooperation. Analyses of Zimbabwe's political history, hybrid regimes in Central Africa, and border conflicts involving Nigeria reveal how political instability and governance structures shape environmental management and development trajectories. The exploration of indivisible security within the SADC region further highlights the interconnectedness of peace, cooperation, and sustainable development. These contributions reinforce the idea that environmental sustainability cannot be pursued in isolation from broader political and security dynamics.

Another important strand in this volume is the emphasis on economic strategies and livelihoods, particularly in rural contexts. Articles on organic agribusiness, marketing strategies aligned with climate action, and the challenges faced by women in agribusiness illuminate the everyday realities of sustainability. They foreground the experiences of local actors, especially women entrepreneurs, whose resilience and innovation are often overlooked. By examining the socio-economic factors shaping revenue growth and participation, these studies contribute to a more inclusive understanding of development.

The volume also makes a significant intellectual contribution by foregrounding indigenous knowledge systems and alternative epistemologies. The exploration of

Ubuntu as a framework for regional governance offers a human-centred perspective that challenges dominant policy paradigms. Similarly, the critique of epistemic violence in transboundary conservation highlights the marginalisation of local knowledge and agency. These interventions are particularly important in rethinking whose knowledge counts in environmental governance and how more equitable frameworks can be developed. Urban spaces and cultural expressions are not left out of this conversation. Contributions on city branding in Harare and the intersection of art, space, and identity in Durban demonstrate how environmental and political dynamics are experienced and expressed in urban contexts. These studies expand the scope of environmental politics by incorporating cultural and spatial dimensions, offering fresh insights into how cities in the Global South are responding to climate change.

Notably, this issue also extends its analytical reach beyond Africa, with a study on urban climate initiatives in Brazil and a comparative examination of socio-economic vulnerability in Sub-Saharan Africa and the Pacific Islands. These contributions enrich the volume by situating African experiences within a broader global context, encouraging cross-regional learning and dialogue.

Finally, the inclusion of research on language and education, such as the study on tense substitution errors among Tshivenda-speaking students, serves as a reminder of the interconnectedness of knowledge production, communication, and development. It highlights the importance of education in shaping the capacity to engage with complex environmental and political issues.

Taken together, the articles in this issue reflect a vibrant and interdisciplinary field of inquiry. They challenge simplistic narratives and instead offer nuanced analyses that recognise the interconnected nature of environment and politics in Africa. As the continent continues to navigate the pressures of climate change, population growth, and political transformation, the insights presented here are both timely and necessary. This volume invites scholars, policymakers, and practitioners to think more critically and act more collaboratively. It is our hope that the conversations sparked within these pages will contribute to more just, sustainable, and context-sensitive approaches to environmental governance in Africa and beyond.

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LAPSES IN WATER SERVICES MANAGEMENT WITHIN GAUTENG PROVINCE- A SCOPING REVIEW OF HAMMANSKRAAL WATER WOES

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Abstract

Sustainable access to safe drinking water depends on effective water services management to consistently deliver potable water to South African residents. In Gauteng, recurring breakdowns in potable water supply and quality persist despite a robust policy framework and major bulk-water infrastructure, such as the Integrated Vaal River System (IVRS). Hammanskraal remains a high-risk case, marked by unstable supply and unsafe water outcomes despite extensive policy commitments and provincial capacity investments. An adaptive resilience approach can strengthen WSM by translating infrastructure and policy into safe, reliable potable water by reducing service disruptions over time. Consequently, this study examined the Hammanskraal case through a PRISMA-ScR scoping review (July 2025), with record screening conducted in Covidence and thematic coding undertaken in NVivo and ATLAS.ti networks. Bibliometric mapping (Biblioshiny) complemented the analysis by tracing patterns of evidence over time. Triangulated findings identified five themes and indicated that structural, procedural, and behavioural disruptions necessitate a practical improvement plan. Accordingly, the study developed a sequenced six-step adaptive resilience improvement plan to strengthen WSM tailored for Hammanskraal, Region 2 of the City of Tshwane, which is comparable to vulnerable urban municipalities.

Keywords: water services management (WSM), water resilience theory, SDG 6, Hammanskraal, Gauteng,

Introduction

Sustainable access to potable water is critical for public health, economic development and environmental sustainability. Safe drinking water is essential for achieving SDG 6, particularly target 6.1, which calls for universal, equitable access to safe and affordable water (UNICEF, 2022, p. 2). In a similar vein, the African Union Agenda 2063 advances sustainable and equitable water resources management as a foundation for socio-economic development (African Union Commission, 2015, p. 3). Despite these imperatives, major water access gaps persist: the World Bank (2023:8) reports that as of 2022, approximately 2.2 billion people still lacked access to safe, potable water. South Africa also reflects these global pressures. As a semi-arid country, it has experienced recurring drought conditions over the past four decades (Meza et al., 2021, p. 4). While also contending with longstanding water-related public service delivery challenges shaped by historical inequalities (Johnson & Hlatshwayo, 2025, p. 120; Maremane et al., 2024, p. 2), underdeveloped and poorly maintained infrastructure (Nephawe, 2023, p. 37), and ineffective governance interventions (Chagopa, 2023).

In Gauteng Province, rapid urbanisation, population growth, and economic concentration intensify demand in an already strained water services management environment. The province is located across the continental surface watershed dividing the Limpopo and Orange River basins (Van Vuuren, 2024, p. 10), and it meets much of its water-for-use demand through a highly engineered bulk-water storage and delivery system- the Integrated Vaal River System (IVRS) (Kotzé, 2020, p. 39). Despite the engineered IVRS (Kotzé, 2020, p. 38; Van Vuuren, 2024, p. 10) and recent technological advancements, the fragility of water demand, and monitoring and control systems is evident. The province experiences recurring reticulation crises driven by high water loss linked to poor

infrastructure maintenance, sabotage and theft, demographic challenges (including inaccurate censuses), and persistent inefficiencies in public management. Several municipalities have consistently failed to reticulate potable water to residents (South African Human Rights Commission, 2023), contributing to ongoing lapses in water availability that undermine the constitutional right to sufficient water. These dynamics strengthen the need to explore resilience theory in water services management to understand the system's capacity to adapt and sustain reliable service delivery.

Although existing studies have explored water services management challenges and proposed resilience-oriented responses in Gauteng (Mnguni & Leonard, 2024, pp. 285–289), and suggested frameworks to assess innovative delivery approaches in municipalities. For instance, the *Resilience Capacity and Strategic Agility* (RCSA) framework to assess the feasibility of an innovative water-delivery system in South African municipalities (Nephawe, 2023, p. 18). These contributions remain largely diagnostic, outlining principles and organisational capacities rather than providing a sequenced, context-specific implementation pathway for the continuity of potable water services. The RCSA's model clarifies the organisational capacities associated with resilience and is primarily designed to assess institutional readiness and responsiveness to change, rather than specifying a sequenced, cross-institutional implementation programme for potable-water service continuity. In a similar vein, Mnguni and Leonard's application of the UNDP Water Governance Framework provides a principled, structured basis for diagnosing governance gaps and advocating policy improvements that advance equity, efficiency, and sustainability. However, its application yields largely recommendation-based outputs rather than a step-by-step operational plan. Consequently, the existing research gap is practical rather than diagnostic in nature.

While prior studies identify governance and infrastructure constraints and recommend reforms, they do not specify a sequenced, cross-institutional implementation pathway to maintain continuity of potable water service during disruptions, particularly in Hammanskraal. Hammanskraal continues to experience recurring disruptions in the continuity and safety of potable water services. Challenges include coordination failures, delayed infrastructure upgrades, and insufficient institutional collaboration, and these undermine sustainable water service delivery (Mnguni & Leonard, 2024; Sobuwa, 2023). Intensifying these dynamics is the inadequate maintenance of the Rooiwal Wastewater Treatment (Johnson & Hlatshwayo, 2025, p. 120) and the effects of load shedding (Makgopela & Radikonyana, 2023, p. 291), which contribute to unsafe tap water quality and supply issues (Mnguni & Leonard, 2024, p. 283; Sobuwa, 2023). These outcomes point to governance and operational weaknesses despite significant budget allocations and sufficient storage capacity (Kotzé, 2020, p. 39). While SDG 6.1 and Agenda 2063 are used to motivate the study's significance, the study is bound to the availability of potable water services in Hammanskraal. It examines provincial and municipal dynamics to understand how they shape a sequenced, implementable adaptive resilience plan for water services management.

