

# Integrating Indigenous Knowledge into South Africa's Free Basic Water Policy for Sustainable Water Conservation in Low-Income Communities: A Systematic Literature Review

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## Abstract

South Africa's Free Basic Water Policy (FBWP) provides low-income households with a baseline amount of water free of charge, addressing basic needs but posing challenges for water conservation due to the lack of direct usage costs. Indigenous Knowledge (IK) offers a valuable complement to FBWP, contributing community-driven, sustainable practices that can encourage conservation while respecting cultural practices. This systematic literature review (SLR) evaluates the potential for integrating IK into FBWP to enhance water conservation efforts in low-income South African communities. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, relevant peer-reviewed studies were identified, screened, and analysed. The key findings highlight strategies such as community-led rainwater harvesting, natural filtration methods, groundwater recharge, traditional governance models, and sustainable agricultural practices. Integrating IK into FBWP can improve water conservation outcomes, support sustainable resource use, and foster a culturally aligned approach to water management in low-income communities.

**Keywords:** Free basic water policy; Indigenous knowledge; Low-income communities; Sustainable water conservation

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## 1 Introduction

South Africa is currently experiencing a "water crisis" stemming from social, economic and ecological challenges. Increased demand for water resources due to rapid population growth and expanding urbanization, combined with unpredictable climate patterns, has left many low-income and rural communities with disparities in access to water (Whittington & Nauges, 2020).

Recent data from community surveys indicate that only 78% of households in urban areas have access to piped water within their homes, leaving about 3.7 million people reliant on communal stand-pipes. For families living in backyard rentals in Soweto or single-room hostels in eThekweni, the monthly allocation of 6 kiloliters of Free Basic Water (FBW) is often depleted by the middle of the month (Department of Water and Sanitation, 2023). In many of these less privileged communities across South Africa, mothers and children face an almost daily reality of waking at the crack of dawn to line up at the communal taps which can take hours. Mokoena (2022) describes this as a form of structural inequality, where poor households end up paying twice for a basic necessity, once through taxes, and the second time through their coping strategies, for example buying water or sacrificing time and safety in order to collect the water.

While these coping mechanisms demonstrate ingenuity, they also increase the risk of petty crime at stand-pipes during nighttime hours and take away valuable time that could be spent generating income. This ongoing struggle between the promise of FBW policy and the reality of shortages underscores the urgent need to revisit culturally rooted water-saving practices as a significant aspect of policy discussions.

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## 1.1 *Legislative and policy*

The existing inequalities in water access are largely attributed to the historical context of apartheid-era policies, which disproportionately favoured white, middle-class urban areas while neglecting the needs of black communities. This legacy has resulted in a systematic allocation of water and sanitation infrastructure that benefits predominantly white neighbourhoods, thereby marginalising black communities in both rural and peri-urban regions (Jegede & Shikwambane, 2021; Mokoena, 2022).

While historical factors may not directly cause contemporary challenges, they continue to obstruct progress by reinforcing deep-seated infrastructural and institutional inequalities that affect disadvantaged communities (Mokoena, 2022). The FBWP provides poor households a minimum amount of 6 kilolitres of free water per month, dealing with an important social need and advancing equitable water access (Whittington & Nauges, 2020).

Indigenous Knowledge Systems (IKS) are recognised within the framework of South Africa's current water legislation. The National Water Act (Act No. 36 of 1998) emphasises equitable access to water and recognises the role of local communities in the formulation of water management strategies (Republic of South Africa, 1998). It provides a comprehensive framework for the protection, sustainable utilisation, development, conservation, and management of water resources, explicitly acknowledging the significance of indigenous practices in ensuring long-term water security. However, whilst this framework lays a robust foundation for the integration of IKS into national water governance, its integration within the FBWP has been inadequate (Botturi et al., 2021).

As such, enhancing this incorporation could yield substantial benefits by utilising indigenous water conservation practices to improve sustainability and resilience in water management, especially in economically disadvantaged communities. There is optimism that by incorporating indigenous knowledge into the structures of the FBWP, adjustments could be made to improve water conservation and management practices, particularly at the household and community levels, where water-use behaviour, cultural norms, and conservation techniques are most directly influenced. However, this review extends beyond policy analysis to explore how end users, especially in low-income urban areas, use Indigenous Knowledge practices to deal with water scarcity and fill formal supply gaps.

Indigenous Knowledge (IK), accumulated by indigenous people and passed down through generations, is ecological knowledge used to sustain the land's productivity while effectively addressing emerging conditions and challenges (Latulippe & Klenk, 2020). These knowledge systems are context-based and adaptive, based on generations of ecological knowledge and enacted through everyday practices such as rainwater harvesting, roof-top collection, and greywater harvesting. It is most pertinent in settings where formal provision of water is inconsistent (Smith & Wishnie, 2000). However, when IK is analysed with attention to context, it can offer culturally relevant, community-driven solutions that are well suited to the realities of South Africa's diverse low-income communities. For example, traditional rainwater harvesting systems and the cultivation of drought-resistant crops have developed in response to various local climatic challenges, providing effective strategies for decentralised water conservation (Grey et al., 2020). These practices are particularly advantageous in regions with limited state-led infrastructure, where community cohesion and local stewardship play pivotal roles in the management of scarce water resources.

Integrating IK into the FBWP provides two key benefits: better water access for everyone, and encouragement of water conservation using culturally appropriate methods (McAllister et al., 2023). However, this type of integration comes with some challenges and raises the question of how the formalisation of IK can be reconciled with the unique IK systems of South Africa's different cultural realities, as well as conflicts with legal frameworks. Furthermore, acknowledging IK systems and incorporating them into the approved governmental frameworks also requires the fundamental shift of valuing IK as an equal partner with conventional science as recognised in the law (Castleden et al., 2017).

