Policy, Legal and Institutional Development for Groundwater Management in the SADC Member States (GMI-PLI)

Framework for Institutionalising Groundwater Management in the SADC Region

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FOREWORD

The Southern African Development Community (SADC) Member States, through the support of International Cooperating Partners have gone through a series of Water Sector Reforms which varied in terms of policy, legal and institutional development. The focus of the water sector reforms has been on Integrated Water Resources Management and aimed at achieving sustainable and equitable distribution of water resources in the respective Member States. To a large extent, the water sector reforms did not comprehensively address the sustainable management of groundwater resources, yet 70% of the population in the SADC region depend on it. Climate change continues to negatively affect the availability of surface water, placing significance reliance on the use of groundwater for both urban and rural supply throughout the region. Human wellbeing, livelihoods, food security, ecosystems, natural habitats, industries and urban centres growth throughout the SADC Region are increasingly becoming more reliant on groundwater. The SADC region in general has an abundance of groundwater resources. However, due to several factors which include the lack of an enabling policy, legal and institutional environment, only an estimated 1.5% of the available renewable groundwater resources are currently being utilised.

It is estimated that there are about 30 Transboundary Aquifers (TBAs) and 15 transboundary river systems and that these systems are central to the water security of the region. There is therefore a need for Members States to establish and strengthen existing policy, legal and institutional frameworks to achieve equitable and sustainable access to water resources through joint management of the transboundary resources. It is in view of the above and in response to the need to strengthen the sustainable use of groundwater resources conjunctively with surface water at both the national and regional level, that the Southern African Development Community – Groundwater Management Institute (SADC-GMI) was established by the SADC Secretariat, on behalf of the Member States.

The vision of the SADC-GMI is, “to be a Centre of Excellence in promoting equitable and sustainable groundwater management in the SADC region”. The key focus areas of SADC-GMI are to 1) advocate, raise awareness and provide technical support in SADC around sustainable management through the dissemination of information and knowledge; 2) create an enabling environment for groundwater management through policy, legal and regulatory frameworks; 3) promote action-oriented research; 4) promote impact-oriented capacity building and training for groundwater management in the region; 5) lead and promote regional coordination for groundwater management; and 6) support infrastructure development for groundwater management.

In pursuance of the focus area of creating an enabling environment, SADC-GMI implemented the project entitled “Policy, Legal and Institutional Development for Groundwater Management in the SADC Member States, (GMI-PLI)”. The methodology for said project included the development of the Desired Future State, conducting a baseline study of best practices, and description of policy, legal and institutional frameworks which promote sustainable groundwater management. Using an in-Country Experts model, a systematic analysis of the existing policy, legal and Institutional frameworks in

comparison with the Desired Future State was conducted to identify gaps that required to be addressed in order to fulfil the SADC-GMI mandate – to achieve sustainable groundwater management in all 16 SADC Member States. The analytical assessment of the gaps identified at national level culminated in the production of 16 National Gap Analysis & Action Plan Reports and the higher-level Regional Gap Analysis Report. The latter summarises the findings across the SADC region.

This framework provides an overview of institutional arrangements to support groundwater management and development. Noting that governance frameworks vary according regional and national contexts, there is no 'blue-print' for these arrangements. The institutional mantra of 'form-follows-function' really underlines that institutional arrangements should be determined to deliver these functions effectively and efficiently. Yet, because institutional arrangements can take lesson-learning and experience to settle, this framework will, it is hoped, aid SADC Member States to refine and improve their own arrangements to facilitate more resilient groundwater management and development at a regional, national and local level.

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Stakeholders Engaged

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DOCUMENT INDEX

Presented in the table below is a list of products developed during the GMI-PLI Project:

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EXECUTIVE SUMMARY

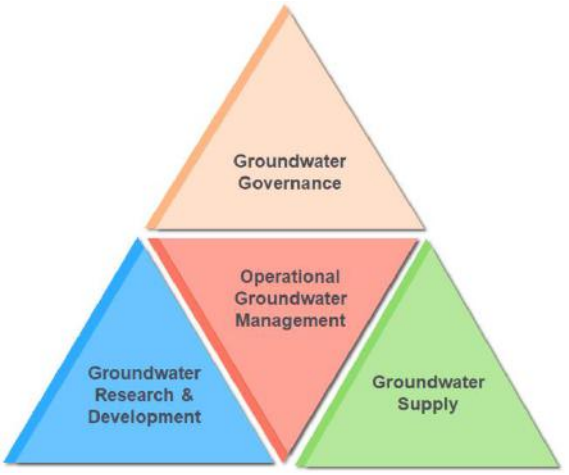
Introduction

The business of groundwater management is indeed complex, entailing a collection of interconnected processes that have strategic, technical and administrative dimensions. The challenges that exist in terms of ensuring improved groundwater governance are many, noting that there are often quite distinctive differences in groundwater development and that of surface water. Most often, the decentralised nature of groundwater infrastructure and use results in users that are most often independent and autonomous, and this creates significant difficulties in effecting sound groundwater management practices and enabling effective regulatory compliance.