To address this gap, the article develops a context-specific, step-by-step adaptive resilience implementation plan to improve the continuity and sustainability of potable water services in Hammanskraal. It employs resilience theory, particularly adaptive resilience, as the organising analytical lens for translating governance and infrastructure diagnoses into actionable design principles for service continuity under disruption. The study draws on a PRISMA-guided scoping review to synthesise evidence on the systemic factors shaping potable water supply-and-demand failures in

Hammanskraal and translate these findings into an implementable improvement plan for municipal practice.

The paper progressively builds towards this improvement plan through four objectives. First, it establishes the rationale for resilience-oriented water services management as a basis for responsive and sustainable potable water delivery (Q1). Second, it positions adaptive resilience as the most applicable resilience paradigm for governance contexts marked by socio-economic and environmental vulnerability, and distils the key principles required for the continuity of potable water services (Q2). Third, it applies these principles to interpret the scoping review evidence and identify the primary governance, operational, and infrastructure constraints undermining water services management in Hammanskraal (Q3). Finally, it integrates the evidence and adaptive resilience principles to develop a systematic, sequenced improvement plan that addresses the structural, procedural, and behavioural drivers of weak water services resilience in the Township (Q4). The study's significance is two-fold. Substantively, it supports SGD 6.1 and aligns with Agenda 63 by advancing practical pathways to safer and more equitable access to drinking water in vulnerable communities (UNICEF, 2022, p. 2; African Union Commission, 2015, p. 3). Practically it contributes to a governance toolset that directly addresses recurring institutional mismanagement, infrastructure decay, weak monitoring and control, and reactive crisis responses that continue to undermine the constitutional right to sufficient water in South Africa.

Water Services Management within a Resilience Framework

Sustainable water services management aims to ensure the equitable, reliable and continuous provision of safe potable water to all users, while maintaining the long-term functionality of the service system and the sustainability of this scarce resource base on which the service depends

(Makanda et al., 2022, p. 11). In South Africa's semi-arid context, where rainfall falls below the global average of 860 mm/year (Hosking et al., 2011, p. 3; Kotzé, 2020), effective water services management becomes especially critical to safeguard equitable access and reliable service delivery. Within this framing, the core objective of water services management systems is to consistently supply users with an adequate quantity of potable water through well-governed institutions, robust infrastructure and effective operational planning (Weaver et al., 2017, p. 399). The National Water Act 36 of 1998 sets out core principles of equity, sustainability and efficiency that shape the broader enabling environment (1998:14). These principles translate into service delivery performance in potable water provision.

South Africa's Constitution (1996) entrenches the governance of water services management and assigns responsibility for water and sanitation services to local government (Hosking et al., 2011, p. 3). Key legislation and institutional arrangements further structure this governance, including the Water Services Act 108 of 1997, the National Water Act (1998), the Local Government: Municipal Systems Act 32 of 2000, the Strategic Framework for Water Services (2003), and the National Water Resources Strategy II of 2013, as well as institutions such as the Department of Water and Sanitation (DWS), water boards, and local government Water Services Authorities (WSAs). Collectively, these statutory and institutional arrangements define the roles, responsibilities, coordination mechanisms, and planning requirements needed for effective water services management. Thus, enabling technical capacity, governance oversight and community responsiveness to support safe and equitable potable water services (Department of Water & Sanitation, 2023). Despite this policy and institutional architecture, persistent lapses in water service delivery continue to undermine

service reliability and equitable access (Mnguni & Leonard, 2024, p. 285). Interconnected pressures, including water scarcity, pollution, infrastructure deterioration, governance inefficiencies, and environmental impacts, constrain the management of water services (Geldenhuys, 2024; Mabadahanye et al., 2024, p. 2). Weak enforcement mechanisms and poor accountability, coupled with inadequate punitive measures, can further entrench poor performance (Mnguni & Leonard, 2024, p. 285). Infrastructure decline reflects underinvestment and fragmented coordination among responsible bodies (Nephawe, 2023). In this context, water resilience becomes a critical lens for water services management because it strengthens the capacity of the potable water service system to withstand disruptions (drought, infrastructure failure, pollution) and recover while maintaining a safe supply (Hosking et al., 2011, p. 3). Given these ongoing disruptions, the study explores how water services management conceptualises resilience by addressing the following question:

Q1: How can resilience-oriented water services management strategies be practically implemented to ensure responsive and sustainable potable water services in South Africa?

Conceptualising resilient water services management in South Africa

Water resilience is increasingly recognised as a critical concept for responding to societal and environmental stresses from both human and physical hazards (Sutherland et al., 2019, p.33). In the context of water services management, resilience is most relevant when it strengthens the capacity of service institutions and systems to deliver equitable, safe, and reliable potable water despite disruptions such as infrastructure failure, operational constraints, financial pressures, pollution incidents, and climate-related shocks. Accordingly, resilience is

not treated as an abstract ecological ideal but rather becomes a service assurance capability that supports the continuity of water supply, service quality, and equitable access under pressure.

Policymakers worldwide are increasingly incorporating resilience thinking into public policy as a practical requirement for service providers. A useful example is the Water Act 2014 in England and Wales. The amendment to the Water Act 2014 now requires water companies to carry out the following:

- Secure the long-term resilience of water undertakers' supply systems in relation to environmental pressures, population growth and changes in consumer behaviour; and
- to ensure that undertakers take steps to enable them to meet, in the long term, the need for the water supply services to customers (Lawson et al., 2020, p. 4).

The example above illustrates how water services managers can operationalise resilience, but it still needs to be translated into enforceable duties that drive long-term planning, investment, and preparedness. Given that environmental, infrastructural and socio-economic pressures disrupt South Africa's potable water services, comparable approaches provide a useful benchmark for strengthening potable water service assurance responsibilities through clear performance duties, long-term planning requirements and accountability mechanisms.

Traditionally, resilience has been defined as a system's ability to bounce back or return to a prior equilibrium after disruption (Welsh, 2014). This interpretation has been dominant in engineering, where resilience is associated with restoring operational stability and performance following a shock event (Givens et al., 2018, p. 3), thereby emphasising stability and recovery to a prior state. When applied to water services management, this view supports immediate

restorations, such as repairs, and restoring the restoration of acceptable service levels after breakdowns. Contemporary resilience research frames resilience as a dynamic, adaptive capacity. Researchers measure it by how quickly systems recover, how much change they can absorb before shifting, and how they adapt afterwards (Givens et al., 2018, p. 3). Accordingly, resilience includes the ability to bounce forward by adapting institutions, infrastructure, and governance arrangements to manage future disruptions better (Davoudi et al., 2012, p. 309). This framing is especially relevant to water services management because persistent service disruptions often reflect structural weaknesses, such as governance and maintenance failures, rather than sudden shocks captured by traditional resilience.

Adapting water services is crucial for building resilience because potable water service systems are increasingly vulnerable to interrelated disturbances that threaten their stability and long-term functionality. Johannessen and Wamsler (2017:4) provide a useful typology of disturbances that can be applied directly to water services management:

1. Socio-economic disturbances, arising from internal institutional dynamics such as corruption, capacity gaps and financial constraints within water institutions;
2. hazard disturbances, arising from external crises affecting the water infrastructure system, such as drought or flooding, and
3. long-term disturbances, including unsustainable pressures and ecological degradation within broader social-ecological systems.

These disturbances reinforce that there is no single approach to water resilience. In water services management terms, resilience is closely tied to improving water security under climate stress while reducing vulnerability to water-related risks (Rodina, 2018, p. 3). Ideally, resilience should enable potable water

service systems to maintain or rapidly restore acceptable service levels during and after disturbances (Balaei et al., 2020, p. 1). Accordingly, South African water services management must evolve towards resilience as ongoing adaptation and transformation, rather than short-term recovery alone. Considering the contrast between traditional (recovery-focused) and contemporary (adaptive) resilience, particularly when applied to water services disturbances, this study defines resilience as follows:

Resilience is the capacity of a potable water service system to withstand disturbances that reduce service performance, and to restore and sustain effective service delivery through timely recovery and ongoing adaptation to interrelated pressures.

This definition integrates the engineering emphasis on recovery with contemporary resilience's focus on adaptation and transformation. Resilience is a service delivery capability which prioritises how quickly and effectively water systems regain and sustain performance while adjusting to ongoing pressures.