## 1.2 *Theoretical framework*

This research draws on Ecological Citizenship theory, which highlights the duties of individuals and communities with respect to sustainable environmental behaviour, beyond compliance with regulations. As articulated by Sarid and Goldman (2021), Ecological Citizenship is based on the idea that individuals have an obligation to care for ecological systems and resources as we are all interconnected with nature and society. Ecological Citizenship is about voluntary behaviour change based on ecological awareness and social responsibility, instead of reliance on imposed policies and rules (Bourban, 2023). In terms of water conservation in low-income communities of South Africa, Ecological Citizenship offers a fertile ground of inquiry to understand and foster community-based conservation practices that align with IK.

When combined with the principles of Ecological Citizenship, using IK to guide the FBWP can promote water-use behaviours that are both environmentally responsible and culturally relevant, while supporting sustainable and resilient community water management. The theoretical lens of Ecological Citizenship guides the literature review to explore specific indigenous water conservation practices that reflect community-driven and behaviourally grounded approaches to sustainable resource management.

This paper uses a systematic literature review to assess the feasibility of incorporating IK practices into South Africa's FBWP. The review is based on documented examples of IK practices, including rainwater harvesting, greywater reuse, and seasonal storage, compounded water use and resiliency, particularly in underserved urban contexts. The review utilises twelve studies that were identified for their depth of methodological rigor, relevance to understandings of context, and general thematic saturation. The study intends to show how IK can improve customary water management practices and encourage sustainable water conservation that considers both cultural traditions and ecological protection. Integrating several indigenous practices into policy can render South Africa's approach to water conservation in vulnerable communities more efficient, benefiting both people and the environment.

The rest of the paper is organised as follows: Section 2 comprises the literature review. Section 3 presents the research methodology, outlining the process and steps undertaken to collect and analyse the data. Sections 4 and 5 are dedicated to the presentation of the results, as well as discussion of the findings. Lastly, Section 6 provides the conclusion of the study, summarising the key insights and implications drawn from the research.

## 2 Literature review

The literature surrounding IKS in water conservation demonstrates how longstanding community-driven practices offer effective, sustainable solutions well suited to the unique challenges faced by South Africa's low-income communities. These methods, developed through intimate knowledge of local ecosystems, represent a valuable but often overlooked resource (Ghorbani et al., 2021) for enhancing contemporary water management policies such as the FBWP. Unlike many traditional, resource-intensive techniques, indigenous water conservation practices prioritize the efficient use of readily available resources, demonstrate respect for local environments, and foster community stewardship through collective participation and deeply ingrained cultural values (Mbah et al., 2021). For example, in Khayelitsha, Cape Town, rainwater harvesting and greywater reuse, drawing on Indigenous conservation knowledge, have been informally adopted by residents to augment municipal supply during periods of water restriction (Mokoena, 2022). In a similar vein, in Bulawayo, Zimbabwe, community stewardship of customary wells during drought provided a viable source of water for peri-urban households when piped supply was unavailable (Dube et al., 2021). The following sub-sections provide an overview of significant IKS practices that are pertinent to water conservation efforts.

## 2.1 *Rainwater harvesting*

Indigenous communities have historically adapted rainwater harvesting techniques to suit their local conditions, providing a vital alternative to centralized water systems. (Rawat et al., 2023). For instance, traditional methods such as clay pots, thatched roofs and natural catchment systems effectively facilitate the collection and storage of rainwater. These cost-effective and user-friendly solutions contribute to improving water availability during droughts and alleviating the pressure on municipal water systems, which are often strained in underserved communities. However, these methods are inherently reliant on natural rainfall, making them inadequate during extended periods of drought. FBWP is implemented through municipal piped water systems; however, it does not extend to households in many remote or infrastructure-deficient regions lacking a piped supply. In such contexts, Indigenous practices serve not merely as a supplementary resource to the FBWP but rather as a critical lifeline for achieving basic water access. As of 2021, approximately 11% of South African households did not have access to piped water, either within their homes or in close proximity, with the most significant deficiencies occurring in rural provinces such as Limpopo and the Eastern Cape (Statistics South Africa, 2021). The application of IK is particularly relevant and urgent in these areas (Aklan et al., 2023).

## 2.2 *Natural filtration methods*

The absence of modern filtration systems poses significant challenges for water purification in remote rural regions, particularly in under-resourced provinces such as Eastern Cape and Limpopo (Fanteso & Yessoufou, 2022). In these localities in particular, traditional indigenous methods present a viable alternative. By utilizing locally sourced materials such as sand and charcoal, along with plant-based filtration techniques, these methods are not only cost-effective but also environmentally sustainable (Tamagnone et al., 2020). They reflect a deep understanding of local resources and their intrinsic properties, proving essential in areas where untreated water is prone to contamination. These highly effective practices are well-suited for integration into contemporary water management strategies such as the FBWP as they can significantly enhance water quality without necessitating substantial financial investments or extensive technical resources (Huang et al., 2021).