The complexity of these characteristics results in considerable debate about the appropriate levels at which to locate groundwater governance. Preferences for localised management can collide with the need for certain strategic functions to take place in a more centralised manner, as well as the need to ensure better coordination within or between groundwater basins. This potentially provides an argument for a more harmonised approach that realises certain strategic functions taking place in a more centralised manner, whilst the more operational functions take place at the lowest possible scale.

Understanding the Groundwater Business

To understand institutional arrangements to effectively undertake groundwater management and development, it is important to understand the functional aspects that make up this business. These broadly can be categorised into four keys areas:



- **Groundwater governance**: provides the enabling framework and guiding principles within which groundwater management operates and provides the overarching guidance as to how groundwater resources will be managed.
- **Operational groundwater management** provides the collection of instruments and tools that are used to manage groundwater resources on a day-to-day basis**.**
- **Groundwater supply** provides the array of interventions that enable the development of groundwater resources for the provision of water supplies; and
- **Groundwater research and development** provides research and development studies to better understand groundwater resources as well as develop improved and innovative approaches to groundwater governance, operational groundwater management and development of groundwater supply systems.

These dimensions of the groundwater management business take place across regional, transboundary and national scales, with local groundwater management taking place within the national groundwater management context. Therefore, this framework explores the institutions that undertake these across these spatial scales and provides a framework towards strengthening these institutions.

Framework on Strengthening the Regional Framework for Groundwater Management

The regional framework for groundwater management provides a range of legal, policy and strategic instruments that guide the management and development of groundwater resources across the SADC region. This governance framework is implemented by a complex array of supporting institutions. Actions to manage and develop the regions groundwater resources, in order to catalyse regional socio-economic development, are outlined in successive five-year Regional Strategic Action Plans (RSAP). The fifth version is underway – RSAP v (2021-2025).

Broadly, institutions at the regional level develop regional policy and strategy, support in the resolution of conflicts in transboundary watercourses, provide support to transboundary and national water institutions in developing capacity, develop and improving regional understanding through studies and information exchange, and oversee implementation of the Regional Strategic Action Plan.

Five key steps can be taken to strengthen this regional framework:

- **Strengthen institutions**: Strengthen the capacity of the SADC Water Division and SADC-GMI to continue to act as a regional champion, driving awareness and capacity building programmes (staff and skills), and sourcing sustainable funding for these institutions to undertake studies that support improved groundwater management.
- **Improve data and information exchange**: To support transboundary discourse, there is a need for shared and agreed-upon data sets and information. There is still much to be done to strengthen the collation, updating and exchange of data and information to support management decision making. In addition, the need to utilise other media as a means for information exchange is critical, especially to support the regional network of experts. SADC-GMI should play a key role in this regard.
- **Leverage the network of expertise**: The WRTC Hydro-geology sub-committee is important for the business of strengthening the regional approach to groundwater management and development. There are resource constraints that inhibit the functioning of this network and strengthening the funding as well having more time allocated to these staff, by their national ministries, would improve the ability of this network to realise its potential. This needs to be supported by the development of groundwater management and development knowledge products.
- **Strengthen groundwater planning:** Future iterations of the Regional Strategic Action Plan need to build on the current efforts to improve groundwater management and must promote conjunctive

surface and ground water management and development. This will require some strategic and institutional thinking as to how to best affect this more integrated approach.

- **Review the SADC regional framework**: Noting the increasing pressures upon water resources to support socio-economic development, there is a need to look for improved approaches that will enable effective and efficient conjunctive use of surface water and groundwater, as well develop improved resilience to climate impacts. Thus, key elements such as the SADC Regional Water Policy and SADC Regional Water Strategy, need to be reviewed and possibly be revised.

Framework on Institutional Arrangements for Transboundary Aquifer Management

The regional institutional framework does allow for the establishment of bi-lateral or multi-lateral water institutions in order to support the management and development of transboundary water resources. These have been utilised in a significant number of shared river basins to support the management of shared watercourses and the development and operation of joint water projects. In many instances these have taken the form of Watercourse Commissions, Joint Water Commissions and technical committees.

In looking to develop institutional arrangements to support the improved management and development of transboundary aquifers, four key steps are useful to consider in guiding the process.