Nevertheless, despite the evolution of resilience theory towards dynamic and adaptive interpretations, the practical application of resilience in water services management often remains tethered to static models that prioritise recovery to the prior state after disruption (Welsh, 2014, p. 16). While valuable for immediate restoration, static approaches are less effective for addressing long-term vulnerabilities and systemic risks. Persistent challenges, including water scarcity, pollution, infrastructure decay, governance issues, environmental impacts, and community engagement (Geldenhuys, 2024; Mabadahanye et al., 2024), are frequently reproduced where the focus remains on restoring current services rather than proactively transforming systems to anticipate future disruptions. Contemporary resilience scholarship stresses that resilience is not primarily

about maintaining stability, but about evolving in response to disturbances (Davoudi et al., 2012, p. 304; Lu & Stead, 2013).

Accordingly, water services management in South Africa often lacks sufficiently embedded adaptive capacity, creating a gap between resilience theory and day-to-day governance and operational practice. Static mechanisms have not kept pace with evolving potable water demands and escalating disruption risks, as reflected by the persistent service delivery challenges mentioned earlier. Addressing these challenges requires a shift in water services management towards adaptive governance. Against this tension between static and adaptive resilience paradigms, the following critical gap emerges:

Q2: How can practitioners operationalise adaptive resilience principles in real-world water governance and management, particularly in contexts facing socio-economic and environmental vulnerabilities?

Operationalising Adaptive Resilience in Gauteng's Water Services Management

Adaptive resilience principles offer a pragmatic approach for strengthening water services management in Gauteng, where a complex bulk supply and distribution system, inter-institutional dependencies and persistent socio-economic and environmental pressures shape service delivery performance. Rand Water supplies most water users across the province (Van Vuuren, 2024, p. 11), while the Apies River and Leeuwkraal Dam serve as critical natural water sources for other regions, including Hammanskraal (Nephawe, 2023). The Integrated Vaal River System (IVRS) supplies Gauteng's water needs through a highly engineered bulk water storage and delivery network (Van Vuuren, 2024, p. 10). It imports water from five river basins across six provinces and Lesotho, including the uThukela, upper uSuthu, Lesotho Highlands, and Senqu

River, supported by a system of 14 dams (Kotzé, 2020, p. 39). The IVRS supports Gauteng's industrial and economic growth by generating 50-60% of the region's output, significantly contributing to South Africa's GDP (Tempelhof, 2021, p. 29). However, systemic failures threaten the reliability of this service system, particularly where dependence on external transfers, degradation of water bodies and inadequate infrastructure management constrain the continuity and quality of potable water services.

This context demonstrates a central problem in water services management: *sophisticated bulk infrastructure does not automatically translate into reliable, sustainable services management and delivery outcomes*. Droughts persist, and climate change intensifies water-scarcity pressures (Kotzé, 2020, p. 39), while Gauteng's position on the watershed dividing the Limpopo and Orange River basins increases dependence on inter-basin transfers and on coordinated regional governance (Van Vuuren, 2024, p. 10). Although the IVRS and Rand Water's infrastructure, including 3,500 km of pipelines and 60 reservoirs (Van Vuuren, 2024, p. 11), provide critical bulk supply capacity, repeated service disruptions highlight the limitations of static, supply-driven planning in a highly interconnected, risk-exposed system. In the water service management context, this means resilience must be operationalised through infrastructure, adaptive governance, and operational capability, including responsiveness in institutional decision-making, strengthening coordination across responsible bodies, and enabling meaningful community engagement in planning and accountability.

Against this provincial backdrop, Hammanskraal provides a focused case through which to examine how adaptive resilience can be translated into practical water services management strategies. The Township faces recurrent coordination

failures, delayed upgrades, and weak institutional collaboration (Sobuwa, 2023), along with infrastructural maintenance issues at Rooiwal and load shedding disruptions impacting water quality and service (Johnson & Hlatshwayo, 2025, p. 120; Makgopela & Radikonyana, 2023, p. 291). Despite available budgets and storage, governance and management constraints persist (Chagopa, 2023; Kotzé, 2020, p. 39). The following section uses a scoping review to identify evidence gaps and inform an adaptive, resilient water management approach, leading to the following question:

Q3: How can Hammanskraal apply adaptive resilience principles to sustain potable water continuity amid infrastructural decline, environmental pressures and water services management constraints?

Research Methodology

This study employed a qualitative scoping review to answer Q3 by mapping and synthesising existing evidence on Hammanskraal Township's potable water disruptions and water services management conditions, including governance capacity, treatment performance, distribution reliability, monitoring and response, and community-level impacts. A scoping review was appropriate because the Township's crisis is multidimensional, spanning from institutional performance, infrastructure condition, risk management, and public health, and because the study aims to identify the breadth, nature, and patterns of evidence, as well as the practical resilience-oriented strategies discussed in the literature. The review followed PRISMA-ScR guidance to ensure transparent reporting of the search, screening, and inclusion process. A bibliometric mapping component was embedded alongside thematic synthesis to strengthen the WSM focus and show how the evidence base has evolved.

Database selection

A structured scoping review search strategy was used to map the literature on Hammanskraal's potable water challenges and related water services management in the City of Tshwane/Gauteng context. In July 2025, the review team searched Google Scholar ($n = 76$), Web of Science ($n = 50$), Scopus ($n = 7$), and JSTOR ($n = 39$). The team limited searches to English-language publications from 2015–2025 to prioritise contemporary evidence relevant to the current service delivery context and institutional arrangements.

Search Strategy

Search strings combined Boolean operators and keywords aligned to the review objective, including “potable water”, “Hammanskraal water crisis”, “water services management”, “Gauteng”, and “City of Tshwane”. Database-specific adaptations were applied where required.

Eligibility criteria

The eligibility criteria were operationalised in Covidence using a structured screening framework, PICOS, adapted to a scoping review logic focused on Population-Intervention-Comparator-Context. The diagram below presents the results

Figure 1: Inclusion and exclusion criteria

POPULATION • Include: Residents, households, and communities in Hammanskraal Township. Vulnerable groups affected by potable water lapses. Municipal governance structures directly involved in potable water services. • Exclude: Studies not involving Hammanskraal Township. Populations outside Hammanskraal. Commercial/ agricultural populations.
INTERVENTION • Include: Failures in potable water service delivery, Infrastructure decay, Governance failures, Pollution affecting potable supply, Public health risks/outcomes linked to potable water failures • Exclude: Water service issues unrelated to potable drinking water.
COMPARATOR • Include: Local governance arrangements and community response mechanisms, Urban township environment characterised by infrastructure and governance stressors. • Exclude: National/provincial studies that mention Hammanskraal only in passing. General discourse on water access without specific evidence on Hammanskraal potable water failures.
OUTCOME • Include: Potable water quality deterioration (e.g., faecal contamination, unsafe drinking water indicators). Waterborne disease events linked to water quality/supply disruptions. Service delivery breakdowns. Governance responses and failures (e.g., policy gaps, response delays, implementation breakdowns). Community coping strategies and resilience practices • Exclude: Outcomes unrelated to potable water safety, infrastructure performance, or governance of potable services. Purely speculative proposals not grounded in empirical evidence.

Studies that primarily focused on water resources management (e.g., allocation, catchment hydrology, or ecological management) and did not clearly link to potable water service delivery,