## 2.3 *Groundwater recharge*

While stone terraces and contour bunding are commonly linked to groundwater recharge, their primary traditional purpose in various contexts has been to mitigate soil erosion and surface runoff. For instance, in Rajasthan, India, people have constructed contour bunds and Johad systems in semi-arid villages, leading to significantly increased groundwater recharge while restoring dried-up wells and stabilizing water availability for agriculture (Tanwar et al., 2023). However, it is now linked to groundwater recharge, reflecting a sophisticated understanding of hydrology rooted in indigenous knowledge systems. By slowing surface runoff and encouraging water infiltration, these methods play a crucial role, especially in those regions facing an increased risk of drought due to climate change (Tamagnone et al., 2020). Interestingly, research conducted by Wasko et al. (2021) suggests that increased rather than decreased rainfall is the more frequent outcome of climate warming. Both evaporation and precipitation are expected to rise as a result of higher average temperature (Neelin et al., 2022; Tyson et al., 2000). In South Africa, however, droughts are becoming increasingly frequent due to climate change. Incorporating these practices into contemporary water management policies could offer lasting solutions to combat water shortages (Rawat et al., 2023).

## 2.4 *Traditional water source protection*

The conservation of water sources by indigenous communities is frequently rooted in the reverence for springs and rivers as sacred or culturally significant. This perspective fosters the establishment of collective rules that govern their use and mitigate pollution (Huang et al., 2021). Such practices underscore the integral role of cultural values in sustainable resource management, which are further supported by community standards and social practices. For example, in the Nqeleni region of the Eastern Cape, local amaXhosa communities continue to protect forest springs in accordance with customary rules limiting access in the dry season and preventing livestock from entering upstream catchments (Amoah, 2021). Indigenous communities effectively manage their water sources through a communal system that prevents overuse and ensures equitable distribution (Fuente-Carrasco et al., 2019). This approach aligns with conservation goals and offers a culturally resonant framework for managing water resources in low-income communities under the FBWP.

## 2.5 *Drought-resistant agriculture*

Indigenous agricultural practices for effective water conservation are especially important in rain-fed agricultural areas, such as Limpopo and Eastern Cape regions. Specific practices documented in the literature include drought-resilient crops, less frequent irrigation, and surface mulching to enhance soil moisture in eastern Zimbabwe (Tamagnone et al., 2020). These practices also emphasize the significance of intercropping, mulching, and crop rotation — practices which are prevalent in several sub-Saharan contexts — suited for cultivating crops to enhance soil fertility as well as access to water. These practices are important for food security as they capably retain crop yields despite increasingly volatile impacts of rainfall (Rawat et al., 2023).

However, it remains important to differentiate between water used for household consumption and water required for irrigation farming, as the latter necessitates larger volumes and different infrastructure. Often, the amount of municipal tap water from FBWP is insufficient for irrigation purposes (Alayu & Leta, 2021). Additionally, using municipal tap water for crop irrigation is not cost-effective. According to Masemula (2023), historical research indicates that pre-colonial South African farming was primarily rain-fed, with little reliance on formal irrigation systems. In the case of the latter, IKS emphasizes the importance of soil moisture conservation as opposed to water diversion or engineered irrigation methods (Masemula, 2023). Integrating indigenous water conservation practices into the FBWP could offer a promising solution, and this approach may address the policy's failings in promoting sustainable water use. This integration needs mindful deliberation of the social and cultural context and the regulations in different communities. Although many indigenous methods are demonstrably effective, they are often sidelined in official policy because they lack institutional recognition and support (Jackson, 2018). A systematic approach to integrating IKS into the FBWP would necessitate fostering cross-cultural understanding, supporting knowledge exchange between indigenous practitioners and policymakers, and creating avenues for community engagement in water governance.

Although these studies provide evidence showing the usefulness of IK to address water scarcity, they also emphasize the contextual challenges affecting the application of this knowledge. The differences between IK in rural contexts and the FBWP in an urban context raise questions about integration, particularly in an era of rapid urbanisation and climate change. IK is often understood as strategies mainly associated with rural contexts and without formal mechanisms, such as rainwater harvesting and natural filtration (Sakapaji, 2022). Nevertheless, residents in many informal urban settlements have adopted traditional practices, such as collecting rooftop rainwater, and reusing greywater, to help meet their needs given the sporadic and unpredictable networked delivery of water (Rawat et al., 2023). These cases illustrate that IK is still in

the process of being adapted to an urban context when faced with water insecurity and provides locally relevant conservation strategies in urban settings, despite its limits (Asad et al., 2023). This development suggests that context-specific forms of integration are needed, considering how IK can support FBWP in urban contexts with under-served citizens, to ultimately strengthen the resilience of communities.

### 3 Methods

This study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring transparency in the selection process. The PRISMA flowchart (Figure 1) visually represents the step-by-step filtering of studies, from identification to final inclusion. This systematic literature review was conducted in five key steps as outlined by Hesse-Biber and Johnson (2015): first, defining the research question; second, identifying relevant studies; third, selecting studies for inclusion; fourth, analysing and summarising the data; and fifth, reporting the results.