- **Strengthen shared watercourse agreements:** Very few bilateral or multilateral agreements specifically mention groundwater and most treat groundwater as part of the water resource. Noting the importance of groundwater across the region, it is important to strengthen these agreements to address the specific details required to manage and develop groundwater resources.
- **Strengthen existing shared watercourse institutions:** These institutions require ongoing support to develop the capacity needed. These institutions will require staff that have the necessary strategic, institutional, financial and technical skills. The management of groundwater resources does require technical expertise and the appointment of a groundwater advisor in these institutions is important. Likewise, the development of procedures and processes will be essential, and the Member States must agree upon these.
- **Develop targeted groundwater management and development strategies:** There is a need to strengthen existing IWRM plans or develop more targeted groundwater management and development strategies that more effectively explore conjunctive use.
- **Undertake pathfinder projects:** Undertaking initial projects towards the implementation of the groundwater management and development strategy or plan, is important in terms of jointly (between the Member States) acting and working collectively. These may be new or existing projects but create the opportunity to establish technical teams that develop a common understanding of the resource and the requirements for managing and developing the resource.

Framework on Strengthening the National Framework for Operational Groundwater Management

At the national level, there is a need to construct policies, legislation and institutional frameworks that guide the operational management of groundwater resources, to enable the sustainable development of these resources to provide water services. The nature of groundwater resources, requires that the various dimensions of operational groundwater management need to take place at varying spatial scales whilst considering a range of policy and strategic issues that have varying impact across these spatial scales. Groundwater is often significantly impacted upon by land use practices and hence, ensuring effective alignment between other sectoral governance frameworks and the strategic intent of these various sectors is essential.

Towards developing institutional arrangements to support the improved operational groundwater management at national to local levels, five key steps can be considered.

- **Strengthen sector leadership:** The leadership of the Ministry of Water is essential in developing clear and stable policy positions for sustainable groundwater management and to guide implementation by sector institutions. Taking actions to strengthen this leadership role is imperative and will include effective delegation of powers and duties, overseeing progress on strategic interventions and improving communications.
- **Establish and empower catchment-based institutions:** The need to devolve the more operational management and catchment-based oversight to institutions within catchments is generally recognised as best practice. These institutions not only enable an improved level of planning and coordination by supporting engagement across a range of sectors and levels of government, but also by enabling better stakeholder engagement.
- **Establishment of Water Users Associations:** WUAs are recognised as being important in terms of ensuring localised management and undertaking operational water use management, as well as supporting effective compliance monitoring. It is important to revisit policy and legislative instruments to clarify and strengthen the roles of WUAs in terms of local groundwater management. Providing focused support to develop capacity in these institutions is important.
- **Improve stakeholder engagement**: Considerable value-add is gained from stakeholder engagement processes, but often there is significant room for improvement. Developing appropriate institutional platforms to enable effective engagement and advocacy initiatives, that promote conjunctive water use, for example, are important. This will require an appropriate funding strategy.
- **Strengthen approach to build capacity**: There is a shortage of skilled geohydrological expertise with many institutions having only limited skills or experience in this regard, and those trained staff are unable to handle the heavy workload. There is a need to have technical capacity regarding the

complexities of groundwater management and developing targeted strategies to develop this capacity is needed.

Framework on Strengthening the National Framework for Groundwater Supply

Rapid urbanisation is placing significant pressure on local authorities to be able to timeously undertake the required planning, develop the necessary infrastructure and ensure there is the capacity (technical skills and finance) to operate and maintain water supply infrastructure. This challenge is begging new questions of existing institutions in terms of being able to cope with these socio-economic pressures and meet the requirements of water supply as set out in national targets and international goals such as the SDGs. To this end, groundwater resources become increasingly important.

In order to strengthen institutional arrangements to support the improved groundwater supply at national to local levels, five key steps are useful to consider.

- **Strengthen national groundwater development and water supply strategies:** The Ministry of Water needs to look towards improved approaches towards ensuring water supply needs are met. This requires improved alignment in planning across these economic sectors as well as strategies to meet supply needs in rural communities. These strategic approaches may require innovative institutional approaches that include engaging more effectively with the private sector and communities themselves. Engagement with civil society will be important in shaping these approaches.
- **Strengthen local government's ability to ensure water services are delivered:** Local government as the hub for local socio-economic development faces a considerable array of institutional, technical and financial challenges. Building institutional capacity (technical and financial) within municipalities is a critical part of ensuring their ability to deliver on their mandate.
- **Establish and develop public-private partnerships:** Developing groundwater resources requires a range of partnerships with the private sector. These partnerships take on various formats depending on the nature of the services-support provided. Developing robust partnership arrangements can provide significant support in the provision of services. This does require a sound working relationship between the public sector and the private sector.
- **Establish a professional drillers association and/or National Groundwater Association**: The promotion of technical excellence in the drilling and groundwater development industry is imperative. The establishment of a professional drillers association, a professional geohydrological technical association or a National Groundwater Association would provide a useful technical interface between the public sector and the private contracting sector.
- **Develop capacity across institutions**: The provision of water supply from groundwater resources is effectively a local matter and gains more 'regional' importance when developed conjunctively with surface water resources. Developing groundwater resources requires adequate technical, geohydrological skills at these localised levels, and that these skills are often not available. Ongoing

capacity building to support localised institutions where water supply services are desperately required, is needed. This does require training interventions to develop technical capacity, but also needs to introduce a range of interventions that provide 'hands-on' technical support. At community level, there is a need to find more efficient approaches to enable communities to lawfully develop groundwater resources to meet their water supply needs.