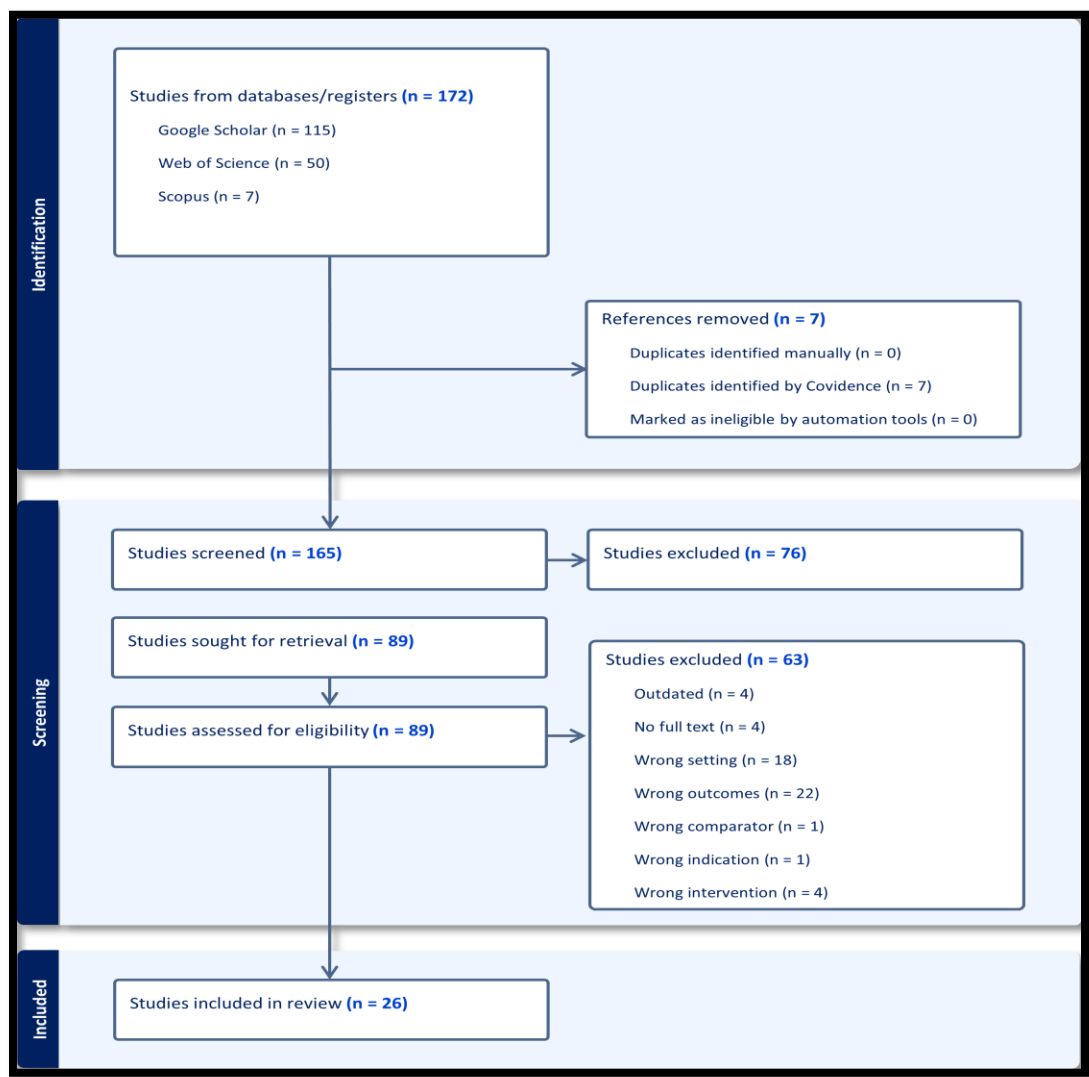
management performance, or service continuity were excluded.

Selection process and screening

All retrieved records were uploaded to Covidence for deduplication and screening. After removing seven duplicates, 165 records underwent title and abstract screening. 78 records were excluded for failing to meet eligibility criteria, leaving 87 full-text articles eligible for assessment. Following full-text screening, 61 studies were excluded due to the wrong setting,

wrong outcomes, wrong intervention focus, or incompatible study design. Twenty-six studies were included in the final synthesis. Screening was conducted by two independent reviewers, with disagreements resolved by the primary reviewer. The screening and inclusion process is summarised in the PRISMA-ScR flow diagram (Figure 2).

Figure 2: Hammanskraal Case Study
Source: Covidence Software



Data Extraction

Data were extracted in Covidence using a structured charting approach designed to capture evidence relevant to the continuity of water services management in Hammanskraal. Extracted fields were organised across:

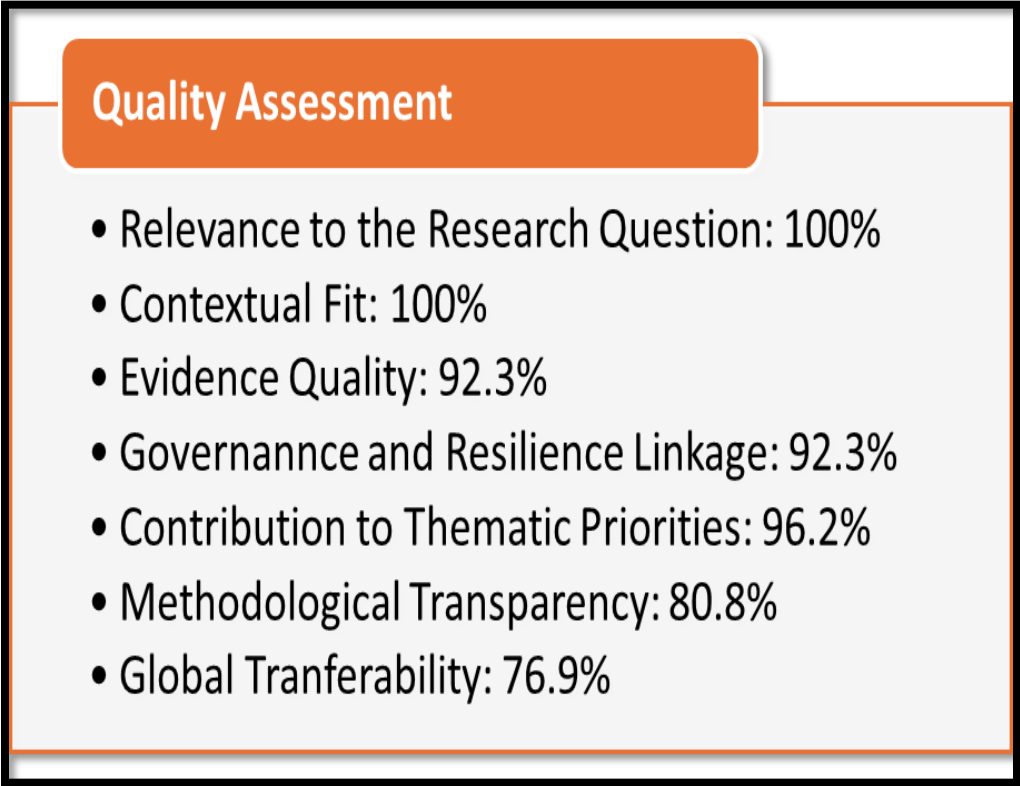
1. water supply, treatment, and distribution performance;
2. municipal governance, institutional capability, and coordination;
3. infrastructure maintenance, rehabilitation, and operational management;
4. policy, planning, monitoring, and regulatory mechanisms; and

5. community-level experiences, engagement, and civil society responses.

Quality Assessment

A structured quality appraisal in Covidence was conducted to assess the 26 included studies and strengthen interpretive rigour. The appraisal team evaluated each study across seven domains: relevance to Q3, contextual fit, methodological transparency, evidence quality, governance–resilience linkage, contribution to thematic priorities, and transferability. The team assigned High/Low/Unsure ratings and documented brief justifications for each judgement, then retained consensus ratings to ensure auditability.

Figure 3: Quality Assessment



The quality assessment indicates that the selected literature base is well-suited to the study. Most selected literature aligns with the research question and applies to the Hammanskraal potable water context, providing sound evidence on the relationship between governance challenges and resilience. Methodological transparency and global transferability indicate that some studies fail to explain their methodology clearly. Moreover, some findings are best treated as context-specific rather than broadly generalisable beyond Hammanskraal. Despite the modest sample size, 26 included studies are justified for this scoping review because they demonstrate strong contextual relevance and fit, and an overall high-quality appraisal profile.

Data Analysis and Synthesis

Data analysis proceeded in two complementary streams:

Thematic Synthesis

The data extracted were exported to NVivo to generate an initial coding structure. The team then imported the coded dataset into ATLAS—ti for confirmatory thematic analysis and synthesis. Code groups and thematic networks examined how governance performance, infrastructure condition, monitoring and response, and community experience interact to shape the continuity of potable water services management in Hammanskraal Region 2. Outputs included a word-frequency visualisation and thematic networks reported in the findings section.