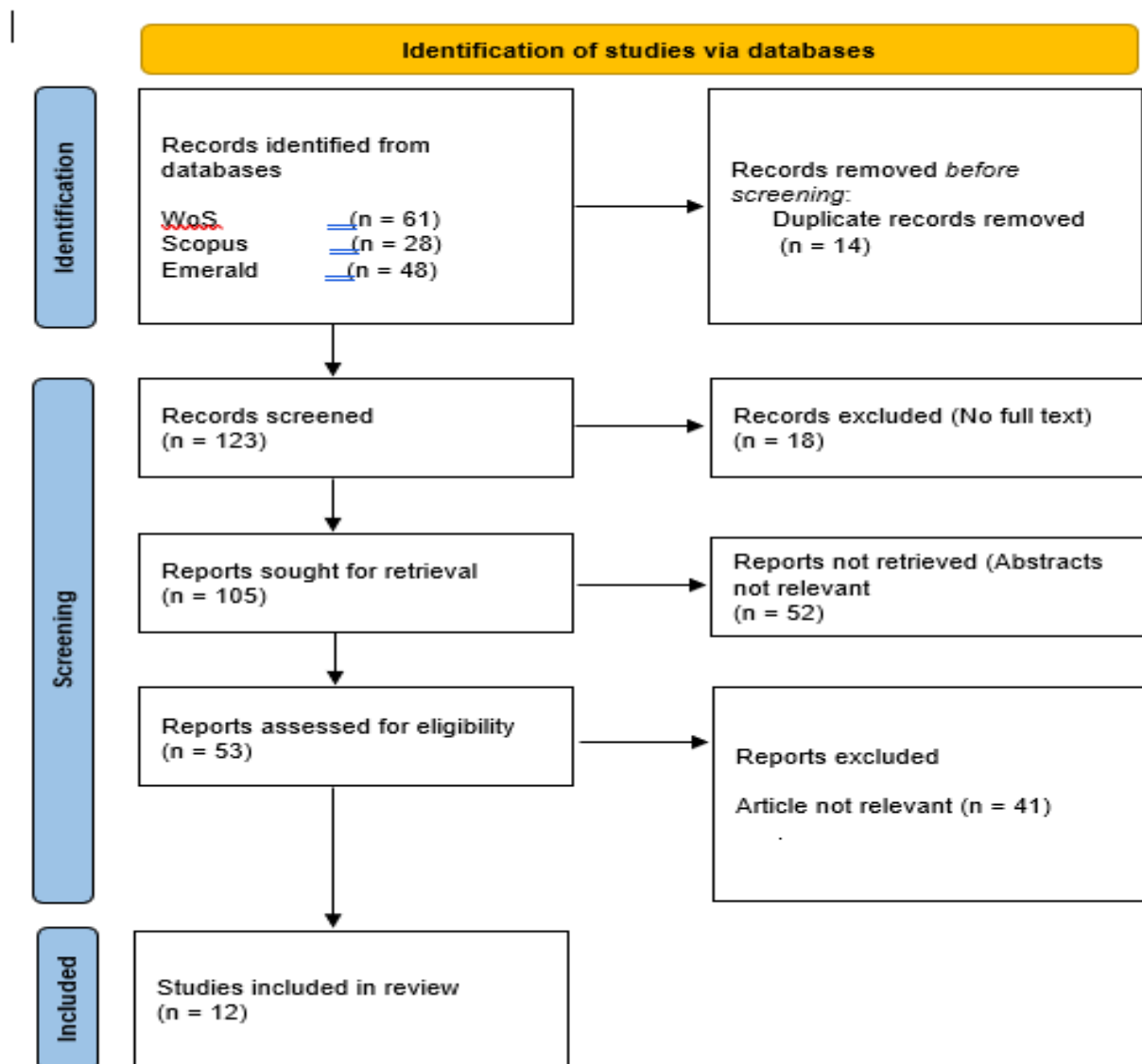


Figure 1: Figure 1. PRISMA flow chart

Source: Adapted from Page et al. (2021)

### 3.1 Defining the research question

The study commenced by establishing broad parameters for the research question, ensuring adherence to the guidelines set forth by Hesse-Biber and Johnson (2015), and incorporating all pertinent literature. This review focused on the following research question:

*What are the opportunities and challenges in integrating Indigenous Knowledge (IK) into South Africa's Free Basic Water Policy (FBWP) to promote sustainable water conservation practices in low-income communities?*

Key concepts and search terms were developed to identify relevant studies. These included various combinations of the keywords in Table 1.

**Table 1.** Key concepts and search terms

| Concept              | Search Operation                                                                     |
|----------------------|--------------------------------------------------------------------------------------|
| Indigenous knowledge | "Indigenous knowledge" OR "Traditional knowledge" OR "Local knowledge"               |
| Water conservation   | "Water conservation" OR "Water management" OR "Sustainable practices"                |
| Community engagement | "Community engagement" OR "Community-led practices" AND "Indigenous water practices" |

### 3.2 Identification of relevant studies

A systematic search of academic databases was conducted to identify relevant publications. Several Boolean operators were used to refine the search. The search strategy combined the key terms listed above using Boolean operators like AND, OR and NOT. The databases used included Web of Science (WoS), Scopus, and Emerald, ensuring a comprehensive scope of peer-reviewed studies on IKS and water conservation. The initial search yielded a total of 132 records distributed as follows:

- **WoS:** 61 records
- **Scopus:** 28 records
- **Emerald:** 43 records

Following the removal of duplicate records ( $n = 14$ ), a total of 123 unique records proceeded to the screening phase. The following criteria guided the search:

**Inclusion criteria:** Peer-reviewed journal articles, academic books, and credible government or institutional reports from between 2003 and 2023. Only documents published in English were searched. Studies were eligible if they specifically examined Indigenous Knowledge Systems (IKS) frameworks as a category in water conservation, water governance, or sustainable water management practices, especially research focused on low-income and/or resource-poor communities.

**Exclusion criteria:** Studies unrelated to indigenous knowledge or water conservation.

### 3.3 *Study selection*

The screening process followed a two-step approach:

**Phase 1:** Abstract and title screening

- A total of 123 records were screened based on their title and abstract.
- Studies that did not meet the inclusion criteria were excluded at this stage.
- A total of 18 records were removed due to lack of full-text availability.