Framework on Strengthening the National Framework for Groundwater Research and Development

Increased climate risk and ongoing socio-economic development will continue to place water resources under pressure. There is a need to develop new and innovative solutions for groundwater management and development to deal with the varying and complex challenges that are emergent. Therefore, research and development (R&D) activities are, and will increasingly become, important to institutions.

R&D is typically understood to be the expertise of universities and research institutes, but there is a more complex array of institutions that need to engage in setting the research agenda, in advising on programmes and projects, as well as actively participating in action-research.

Strengthening the institutional arrangements to support groundwater R&D will be an important part of developing climate resilience and three key steps can support this process.

- **Strengthen R&D institutional arrangements:** The Ministry of Water needs to look towards improved approaches towards R&D and strengthening the institutional frameworks. This may not involve establishing new institutions, but only clarifying and strengthening mandates. It is essential as sector lead, that the Ministry leads in ensuring that water sector institutions actively engage in these R&D initiatives.
- **Improve the groundwater R&D strategy:** The development of a coherent national level R&D strategy for groundwater provides the opportunity to not only link the R&D agenda to the needs of managers and developers, but also provides the opportunity to develop a more balanced strategy that covers technical and managerial aspects, short-term and long-term interventions as well as issues at various spatial aspects. Engaging with international development partners and regional institutions such as SADC GMI, will assist in linking this national strategy to international and regional R&D programmes.
- **Improve funding streams for R&D:** Often, financial constraints hamper the ability to undertake necessary research. This requires that countries revisit the financing frameworks for R&D and endeavour to improve these. Whilst there is a need to consider how funds from the national fiscus supports R&D, it will be important to engage with international development partners, R&D foundations and the private sector in order to diversify the financial support.

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LIST OF ACRONYMS

Acronym	Definition
AMCOW	African Ministerial Council on Water
DFI	Development Finance Institutions
DRC	Democratic Republic of The Congo
DWS	Department of Water And Sanitation
EU	European Union
GMI-PLI	Groundwater Management Institute – Policy, Legal and Institutional
IHP	Intergovernmental Hydrological Programme
IWRM	Integrated Water Resource Management
JPTC	Joint Permanent Technical Committee
LIMCOM	Limpopo Watercourse Commission
MCCM	Multi-Country Cooperation Mechanism
MOU	Memorandum of Understanding
NGO	Non-Governmental Organisation
O&M	Operations and Maintenance
ORASECOM	Orange Senqu Water Course Commission
PPP	Public Private Partnerships
R&D	Research and Development
RBO	River Basin Organisation
RSAP	Regional Strategic Action Plan
SADC	Southern African Development Community
SADC-GMI	Southern African Development Community – Groundwater Management Institute
SWPN	Strategic Water Partners Network
TBA	Transboundary Aquifer

UNESCO	United Nations Educational, Scientific and Cultural Organization
WEFE	Water-Energy-Food-Environmental
WFD	Water Framework Directive
WRG	Water Resources Group
WRTC	Water Resources Technical Committee
WUA	Water User Association
WWF	World Wide Fund for Nature

1. INTRODUCTION

1.1. Background

The business of groundwater management is indeed complex, entailing a collection of interconnected processes that have strategic, technical and administrative dimensions. Frequently, there is significant focus placed upon the highly technical dimensions of groundwater management and for many years there has been considerable effort towards developing our understanding of the science behind groundwater management. This has strengthened the functional approaches used to manage groundwater resources and as such this informs the frameworks for the governance of the resource.

As a result, our understanding of the importance of groundwater resources in supporting socio-economic development has adapted and is still developing. Increasingly, there is the realisation that as an important dimension of our resilience to climate variability and change, groundwater resources need to be managed and developed in conjunction with surface water resources. Currently it is estimated that half of the global drinking water supply and 40% of global irrigation supply comes from groundwater resources (Kiparsky, Milman, Owen and Fisher, 2017). Equally, there is the need to understand within catchment contexts the importance of groundwater in sustaining ecological infrastructure and supporting ongoing water security.

Despite this recognition of the importance of groundwater and the ongoing development of related sciences, there are increasing concerns about the degradation of groundwater resources. As a result, many systems are experiencing resource depletion, concerns with regard to resource pollution and degradation of groundwater quality, reduction in surface water flows and impact on biodiversity and ecological infrastructure such as wetlands. Noting the growing level of impact, this has been described as an emerging 'global groundwater crisis' (Foster, Chilton, Nijsten, and Richts,2013; Famiglietti, 2014).