Bibliometric Mapping

A bibliometric analysis was conducted using the Biblioshiny interface of the Bibliometrix R-package (Aria & Cuccurullo, 2017) in RStudio. This component used a Scopus-indexed dataset (separate from the scoping review dataset) to generate a temporal co-occurrence

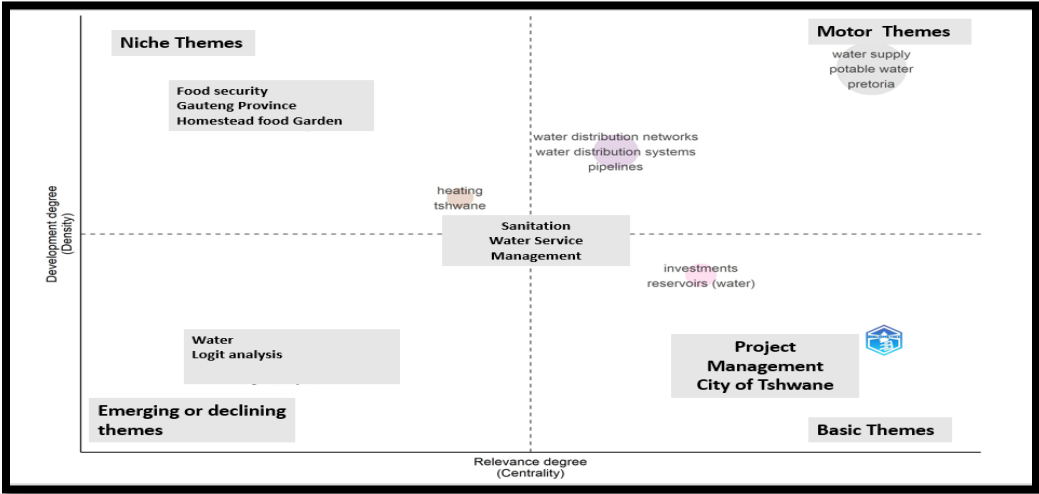
overlay map of peer-reviewed literature relevant to water services management within the City of Tshwane/Gauteng context over 2004–2024. Bibliometric outputs (thematic maps and overlay networks) were used to contextualise shifts in research emphasis across service delivery, treatment quality, governance, and risk/monitoring themes (reported in the findings section, Figures 3–4). These bibliometric outputs were then triangulated with the thematic synthesis to strengthen conclusions about the operationalisation of adaptive resilience in Hammanskraal.

Discussion of Hammanskraal Findings

Data triangulation of ATLAS.TI networks and bibliometric maps consistently characterise the crisis in Hammanskraal as a WSM failure, which indicates a breakdown in the capacity to supply safe, reliable, and equitable potable water services through effective governance, infrastructure performance, and monitoring. The five themes outlined below represent the most recurrent and analytically distinct clusters emerging from the data. These themes stem from (i) the most frequent problem signals in the ATLAS. ti coding (Figure 3), (ii) the networked relationships mapped in the ATLAS.ti outputs (Figures 6–9), (iii) the dominant and enabling themes in the bibliometric map (Figure 5), and (iv) the water service delivery and water quality risk management observed in the overlay network (Figure 5).

Theme 1: Service Delivery Performance for Potable Water Access

The word cloud in Figure 3 foregrounds quality (49), supply (58), access (63), and potable (37), as dominant codes, confirming that the central problem is not water (444) in the abstract, signalling that the challenge in Hammanskraal is whether

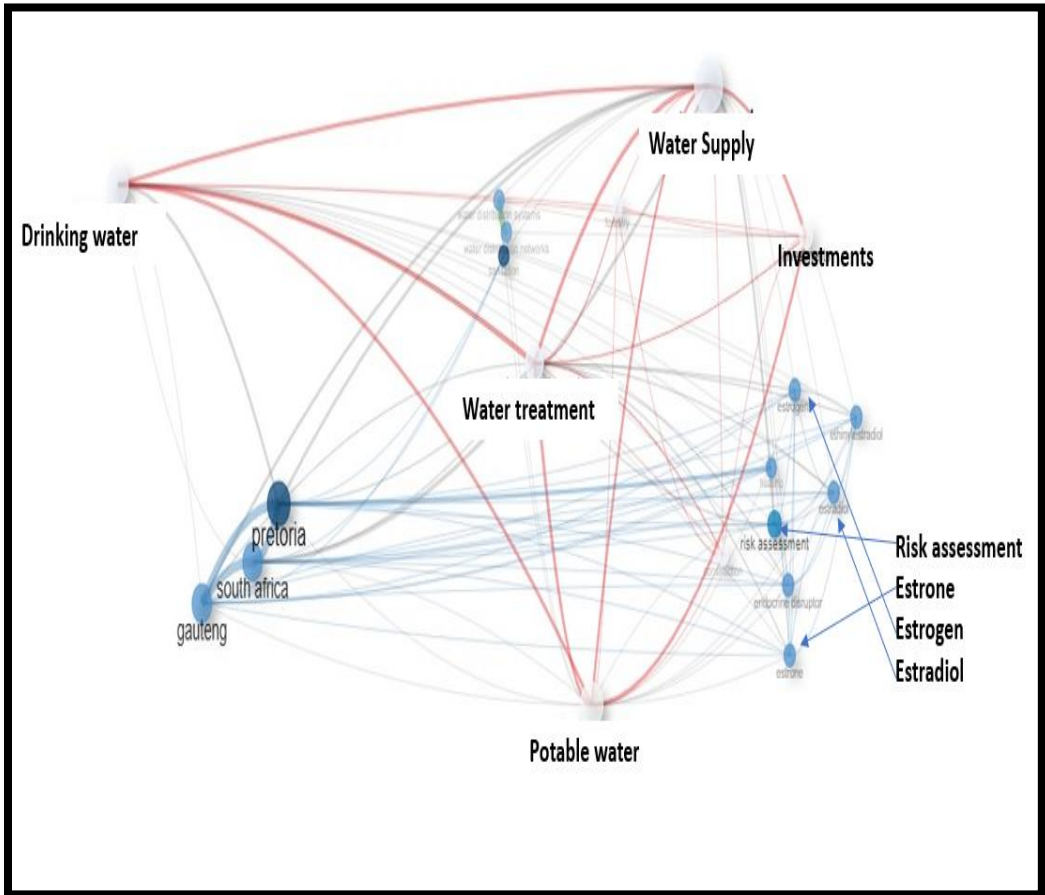


Source: Biblioshiny Software

The overlay network (Figure 5) further supports this interpretation by connecting a delivery-performance cluster ("potable water," "water treatment," "investments," "water supply") to a distinct risk-

governance cluster ("risk assessment" and contaminant-related terms). This implies that the current research framing links water quality to risk management.

Figure 5: Overlay of Research from 2004-2024



Source: Biblioshiny Software

Theme 2: Municipal Governance and Implementation Capacity

The prominence of administrative codes (*municipality, services, management, Tshwane, Gauteng*) in Figure 3 signals that the crisis is mediated through institutional performance, with governance/implementation failures repeatedly implied. The literature does not treat potable water failures solely as technical malfunctions. However, it repeatedly frames it as a breakdown in the municipal capacity to plan, coordinate, and implement core water services management functions. This is reinforced by the bibliometric map, which similarly positions “*project management–City of Tshwane*” as a

basic theme, which can imply a necessary enabling condition, but an underdeveloped theme (Figure 4), suggesting that governance competence is acknowledged as essential to service delivery, but not sufficiently theorised or operationalised in the evidence base.

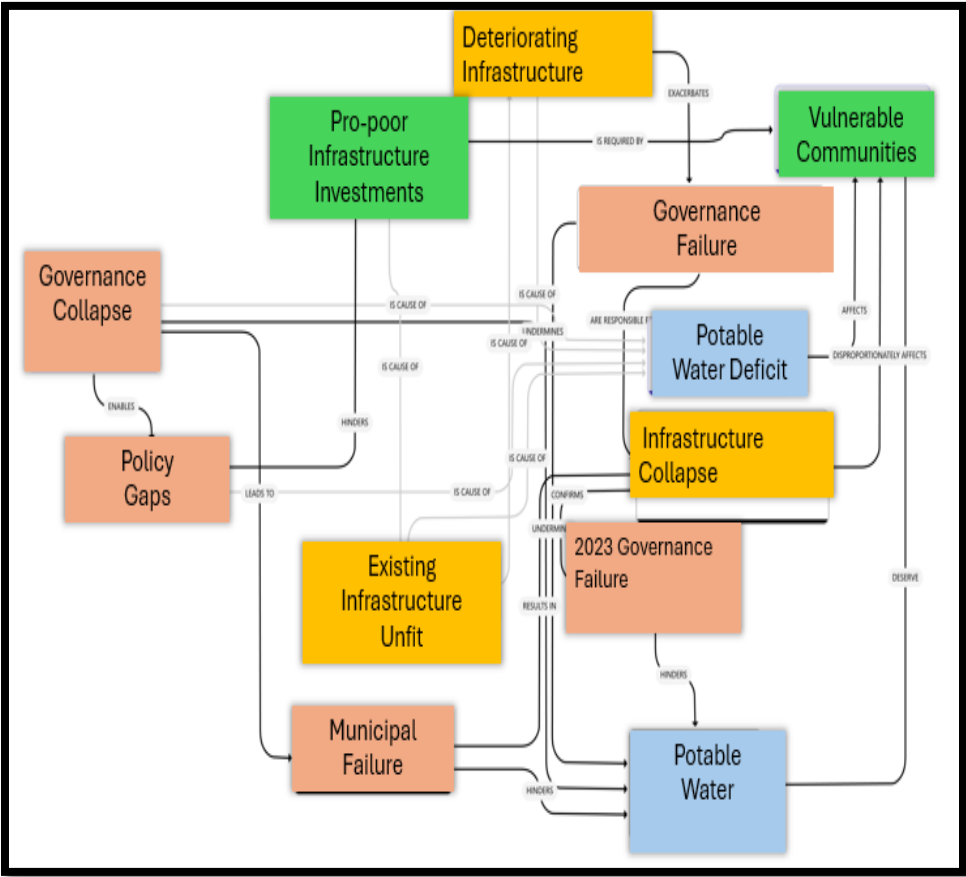
Theme 3: Infrastructure and Operational Breakdown