**Phase 2:** Full-text review

- The remaining 105 reports were sought for full retrieval.
- Of these, 52 reports were excluded based on abstract screening, as they were deemed irrelevant to the study's objectives.
- The remaining 53 full-text studies were assessed for eligibility.
- A final exclusion was made, removing 41 articles due to irrelevance after a detailed review.

Thus, 12 studies were included in the systematic review. The 12 included studies were then subjected to detailed data extraction and thematic analysis as outlined in the following sections.

### 3.4 *Charting and synthesising data*

Data extraction followed a standardised approach using a data charting form. The form included the following categories:

- I. Publication details, specifically the author(s) and the year of publication.
- II. Title of Study, which provided significant insights.
- III. A comprehensive description of the geographical context of the study setting, along with a thorough explanation of its socio-economic context.
- IV. The central aim of the study.
- V. An overview of various water conservation methods, encompassing both traditional and contemporary practices.
- VI. The integration of Indigenous Knowledge into the Framework-Based Water Planning (FBWP) process, noting that certain factors can either significantly facilitate or hinder this integration depending on the opportunities and challenges encountered.
- VII. An exploration of the policy implications of aligning indigenous knowledge with water policy.
- VIII. Study outcomes relevant to the research question.

A narrative approach to data synthesis organised these findings into key thematic areas identified through analysis.

### 3.5 *Collating, summarising and reporting results*

Thematic analysis utilising NVIVO software (Version 12) was employed to organize and summarize the results. Five key themes were identified, reflecting recurring patterns and insights across the selected studies. These themes included: 1) indigenous water conservation practices; 2) challenges in policy integration; 3) opportunities for community engagement; 4) culturally resonant water governance models; and 5) collaborative frameworks for integrating IK with scientific approaches.

### 3.6 *Methodological justification*

In order to ensure methodological rigor, quality was assessed by a simple appraisal adapted from the CASP checklist, specifically focused on aims being clear, methodological transparency, and relevance to the research question. Non-conforming studies were excluded in the full text review stage if they did not meet a minimum threshold. The final number of included studies is twelve, which was a conscious methodological choice; choosing conceptual depth, thematic saturation, and local context over quantity. Each study met all quality requirements. All studied the incorporation of Indigenous Knowledge into water conservation strategies and, as such, were appropriate for this review's scope and purpose. The selection process, based on a transparent and reproducible search strategy, ensures the review's integrity, informed by its aim to provide recommendations for incorporation of IKS into the current Free Basic Water programme.

To achieve the aim of the study, the reviewed sources were purposefully chosen and examined for empirical and conceptual perspectives into how IK practices are used in water conservation, and how these practices could be used within formal water service systems like the FBWP. The findings are presented in a narrative style, incorporating a thematic discussion and several visual aids, including a word cloud. These tools provided a thorough overview of the study's principal findings and pointed out several important implications for policy and practice.

## 4 Results

The word cloud in Figure 2 highlights key themes relevant to this study on integrating IKS into water management for low-income communities, with a particular focus on South Africa. The word cloud was generated using NVivo 12 software based on word frequency analysis of the 12 academic articles identified as relevant in the systematic review. Dominant terms like "water," "indigenous," "knowledge" and "management" underscore the importance of traditional ecological practices in addressing water-related challenges. The prominence of words such as "climate," "adaptation," "community" and "drought" reflects the interconnectedness of climate adaptation strategies and IKS in supporting resilient water management. The inclusion of "Africa," "responses" and "government" suggests the need for policy integration that respects cultural practices and empowers local communities. Additionally, terms like "project," "resources" and "systems" point to the importance of collaborative efforts and frameworks to sustain water resources. This visual representation of keywords emphasises how indigenous knowledge can enhance adaptive water management, especially in vulnerable regions impacted by climate change and resource scarcity.