This emergent crisis begs questions of the ability to manage groundwater resources effectively and sustainably. In many areas, groundwater governance is found to be absent or insufficient (Foster and Gorduño, 2013; FAO, 2016) with the potential for longer term socio-economic and environmental impacts.

The challenges that exist in terms of ensuring improved groundwater governance are many, noting that there are often quite distinctive differences in the nature of groundwater development and that of surface water (Table 1). Most often, the decentralised nature of groundwater infrastructure and use results in users that are most often independent and autonomous, and this creates significant difficulties in effecting sound groundwater management practices and enabling effective regulatory compliance. This is further complicated by the significant levels of private investment that goes into groundwater development and, therefore, the understanding of groundwater users as to the nature and importance of this resource and their willingness to comply with regulations has impact upon the ability to improve groundwater management.

These challenges vary across the SADC region, from country to country and between regions within countries.

Table 1: Characteristics distinguishing surface water and groundwater (after Turral and Fullagar, 2007)

Characteristic	Surface Water	Groundwater
Primary nature of development	• Centralized	• Decentralized
Infrastructure funding	• Largely publicly subsidised and centralised financing	• Largely private in urban areas, with donor funding in more rural landscapes
Management of flow	• Linearly regulated (rivers and canals)	• Unregulated
Public awareness	• High	• Low
Security of supply	• Low	• High
Water quality	• Good (managed)	• Variable (unmanaged)
Extraction limits	• Volume in storage	• Bore capacity, drawdown and volume in storage
Capacity to enforce regulation	• High (linearly regulated)	• Variable (often private infrastructure on private land)
Monitoring and reporting	• Regulatory and centralised	• Variable and generally less than surface water
Ease of monitoring and building resource information	• Relatively high	• Low
Primary financial costs of water use and entitlement	• Volumetric water use charges	• Infrastructure installation, operation and maintenance

The complexity of these characteristics results in considerable debate about the appropriate levels at which to locate groundwater governance. Kemper (2007) notes that manageability of groundwater use is impacted upon by the size of the country, the relative size of aquifers and their yields, the core water uses, the storage capacity and the population density. This implies that increasing complexity results in increasing transaction costs to ensure effective institutional arrangements and strategies for groundwater management, noting that the requirements for groundwater management adjust with time.

This then presents a strong argument for the decentralisation of groundwater management to more local levels, aligned to the general realisation that groundwater is a local resource, and hence requiring due consideration of appropriate institutional arrangements to support community engagement and local operations and maintenance. These preferences for localised management can collide with the need for certain strategic functions to take place in a more centralised manner, as well as the need to ensure better coordination within or between groundwater basins. This potentially provides an argument for a more harmonised approach that realises certain strategic functions taking place in a more centralised manner, whilst the more operational functions take place at the lowest possible scale.

Across the SADC region there are several transboundary aquifers that require differing states to engage in the management of these international groundwater resources. These present an even further level of complexity. Hence, this framework explores the various challenges and opportunities with regards to

developing groundwater governance across these various spatial scales and provides some lessons and insights towards strengthening the institutional approach across these various spatial scales.

Even though the policy and strategy instruments for water resource management, across the SADC region, have been in place for some time, the governance frameworks and the institutional arrangements that underpin these frameworks, are still under development and evolving. Different countries have applied different approaches that are relevant to their governance contexts. There is not a "one size fits all" approach that can be applied to groundwater governance, especially when one notes the considerable climatic and water resource variability across the region. Nevertheless, there are valuable lessons that can be learned from the approaches utilised across SADC, and as such, this report shares some of these lessons with the intent to help countries improve their approaches.

It is important to note that the development of institutional arrangements for water resource management can take time to evolve and often this process is iterative in nature (Blomquist, Dinar and Kemper, 2005). In the complex and highly variable contexts of groundwater resources, it could be argued that such institutional process could take longer to resolve. However, with the pressures being placed upon groundwater resources to support regional socio-economic development, it can be argued that there is no longer the luxury of time and of learning-by-doing, but rather utilising the experience of other countries and regions to develop improved approaches to governance and the institutional arrangements that support this.

1.2. Purpose of this document

This document draws up a framework garnered through the course of the SADC-GMI policy, legal and institutions project; supplemented by additional findings from a desktop review. This has been produced with the intention of providing:

- a framework for how groundwater management institutionalised;
- lessons learned in terms of institutional processes across the SADC region that support effective groundwater management;
- understanding of these institutional arrangements across differing spatial scales (regional, transboundary, national and local); and
- a framework towards institutional arrangements and processes that can better support conjunctive surface water and groundwater management.

This report firstly sets the context of groundwater management and how this integrates with institutions and their processes. With that primary understanding the document then looks at the various institutional arrangements at the various scales noting the key functions that need to be performed and lessons learned in terms of set-up, establishment, and operationalisation.