The infrastructure network (Figure 6) consolidates a key finding: *deteriorating infrastructure, governance failure and infrastructure collapse* operate together to produce a *potable water deficit*. The placement of “*Sanitation–Water Services Management*” alongside distribution-

system nodes (pipelines, distribution networks/systems) in Figure 4 supports this system's view: water treatment functionality and distribution integrity jointly shape the lived service experience (reliability and safety at the tap). Governance failures are shown to directly intensify infrastructure collapse, thereby producing a potable water deficit that disproportionately affects vulnerable groups. This aligns with the literature on a persistent governance culture of policy fragmentation, underinvestment, and reactive maintenance (Nephawe, 2023;

Figure 6: Infrastructure Failure

Sheridan, 2024). A concrete example is the longstanding dysfunction of the Rooiwal Wastewater Treatment Plant, which has not been updated since the 1970s, despite population growth and rising system pressure (Johnson & Hlatshwayo, 2025). Structurally, this creates a service system that cannot consistently protect potable water quality, because treatment and upstream performance remain misaligned with demand and risk.



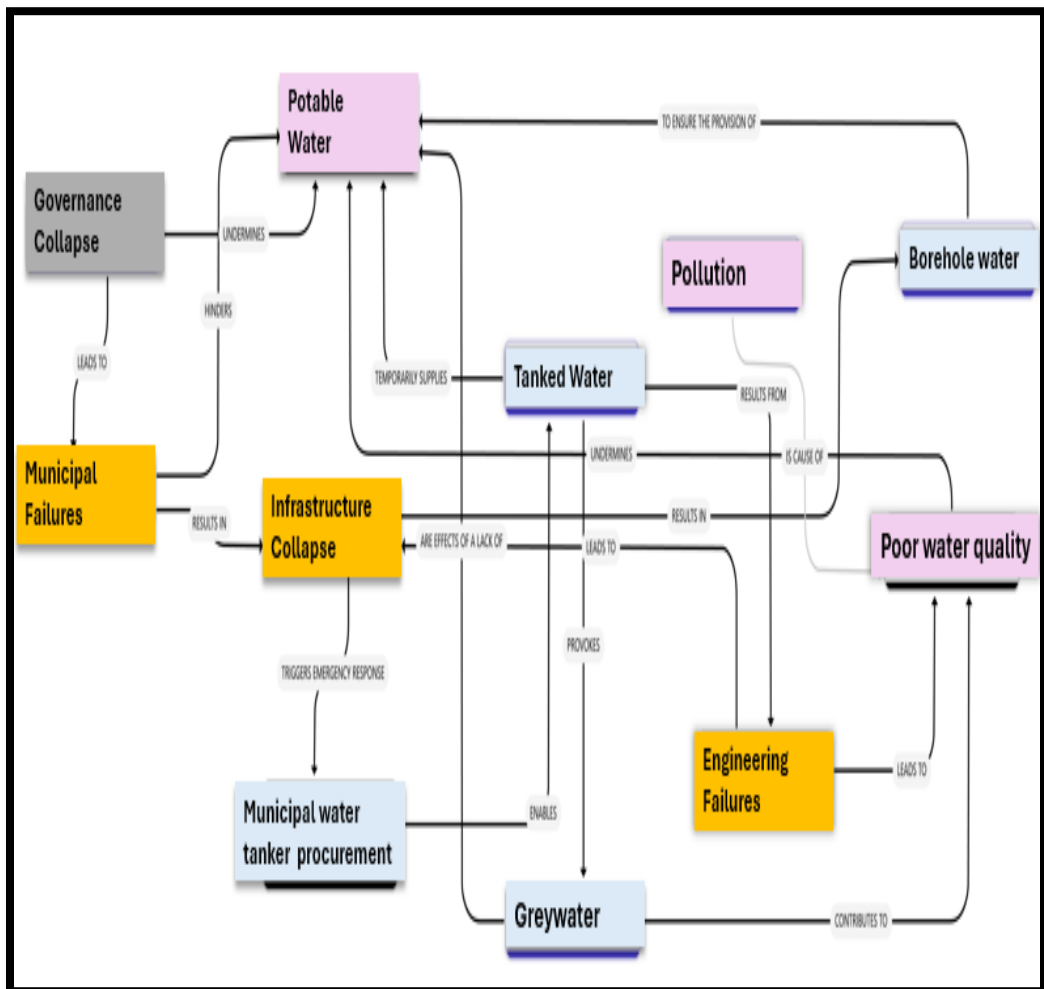
Source: Atlas-ti

Theme 4: Water Service Failure, Health, and Equity

The environmental-risk network (Figure 7) and the socio-economic individualisation network (Figure 8) illustrate that the Hammanskraal potable water crisis is driven by service-delivery risk pathways rather than by isolated events. Drought, pollution, and poor water quality are not framed solely as external shocks; they become sustained service risks when governance collapses, and infrastructure breakdown weakens the ability of water service management to assure safe

treatment, reliable distribution, and routine monitoring. Within this logic, disruptions trigger a patterned response: the system repeatedly shifts from reticulated provision to emergency water provision, particularly through reliance on municipal water tankers and boreholes (Figure 7). These measures provide immediate relief, but the evidence indicates they can normalise short-term crisis containment and delay restoration of stable potable services, especially where oversight and monitoring are weak.