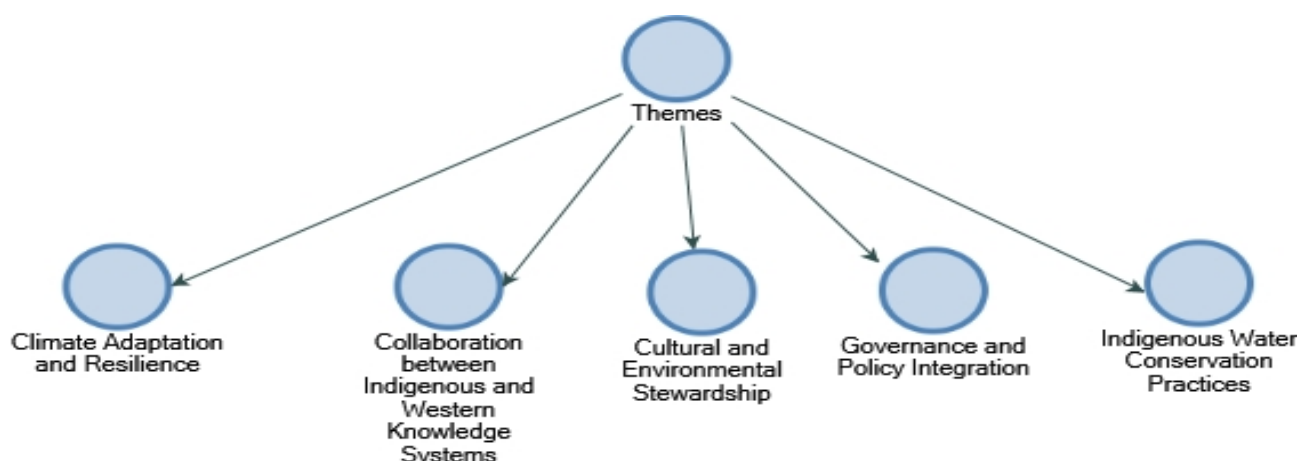


**Figure 2: Figure 2. Word cloud**

Source: NVIVO12 software

#### 4.1 Summary of themes

The results and discussion sections of qualitative studies are often structured around key themes to aggregate and compare findings across different studies. Figure 3 presents a project map depicting the five core themes that emerged from the systematic review. These include *Climate Adaptation and Resilience*, *Collaboration between Indigenous and Western Knowledge Systems*, *Cultural and Environmental Stewardship*, *Governance and Policy Integration*, and *Indigenous Water Conservation Practices*. The visual framework illustrates how each theme branches from the central node of “Themes”, reflecting their conceptual distinctiveness while highlighting their shared relevance to IKS and water conservation. This thematic structure underscores the multifaceted nature of IKS and its potential role in shaping adaptive and inclusive water governance models within policy frameworks such as the FBWP.



**Figure 3: Figure 3.** The five main themes identified in the systematic literature review

Table 2 presents the key themes identified in the reviewed literature, including Indigenous water conservation practices, climate resilience strategies, governance integration and cultural stewardship, along with supporting

references. These themes serve as the analytical foundation for the study and are explored in detail under their respective headings.

**Table 2.** Summary of key themes identified from reviewed literature

| Theme                                                          | Description                                                                                                                                                                                                                                                                                                                                                 | References                                                                                       |
|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Indigenous water conservation practices                        | Traditional methods such as rainwater harvesting, soil terracing and natural water management developed by indigenous communities to sustainably manage water resources in drought-prone regions.<br>Soil and water conservation practices such as contour ploughing and mulching enhance soil moisture retention, crucial for agriculture in arid regions. | Rawat et al., 2023<br>Tamagnone, Comino, & Rosso, 2020                                           |
| Climate adaptation and resilience                              | Indigenous communities cultivate drought-tolerant crops, reducing reliance on irrigation and enhancing food security.<br>Integrating trees with crops improves microclimates and water retention, aiding adaptation to changing climate conditions.                                                                                                         | Aklan et al., 2023<br>Tamagnone, Comino, & Rosso, 2020<br>Tamagnone, Comino, Rosso, et al., 2020 |
| Governance and policy integration                              | Indigenous governance models emphasize collective decision-making in water resource management, promoting sustainable use.<br>Integrating IKS into formal water policies faces obstacles, including lack of recognition and institutional support.                                                                                                          | Huang et al., 2021<br>Gadgil et al., 2021                                                        |
| Cultural and environmental stewardship                         | Cultural beliefs assign sacred status to certain water bodies, leading to their protection and sustainable management.<br>Indigenous practices are rooted in a deep respect for nature, fostering conservation and responsible resource use.                                                                                                                | Rawat et al., 2023<br>Mazzocchi, 2020                                                            |
| Collaboration between indigenous and Western knowledge systems | Combining IKS with scientific methods enhances water management strategies, leveraging the strengths of both systems.<br>Collaborative efforts between indigenous communities and researchers lead to more effective and culturally appropriate water management solutions.                                                                                 | Loch & Riechers, 2021<br>Adade Williams et al., 2020                                             |

## 5 Findings from the Literature Review

### 5.1 Theme 1: Indigenous water conservation practices

Indigenous communities have long relied on rainwater harvesting, stone terracing, and natural water management systems to improve water availability and reduce soil erosion (Rawat et al., 2023; Tamagnone, Comino & Rosso, 2020). These techniques, which are well-suited to semi-arid environments, ensure efficient water retention and sustainable land management. However, they do not completely align with the FBWP due to limitations in piped infrastructure. These initiatives exemplify aspirations for equitable and sustainable water access and could inform local strategies that complement traditional systems in developing areas. Nonetheless, their wider implementation is hindered by institutional challenges (Leonard et al., 2023), high labour demands, limited scalability, and modest short-term financial returns. Moreover, gaps in technical and financial resources impede the systematic documentation and validation of these practices (Mishra et al., 2021). For instance, in Limpopo, homestead ponds are utilized for rainwater collection and storage, thus reducing reliance on municipal water supplies (Budeli, 2021). However, the management of such systems is crucial to prevent health risks, such as mosquito breeding. A context-sensitive approach that integrates hybrid solutions—supporting both piped water access and traditional, decentralized systems could significantly enhance water security in low-income communities. Indigenous strategies for water conservation provide a decentralized, community-based model of water use that is particularly suitable for meeting the needs of un-serviced informal settlements. Incorporating models of water management that reflect indigenous water conservation practices into FBWP consumption models could strengthen sustainability and equity of service delivery.

### 5.2 Theme 2: Climate adaptation and resilience

Indigenous communities have historically adapted to climate variability through practices such as drought-resistant cropping, agroforestry, and soil moisture retention. These approaches have allowed them to reduce reliance on irrigation. Crops like sorghum and millet, which require minimal water, have been cultivated in regions experiencing prolonged dry spells, thereby ensuring consistent food availability and promoting sustainable land use (Aklan et al., 2023). Agroforestry systems, which integrate trees with crops, contribute to soil stabilisation, regulate microclimates and enhance moisture retention, ultimately improving resilience to irregular rainfall (Tamagnone, Comino & Rosso, 2020).