1.3. Target Audience

Whilst this report is primarily focused upon providing a framework to support groundwater managers and practitioners within the public service and private sector, it is also aimed at groundwater users who most often use groundwater resources in a decentralised and autonomous manner. Whilst the dilemma of the "tragedy of the commons" impacts upon all water resources, the nature of groundwater as an "invisible" resource, makes it particularly susceptible to this. Therefore, the need to strengthen the governance of groundwater resources is significant. Awareness regarding the various dimensions that make up this governance framework is often incomplete and hence, there is frequently only a limited understanding of the steps that could be taken to improve this framework and to strengthen the institutions that give effect to it.

It is important to note, that there is no ideal or perfect institutional framework yet there are various steps that could be taken to improve these frameworks and strengthen the institutions. This document provides several such steps, noting that groundwater managers and developers can then undertake identified priorities, as appropriate to their own contexts. It is hoped that this report can support in improving these governance arrangements.

2. UNDERSTANDING THE GROUNDWATER MANAGEMENT BUSINESS

Institutional theory understands that form follows function, with function being guided by strategic intent. As such, it is essential to understand the business of groundwater management in order to construct the appropriate institutional frameworks. In so doing, it is essential to be pragmatic noting that the phased development of institutions enables a process of progressive capacitation and functional development.

2.1. Understanding the Business of Managing Groundwater

Groundwater is vital for socio-economic development and for livelihoods enhancement at global, transboundary, national, catchment and local levels. This requires a holistic and integrated approach towards the various dimensions of managing and developing groundwater resources. Noting the connectivity of groundwater resources hydrologically to surface water resources and an array of ecological infrastructure, the business of groundwater management must be effectively integrated, and the development of these natural resources must be coordinated to enable conjunctive and supportive approaches.

Evidently, addressing groundwater issues in isolation can inadvertently create or exacerbate other problems. Therefore, a joint assessment and treatment of issues across various policy sectors is important to avoid perverse outcomes. This includes engaging with policies related to agriculture, energy, environment, land-use planning, and urban development (Megdal, 2018). This requires a holistic treatment of groundwater related issues to ensure that all stakeholder (public sector, private sector and civil society) views are included, and conflicts in policy, strategy and implementation are considered. The essence of the groundwater business then does include clearly articulating resource management imperatives and making trade-offs to limit adverse impacts and balance the needs and values associated with competing developmental objectives. This process can involve selecting appropriate environmental, social and/or economic indicators as evaluation criteria, and using integrated assessment and modelling to assess the system performance under different scenarios (Hamilton et al. 2015).

This need for cooperative government approaches is being increasingly recognised as pressure upon water resources increase, and the recognition that water availability and assurance of supply can constrain socio-economic development. Across the regional, transboundary, national and local scales this more integrated and cooperative approach requires clarity in institutional arrangements, underpinned by well-defined institutional mandates.

The groundwater governance and management practices implemented will be a construct of the geographic reach of aquifers, the various jurisdictional boundaries, and the rules and regulations that guide groundwater management and development within the relevant region, member state, transboundary basin or locality (Megdal, 2018).

The Groundwater Governance Diagnostic (FAO, 2015) noted that "*Groundwater governance and management are typically public responsibilities in law, although how this translates into practice – and the degrees of stakeholder participation – vary considerably*". This is re-emphasised by Megdal (2018) who

notes that there is plethora of definitions and approaches to groundwater governance and that these do need to be context specific.

In reviewing the literature, as well as in reviewing the current groundwater management approaches across the SADC region, there are four key dimensions to the business of groundwater management (**Figure 1**). These are discussed briefly below.