Figure 7: Environmental Risks

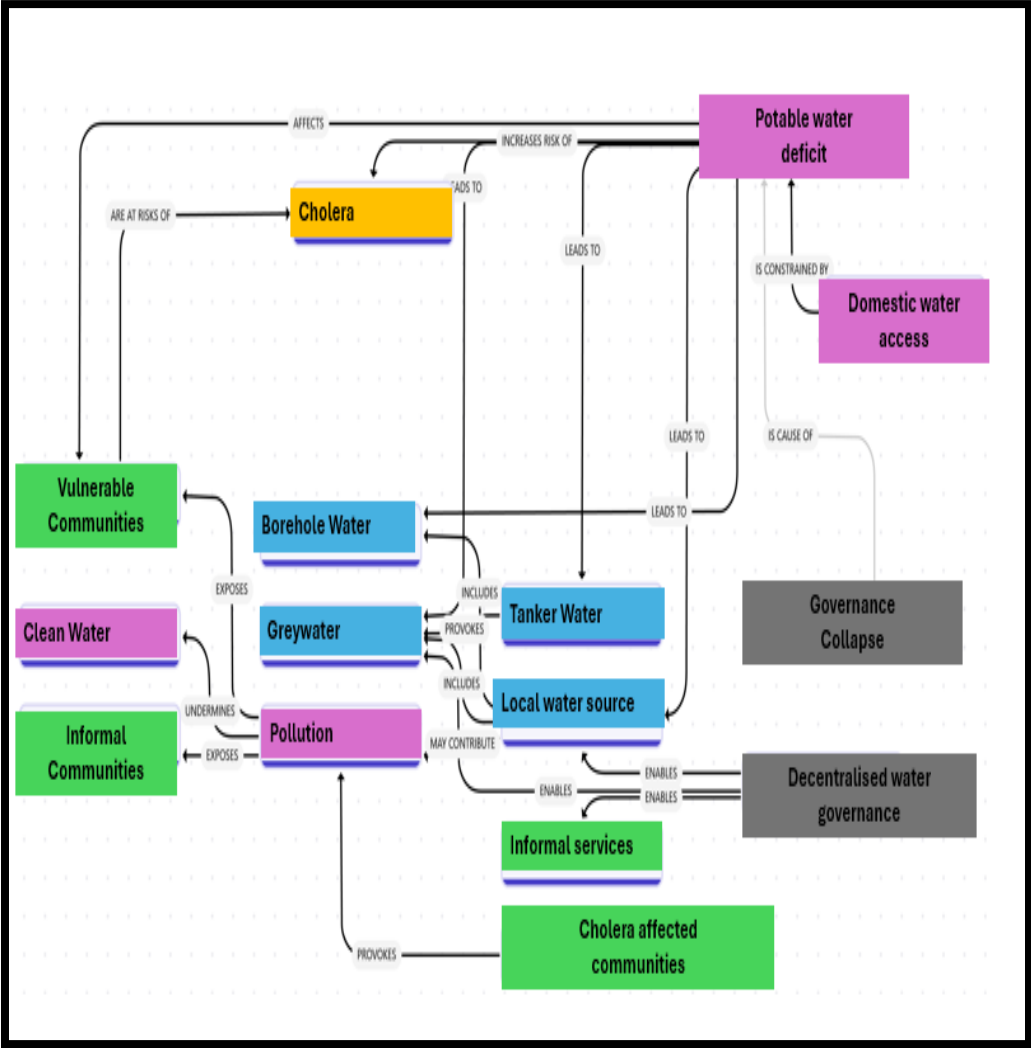


Source: *Atlas-ti*

Figures 7 and 8 further demonstrate how emergency water provision reorganises risk at the household level. When tankers and boreholes cannot provide a stable, safe, and regulated supply, households adopt coping strategies, including greywater use as a necessity due to constrained access

(Figure 8). Consequently, coping practices become part of the service system's delivery chain, operating with uneven monitoring and accountability and increasing exposure to contamination.

Figure 8: Socio-Economic Individualisation



Source: Atlas-ti

This directly connects to the public health signals visible in the coding (Figure 3), where terms such as cholera, outbreak, risk, and ill indicate that service failures translate into measurable health

vulnerability. Unequal impacts are concentrated among low-income residents and residents of informal settlements, as they have fewer safe alternatives and face greater risk when formal services fail

communicate, and control service risks, especially under disruption. This also aligns with the synthesis that formal instruments can become reactive control tools rather than adaptive mechanisms: crisis-driven re-centralisation and legal/technical formalism may speed emergency action but can also delay deeper reform and lock responses into short-term cycles (Sheridan, 2024; OECD, 2021). The bibliometric overlay strengthens these findings by linking a delivery cluster (potable water, treatment, supply, investments) directly to a risk-governance cluster (risk assessment and contaminant-related terms) (Figure 5). Accordingly, reliable service delivery is conceptualised as quality-risk management and exposure control. Nevertheless, the Hammanskraal case shows that monitoring and response systems are not sufficiently robust to deliver reliable service outcomes.

Holistically, Hammanskraal Township's potable water crisis is not the result of a single failure but a water services management failure cycle in which weak capability, deteriorated infrastructure, and insufficient risk control repeatedly reproduce unsafe and unreliable service outcomes. Theme 1 establishes that the core issue is service performance at the point of use, encompassing safe quality, dependable supply, and equitable access, rather than "water" in the abstract. Themes 2 and 5 indicate that the institutional conditions required to secure this performance are not consistently embedded: *municipal governance and implementation capacity are repeatedly invoked in the evidence but remain underdeveloped as operational pathways*. Fragmented planning, weak oversight, and monitoring breakdowns limit the water

services management system's ability to detect failures early, coordinate corrective action, and sustain recovery. Theme 3 demonstrates how this capability gap materialises structurally through the decline of infrastructure and operations. Declining operations and infrastructure jointly undermine the integrity of water treatment and distribution. Persistent dysfunction and ageing treatment infrastructure illustrate long-term underinvestment and reactive maintenance. As a result, the system cannot reliably protect potable water quality under routine operating conditions, let alone during disruptions. Theme 4 demonstrates that when reticulated services cannot ensure a stable, safe supply, emergency water provision and household coping strategies become normalised, heightening exposure to contamination and concentrated burdens on residents of low-income and informal settlements. At the same time, commodified arrangements such as tanker mafias further erode equity and public trust.

The crisis in Hammanskraal, therefore, reflects structural disturbances (asset decay and institutional neglect), procedural disturbances (fragmented governance and weak monitoring/response control), and behavioural disturbances (informalised coping replacing dependable public provision), with public health vulnerability emerging as an outcome of this combined system failure. From an adaptive resilience perspective, the findings suggest that improvements in water services management are contingent upon strengthening implementation capacity, restoring the effectiveness of treatment and distribution systems, and institutionalising integrated monitoring

alongside responsive governance, such that disruptions become progressively less frequent, less severe, and less unevenly distributed over time. This observation motivates the subsequent research question:

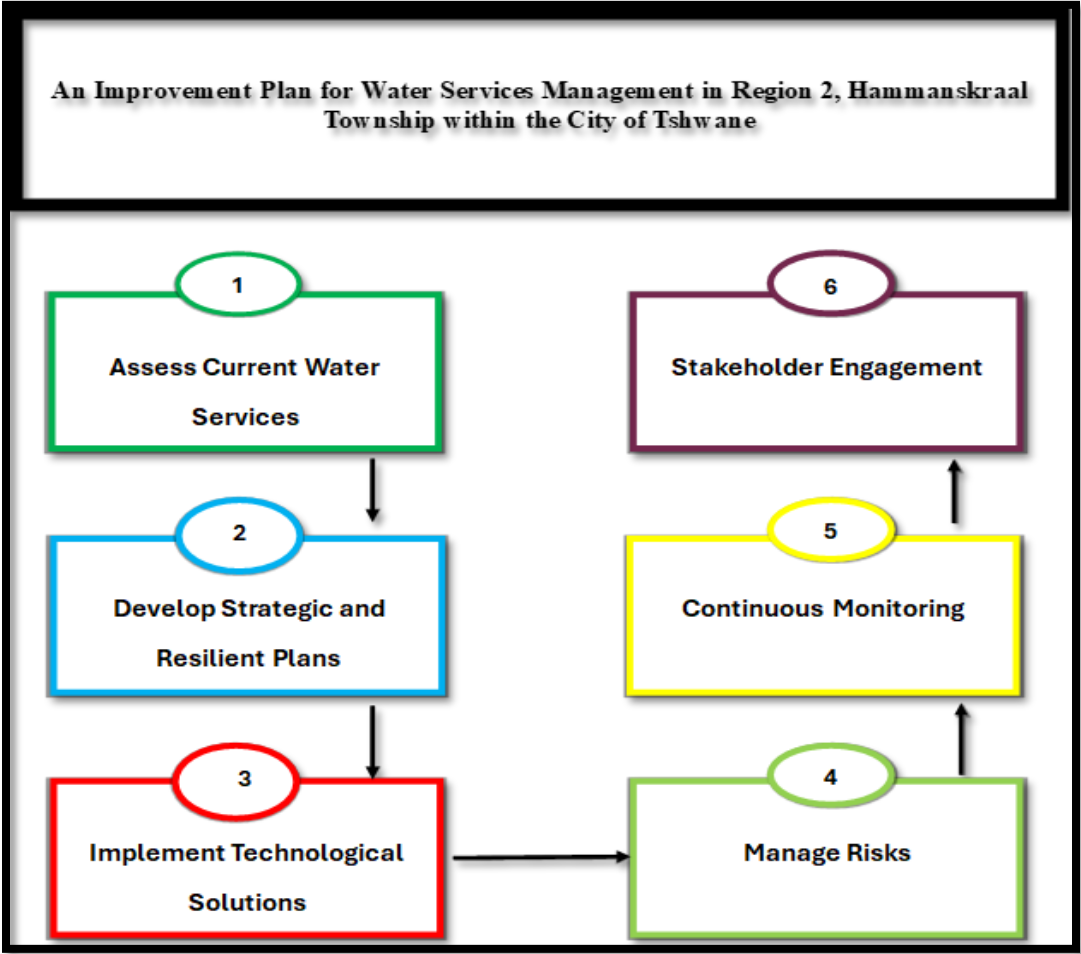
Q4: How can a systematic, step-by-step improvement plan break down the structural, procedural, and behavioural issues that weaken water service resilience in Hammanskraal Township?