Despite these advantages, the shift away from traditional wisdom due to modern advancements has significantly impacted the continued use of these adaptable practices (Brondízio et al., 2021). Current regulations often favour Western farming methods, which can marginalise indigenous farming alternatives and reduce their incorporation into national climate change strategies (Gadgil et al., 2021). A critical challenge is the insufficient transfer of intergenerational knowledge, as younger generations may not receive adequate exposure to traditional water conservation and climate adaptation techniques (Nelson, 2011). Numerous studies indicate that the diminishing interest in traditional farming practices among rural youth is significantly contributing to this disruption (Rawat et al., 2023; Tamagnone, Comino & Rosso, 2020). As younger generations increasingly pursue urban migration or educational opportunities, they often disengage from essential agricultural practices such as soil moisture retention, terracing, and rain-fed cultivation.

Additionally, the influence of modern water supply systems, such as piped municipal water provided under the FBWP, is perceived as more accessible and reliable than traditional methods like roof-based rainwater harvesting or constructing stone bunds for runoff management. While contemporary infrastructure enhances convenience, it also inadvertently diminishes the perceived necessity and importance of traditional techniques. This significant generational shift highlights the critical need for knowledge preservation initiatives and hybrid approaches that integrate IK into modern systems in ways that are highly relevant and culturally significant for younger populations. To ensure the continuity of Indigenous climate adaptation strategies, it is essential to develop documentation programs in collaboration with universities and indigenous elders. Such efforts will create structured knowledge repositories that facilitate policy inclusion and long-term preservation. Implementing these measures will enhance community resilience and guarantee that customary

ecological practices are recognized and integrated into national climate adaptation policies. Indigenous practices enhance climate resilience through drought-resistant cropping methods and techniques that retain soil moisture. This provides options for scalable solutions that may help to strengthen the delivery of FBWPs in critically water-stressed and climate-vulnerable communities.

### 5.3 *Theme 3: Governance and policy integration*

Governance and policy integration are essential for ensuring sustainable water management, particularly within the context of South Africa's FBWP. This policy allocates each household a monthly supply of 6 kilolitres of piped water at no cost, after which a graduated tariff structure is implemented, leading to progressively higher charges for additional consumption (Whittington & Nauges, 2020). In this regard, indigenous practices such as utilizing stored rainwater for non-potable purposes such as laundry or garden irrigation, fostering community-based water-sharing norms, and adhering to water-use restrictions rooted in cultural traditions can assist households in minimizing their dependence on piped water supply and remaining within the free allocation. These practices enhance household-level water efficiency and result in significant financial savings for many low-income families. Therefore, incorporating IK into various FBWP frameworks can achieve both ecological and economic objectives, provided that these practices are adapted to specific piped water systems and supported through robust community engagement.

Indigenous governance structures emphasize community involvement and resource stewardship, enabling communities to manage water equitably and sustainably (Gadgil et al., 2021; Huang et al., 2021). By including indigenous water conservation practices within the FBWP, it offers a potential avenue to encourage community-level sustainable water-use options that aim to mitigate policy challenges to conservation (Ferrara et al., 2023) and promote sustainability through community-based initiatives. However, effective integration requires careful examination of social and cultural environments with a focus on supporting responsible use behaviour and not simply developing a policy (Nguyen-Thi-Kim et al., 2024). Ecological citizenship theory provides a valuable framework for this activity (Wells et al., 2021). The theory frames a person or community as an accountable environmental agent who takes personal initiative, and takes action, to follow through out of a sense of ecological duty (Brand-Correa & Steinberger, 2017). To apply the ecological citizenship framework means linking communities to practices that emphasize responsibility for sustainable water conservation. Systematically building IKS into the FBWP would enhance cross-cultural understanding, facilitate behaviour change associated with ecological citizenship, enhance knowledge sharing between indigenous practitioners and policymakers, and include genuine community engagement within sustainable water governance as outlined by the theory (Brand-Correa & Steinberger, 2017; Ferrara et al., 2023). Fragmented policy frameworks are a key barrier to integrating IKS into FBWP. Enhanced normative and institutional support of hybrid governance could provide new opportunities for inclusive water delivery service that recognizes customary systems of use.

### 5.4 *Theme 4: Cultural and environmental stewardship*

A crucial factor in indigenous water preservation is the integration of cultural and ecological stewardship, particularly through community-led preservation guidelines for sacred water areas. Many indigenous groups hold deep respect for these water sites, viewing them as integral to their cultural beliefs, which fosters strong commitments to their protection. For example, in Venda, South Africa, specific cultural beliefs serve to protect certain springs, thus preventing pollution and overuse (Mazzocchi, 2020; Rawat et al., 2023). These sacred protections function as effective ecological management systems, ensuring the sustainable management of water resources.

However, ongoing urban development and construction projects frequently encroach upon these sacred locations, leading to conflicts between indigenous conservation practices and development initiatives (Ludwig & El-Hani, 2020). Ignoring the cultural significance of these sites in policy-making has undermined the effectiveness of indigenous conservation efforts and has limited the application of traditional ecological knowledge for achieving sustainable water management (Castleden et al., 2017). To align closely with the objective of incorporating IK into the FBWP for sustainable water conservation, it is essential to formally

recognize sacred water sites within national conservation policies. Establishing legal protections for these vital water resources could enhance community involvement in water management, protect vulnerable ecological areas, and encourage greater indigenous participation in sound resource stewardship. The importance of water resources within Indigenous cultural systems supports conservation practices consistent with FBWP's aims. However, the technical focus of the programme often overlooks the ethical and spiritual reasons for local water stewardship.