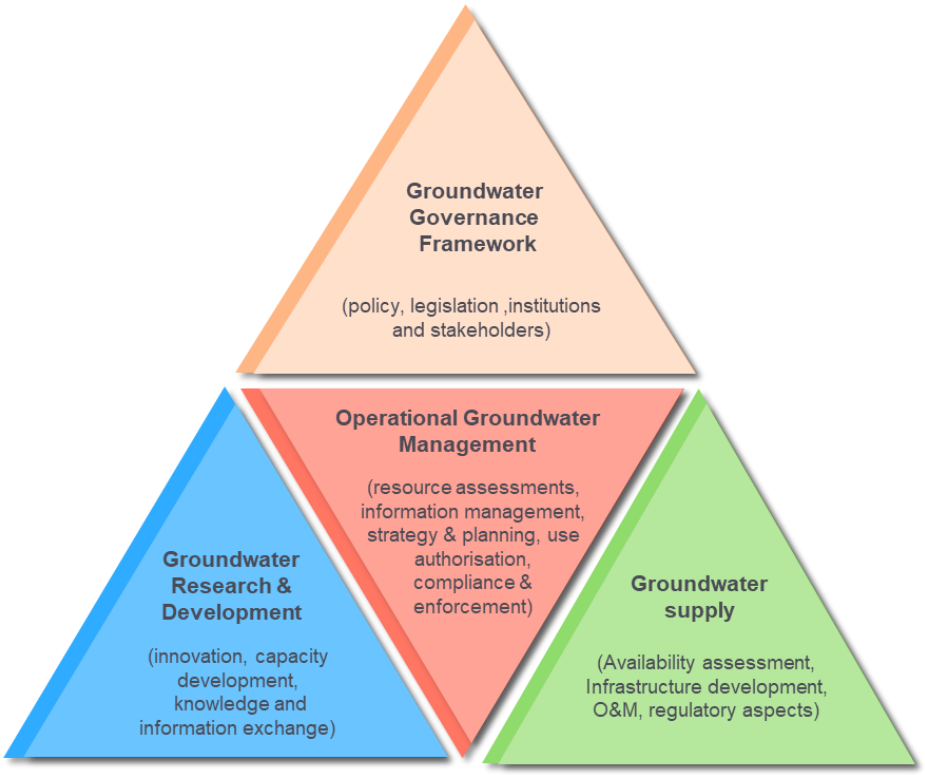


Figure 1: Four dimensions to groundwater management

2.2. Groundwater Governance Frameworks

Groundwater governance provides the enabling framework and guiding principles within which groundwater management operates and provides the overarching guidance as to how groundwater resources will be managed attuned to the goals of society (FAO, 2015). This is, therefore, a construct of:

- **Policy**: The overarching principles and intent with regards to the sustainable management and development of groundwater resources;
- **Legislation**: The legal and regulatory instruments that support the effective implementation of policy and ensure sustainable management and development of groundwater resources; and
- **Institutions**: The various organisations and bodies that undertake actions to implement policy and legislation and effect the sustainable management and development of groundwater resources.

Part of the challenge in giving effect to groundwater governance framework is not only the fact that the resource itself is “invisible” and often poorly understood; therefore being open to abuse, but equally that these frameworks are often weak (FAO, 2015, Megdal, 2018; Cobbing and Hiller, 2019). Hence,

groundwater resources, without establishing a strong governance framework easily fall prey to the "tragedy of the commons" where individual users, acting independently according to their own self-interest, behave in a manner that is contrary to the common good of all users, hence over using or even irreparably damaging the shared resource through their collective action (Hardin, 1968). It is essential to understand that within regional context of SADC, this groundwater governance framework not only straddles differing spatial scales, but also can cut across differing political and economic systems, differing societal environments and values, as well as differing ecological and natural resources environments (GWMate, 2010). These create complexity and hence, the importance of regional and transboundary frameworks to provide the overarching governance direction towards an agreed intent.

Case Study 1: The Groundwater Governance Project

Recognising the increased pressures upon groundwater resources and the inability of groundwater governance frameworks to drive sustainable management approaches the Groundwater Governance Project was initiated by the Global Environmental Facility, the World Bank, the Food and Agriculture Organization of the United Nations (FAO), the UNESCO-International Hydrology Programme, and the International Association of Hydrogeologists. This global initiative to strengthen groundwater governance commissioned 12 thematic papers and a synthesis by leading experts and convened five regional consultations in different parts of the world and a final high-level expert meeting. The outcomes of all these activities were integrated in a Global Diagnostic that became the basis for the Shared Global Vision for Groundwater Governance 2030 and this Global Framework for Action to Achieve the Vision on Groundwater Governance (FAO, 2015).

Key themes included:

- **Creating an adequate basis for governance**: Defining relevant governance improvements that can be adapted to local conditions.
- **Building effective institutions**: Enabling the establishment of capacitated and credible institutions at appropriate spatial and administrative scales that can effectively deliver on groundwater management mandates.
- **Making essential linkages**: Establishing linkages between water resources (surface and groundwater) and other sectors (agriculture, land, energy, urban etc) to enable integrated and sustainable development outcomes.
- **Redirecting finances**: Developing improved and innovative financing mechanisms that can underpin effective groundwater governance.
- **Starting the process of planning and management**: Through prioritisation of focus aquifers, develop pragmatic implementation plans that support phased and progressive improvements in groundwater management, underpinned by stakeholder engagement and measured through an appropriate monitoring and evaluation mechanism.

http://www.groundwatergovernance.org/fileadmin/user_upload/groundwatergovernance/docs/general/GWG_FRAMEWORK.pdf

Yet, the reliance on this resource has grown considerably, with abstraction from more shallow groundwater aquifers having doubled across SADC within the last two decades (Pavelic *et al*, 2012). Hence, the development of groundwater resources has been rapid and, noting that the development and amendment of governance framework takes time, has often led to gaps in these frameworks (FAO, 2015).