An improvement plan for resilient water services management in Hammanskraal Township

A step-by-step improvement plan provides a structured approach to

dismantle the identified structural, procedural, and behavioural deficiencies that undermine water services' resilience, thereby enhancing the effective functioning of water services management in Hammanskraal Township. By sequentially strengthening institutional foundations, improving procedural coordination, and restoring behavioural accountability, this framework facilitates the transition from reactive, individual and fragmented governance towards adaptive, integrated and citizen-responsive water services delivery.

**Figure 10: An Improvement Plan
for Hammanskraal Municipality**



Source: Researchers' compilation, 2025

Step 1: Assess current water services

The first step is institutional, which assesses the foundational infrastructure and service delivery systems underpinning effective water governance. Hammanskraal Township should systematically evaluate the current state of its water infrastructure and public service coverage, identifying infrastructure requiring urgent attention and residents experiencing gaps in public service delivery. The evaluation must include an ecological vulnerability audit that

maps groundwater contamination hotspots, borehole dependency zones, and greywater reuse clusters. The municipality can identify which water infrastructure requires urgent attention, enabling it to direct the necessary resources to replace, repair, or maintain it. The municipality can also identify residents who experience a potable water deficit and follow a similar approach by directing resources to them. Water tankers can be deployed as an interim measure while pursuing long-term solutions. Citizens should

not bear any financial cost for accessing water from these municipal provisions. Long-term measures involve identifying and prioritising areas with inadequate water services or outdated infrastructure. Hammanskraal Township should prioritise replacing, repairing, or maintaining its deteriorating water systems to improve the public water supply. Upgrading the water supply infrastructure will directly improve water services management. Identifying and prioritising water infrastructure needs identifies which areas require extra attention during extended water restrictions or shortages.

Step 2: Develop strategic and resilient plans

Building on the foundational assessment, Step 2 introduces procedural responsiveness through systematic prioritisation. Through strategic planning, the City of Tshwane can identify and determine which areas experience high water demand and the frequency of disruptions. For the Hammanskraal Township, strategic planning should prioritise maintaining water supply infrastructure in line with these projections. These projections can also help develop response measures during prolonged water restrictions or shortages. For example, Hammanskraal Township should schedule water transport trucks to supplement the water supply to residents more frequently and to more locations, thereby increasing access. Given the City of Tshwane, Region 2's estimated population growth, the area could also plan for future disruptions and expand its water supply infrastructure.

Resilient planning must integrate climate vulnerability assessments and land-use trends so infrastructure investments account for long-term

environmental change, not only population growth. Institutions can achieve this by establishing interdepartmental task teams across planning, health, engineering, and environmental departments to co-develop an integrated infrastructure strategic plan. Through a forward-looking strategic planning approach, the municipality will overcome rigid, reactive management practices.

Step 3: Implement technological solutions

Step 3 targets behavioural change by fostering technological standardisation and ensuring qualified expert interventions. All materials, tools, equipment, and vehicles acquired by Hammanskraal Township and utilised for water services management should meet SABS standards without deviation. Skilled professionals must perform maintenance and repairs using certified equipment, significantly decreasing the frequency of failures. Promoting technological consistency and professional practice reduces fragmented and inconsistent responses, reinforcing a culture of operational competence across the municipality's water services. There is a need to create a municipal certification program to ensure technicians meet minimum competencies and adhere to consistent operational protocols across all wards.

Step 4: Manage risks

To enhance operational readiness, step 4 focuses on aligning technical teams, tools, and resources to ensure a unified, rapid response to disruptions. Hammanskraal Township should prioritise having a capable technical team on standby during and after working hours to respond to any water supply disruption. Achieving this requires the development of a decentralised response model with mobile technical units allocated to sub-regions of Hammanskraal to reduce delays caused by dispatch from centralised systems. The team must be

consistently equipped with the necessary tools and equipment to respond efficiently. The above necessitates maintaining emergency stockpiles of water treatment chemicals, spare parts, and mobile tankers in strategic locations to enable quick deployment during crises. Resilience can ensure that experts in the field, as well as the required tools and equipment, are readily accessible. Skilled teams can significantly reduce repair times and swiftly restore water to residents. Strategic stockpiling of essential resources will prevent shortages and enhance resilience, bridging operational gaps and maintaining continuous water supply services.

Step 5: Continuous monitoring

Institutionalising ongoing monitoring processes is essential to bridging procedural governance gaps. Firstly, Hammanskraal should establish a participatory monitoring council comprising civil society, ward councillors, engineers, and public health officials to track performance and advise the municipality. Hammanskraal Township should proactively monitor infrastructure conditions and citizen cooperation by implementing quarterly resilience audits that evaluate technical infrastructure and institutional responsiveness through repair timelines and the resolution of citizen complaints. The overseeing Metropolitan Municipality of the City of Tshwane should regularly evaluate key infrastructure and bulk-water pipelines to anticipate failures rather than react to them. The Township could also determine which areas experience frequent water-pipe bursts, leaks, or where water infrastructure is damaged or stolen.

Regarding consumer cooperation, Hammanskraal Township could identify areas that do not pay for municipal services and launch campaigns to inform residents of the importance of paying for these services. Educational campaigns should promote resident cooperation, encourage timely payment for services, and encourage

reporting of water leaks or theft. This dual monitoring system enables evidence-based management and supports adaptive improvements in water services delivery. The Township should proactively conduct regular maintenance and repairs to enhance the effectiveness and efficiency of its water infrastructure, rather than responding to disruptions such as pipe bursts.

Step 6: Stakeholder engagement

This step can counteract behavioural individualism by emphasising stakeholder engagement to promote shared responsibility for water management. Region 2, Hammanskraal Township in the City of Tshwane Metropolitan Municipality, should establish effective communication channels via its official website to enable real-time interaction with residents. Automated messaging services via applications such as WhatsApp should notify residents of water restrictions and infrastructure maintenance, and educate them on water conservation practices. The municipality can use the automated messaging function to alert residents of expected water restrictions. Residents who experience any water-related issue, such as low water pressure or a lack of water supply, can report it through the platform and receive an immediate automated response. In that case, they can use the messaging services to report the issue and receive an automated response with information related to their query. The computerised messaging feature can also educate residents on water conservation by regularly broadcasting messages on effective water use and minimising waste. A 'Community Water Stewards' programme to train residents in leak reporting, borehole monitoring, and educating neighbours on safe water practices is encouraged to strengthen community trust and embed shared responsibility across all stakeholders by providing accurate and timely information, while also encouraging participation.

This six-step improvement plan addresses documented patterns of fragmentation, infrastructure collapse, environmental apathy, and policy inertia by integrating anticipatory strategic planning, interdepartmental collaboration, community-based monitoring, and technological tracking into municipal practice. In doing so, the municipality moves from crisis response to adaptive resilience, restoring trust and sustainability in the delivery of potable water services.

Conclusion

This article reveals critical governance deficiencies underlying persistent lapses in potable water services management in Region 2, Hammanskraal. This study demonstrates that Hammanskraal's potable water crisis is primarily a failure of water services management, involving a breakdown in municipal and inter-institutional capacity to consistently provide safe, reliable, and equitable drinking water. Restoring trust and enhancing service performance necessitates transitioning from short-term crisis responses to integrating adaptive resilience into governance, operations, and related monitoring domains. Five triangulated themes explain how the crisis is produced and sustained. These findings delineate a reinforcing cycle comprising structural disturbances, procedural issues, and behavioural responses. Although this study focuses on Hammanskraal, its findings apply to broader municipal challenges across South Africa. Explicitly, engineered bulk-water capacity and formal

policy commitments do not, by themselves, translate into safe, dependable potable water services without a functioning service assurance regime that aligns treatment performance, distribution integrity, monitoring, and accountability. In this sense, adaptive resilience is not an abstract concept but a practical requirement for delivering on SDG 6.1, Agenda 2063 ambitions, and the constitutional right to sufficient water, particularly in high-risk urban townships where vulnerabilities concentrate, and the health costs of failure escalate. The study contributes a practical, implementation-oriented response to a gap in the existing literature. It translates the scoping review evidence and adaptive resilience principles into a sequenced, context-specific improvement plan for Hammanskraal. The plan operationalises adaptive resilience and shifts municipal work from reactive crisis containment to integrated, accountable, and citizen-responsive potable water service delivery. Further work should test and refine the proposed improvement plan through implementation-focused research, including monitoring whether the plan measurably improves distribution stability and water-quality risk control over time.

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