### 5.5 Theme 5: Collaboration between indigenous and Western knowledge systems

A crucial element in achieving sustainable water management within South Africa's FBWP is promoting collaboration between IKS and Western scientific methodologies. The integration of indigenous conservation practices with contemporary hydrological models has the potential to improve water conservation outcomes, as demonstrated in the Eastern Cape, where co-designed rainwater harvesting systems have successfully combined traditional engineering techniques with scientific hydrology, enhancing both efficiency and sustainability (Adade Williams et al., 2020). However, prevailing Western-centric research frameworks often do not adequately recognize IKS, resulting in policy gaps that inhibit its formal incorporation into national water strategies (Leonard et al., 2023). Additionally, institutional barriers frequently hinder local Indigenous communities from actively contributing to scientific research, which marginalises their valuable ecological insights. McAllister et al. (2023) highlight that the integration of IKS with hydrological science can lead to the development of sustainable and culturally relevant water conservation frameworks. To bridge this divide, universities and research institutions must engage in partnerships with Indigenous experts, ensuring equal representation in water governance, research, and policy development. Combining indigenous and scientific approaches can improve relevance and acceptance in the design of FBWP interventions, especially where conventional service models don't provide an adequate service. Institutional acknowledgement of local knowledge is necessary to co-produce solutions.

In reviewing the literature, several common challenges surfaced that could impede the integration of IKS into FBWP. Table 3 provides a summary of the challenges including issues of recognition, institutional support, resource limitations, cultural sensitivity, and the erosion of traditional knowledge.

**Table 3.** The challenges postulated in various research studies

| Challenges                                         | Description                                                                                                                                                               | References                                         |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Recognition and validation of indigenous knowledge | Indigenous practices are often undervalued in formal water management frameworks, leading to their exclusion from policy and decision-making processes.                   | Leonard et al., 2023<br>Moggridge & Thompson, 2021 |
| Institutional and policy barriers                  | Existing water governance structures may lack mechanisms to incorporate IKS, resulting in policies that do not reflect the needs and practices of indigenous communities. | Brondízio et al., 2021                             |
| Resource constraints and capacity building         | Limited financial and technical resources hinder the documentation and integration of IKS into broader water management strategies.                                       | Mishra et al., 2021                                |

Continued on next page

Table 3: (Continued)

| Challenges                                    | Description                                                                                                                                                    | References                                 |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| Cultural sensitivity and community engagement | Effective integration requires culturally sensitive approaches that respect indigenous values and actively involve communities in the decision-making process. | Ludwig & El-Hani, 2020                     |
| Knowledge transmission and preservation       | The erosion of traditional knowledge due to modernization and generational shifts poses a risk to the continuity of indigenous water management practices.     | Jacob et al., 2024<br>Nugroho et al., 2023 |

These challenges highlight the difficulty of operationalising IKS in water service, policy-based delivery programmes of which the FBWP is but one example. Adapting to such challenges involves institutional reform and prioritising capacity building alongside more deliberate and serious engagement with culturally respectful practices and knowledge validation. This aspect of the thematic insight helps the study achieve its purpose by articulating the specific limitations that confer or constrain the potential for the successful incorporation of indigenous practices in South Africa's formal water management systems.

## 6 Discussion

The review highlights how IKS continue to play a meaningful role in water management for low-income communities, particularly in areas beyond the reach of piped infrastructure. These insights support the study's objective of identifying practical and culturally grounded alternatives to strengthen the FBWP.

Traditional methods such as rainwater harvesting, soil bunding, and communal water sharing remain central to daily survival in many rural and peri-urban settings (Rawat et al., 2023; Tamagnone, Comino & Rosso, 2020). These practices are not only low-cost and effective but also derived from generations of environmental learning, positioning IKS as a resourceful alternative for sustainable water conservation.

IKS also contributes to climate adaptation and resilience by guiding seasonal water planning, promoting drought-resistant crops, and reducing dependency on inconsistent municipal services (Aklan et al., 2023; Tamagnone, Comino, Rosso et al., 2020). These adaptive strategies allow communities to maintain water security in the face of erratic rainfall and rising temperatures.

However, institutional frameworks seldom recognise or engage these knowledge systems. The exclusion of customary governance structures from formal policy processes limits collaboration, despite evidence that hybrid arrangements can improve accountability and community ownership (Gadgil et al., 2021; Huang et al., 2021). This disconnect weakens local agency and reduces the flexibility of state-led interventions.

Further, water management in Indigenous contexts often carries a deep cultural and ethical dimension. Sacred sites, taboos, and rituals around water reflect a spiritual relationship with nature that supports conservation behaviours and social regulation of access (Ludwig & El-Hani, 2020; Mazzocchi, 2020). These values echo the principles of Ecological Citizenship (Dobson, 2003), where stewardship is seen as a moral obligation rather than a policy directive.

Encouragingly, examples of collaboration between indigenous and Western systems are emerging. Studies show that co-designed water interventions, such as community-based rainwater catchment projects in the Eastern Cape, can enhance the sustainability and acceptance of service delivery (Adade Williams et al., 2020; Loch & Riechers, 2021). Such models demonstrate the feasibility of integrative approaches that respect local context while applying technical innovation.

Taken together, these findings suggest that IKS is not a historical oddity but a dynamic system with contemporary relevance. When understood through the lens of ecological citizenship and supported through inclusive governance, IKS can complement the FBWP by offering flexible, community-anchored solutions to persistent water access challenges.

## 7 Conclusion

This review highlights the potential of indigenous knowledge to address the water conservation challenges in South Africa's FBWP. By incorporating community-led rainwater harvesting, natural filtration, groundwater recharge, traditional governance and sustainable agricultural practices, FBWP can foster a more culturally aligned and sustainable approach to water management. Moving forward, partnerships with indigenous leaders and community organizations will be essential for successful implementation, allowing FBWP to enhance both water security and community resilience.

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