Groundwater governance is being driven by a variety of intentions and aspirations and is often responsive to a range of threats and needs. Of course, in constructing and giving effect to a governance framework

there is a need to find the appropriate balance between the various demands and the need to ensure that groundwater resources are sustainably managed. The ability of the governance system to effectively harness and oversee the operational management of groundwater resources, the supply of water from groundwater resources and the research and development agenda becomes essential.

Understanding how the governance framework across the differing spatial scales is important, especially in a region that has strongly linked social economies and is rich with transboundary basins and aquifers (Table 2).

Table 2: Basic requirements of a groundwater governance framework at various spatial scales

Elements	Regional	Transboundary	National	Local
Policy	▪ Develop regional water policy ▪ Recognition of importance groundwater to regional social economy ▪ Provide overarching frameworks for groundwater governance ▪ Intent to harmonise policy regionally	▪ Uptake and implementation of regional groundwater policies ▪ May develop guidelines that translate the implementation of regional policy into the basin/aquifer context	▪ The social, economic and environmental values of groundwater are all recognised in a national water policy ▪ Frameworks to protect groundwater by preventing pollution and overuse ▪ Groundwater policy is consistent with other water management policies and is considered in other sectorial policies	▪ Utilise national policy frameworks ▪ May translate national policy into localised guidance and approaches
Legislation	▪ Agreements to establish regional institutions and structures to support improved groundwater management (e.g. SADC GMI)	▪ Basin/ aquifer agreements and the need to ensure: ○ Reasonable use and undue harm to the resource ○ Shared beneficiation ○ Prior notification	▪ Groundwater is recognised in law ▪ Enables the authorisation of groundwater use and the development of regulations to support ▪ Enables institutional establishment and delegation of powers and duties	▪ Utilise national legal frameworks ▪ Utilise statutes of institutional establishment and constitutions to guide mandate and delivery
Institutions	▪ Provide advisory support with some oversight ▪ Knowledge and Information exchange (political, economic, technical etc) ▪ Studies to improve groundwater management approaches and develop innovation ▪ Develop platforms for stakeholder engagement	▪ Provide advisory support with some oversight ▪ Information exchange ▪ Studies to improve groundwater management approaches ▪ Exchange of knowledge through stakeholder engagement	▪ Development of national governance frameworks ▪ Enables split of policy and regulatory functions from operational management and resource development ▪ Operational groundwater management devolved to authority or agencies ▪ Engage stakeholders at national level on policy, legislation and strategy ▪ Catchment level engagement on operational groundwater management through authorities and agencies ▪ Research and development enabled and funded	▪ Operational management of localised groundwater resources ▪ Manage and monitor groundwater supply systems ▪ Localised stakeholder and community engagement, largely on managing water supply and improving practice

The shared global vision for groundwater governance (FAO, 2015) outlines key elements that are required to strengthen the governance of groundwater:

- Accurate and widely shared understanding of groundwater systems;
- An effective legal system in which groundwater is under public control;
- Leadership nationally and locally for the resource, with empowered government agencies having appropriate authority, personnel and finance for the task;
- Mechanisms to facilitate and nurture stakeholder participation;
- Co-management with surface water and land-use, and coordination with related sectors (such as urbanisation, agriculture and energy) to address issues and risks; and
- Structured programmes for the elaboration and implementation of priority management action plans, based on sound scientific evidence.

The process to address these aspects needs to be phased and progressive and would be strongly influenced by the contextual specifics of the region, basin or locality. However, it is fundamental that such processes be led by key institutional champions such as the SADC Water Division, the Water Resources Technical Committee and its sub-committee on hydrogeology, as well as innovation leaders such as SADC-GMI.

2.3. Operational Groundwater Management

Whilst the groundwater governance framework provides the overarching enabling environment and guiding principles for managing groundwater resources, the operational management framework provides the collection of instruments and tools that are used to manage groundwater resources on a day-to-day basis. This includes:

- **Resource assessment**: Undertaking geo-hydrological surveys, modelling and technical assessments to understand aquifer types, recharge and discharge characteristics, water quality aspects as well as connectivity to surface water resources and ecological infrastructure.
- **Data & Information management**: Developing the appropriate monitor networks and protocols, supported by information management protocols and systems.
- **Strategy & Planning**: Developing strategies and associated planning tools to guide implementation towards delivery on policy and legislative requirements.
- **Use authorisation**: Implementing a range of instruments to regulate water use and provide water user with a suite of authorisation conditions that support sustainable water practices.
- **Compliance & enforcement**: Undertaking a range of activities to support improved compliance with water use authorisations as well as taking targeted actions to enforce this compliance.

As such, managing groundwater resources is primarily aimed towards enabling sustainable development of the resource for various users. A key issue of sustainable groundwater is balancing the available resources with the increasing demands of water use.

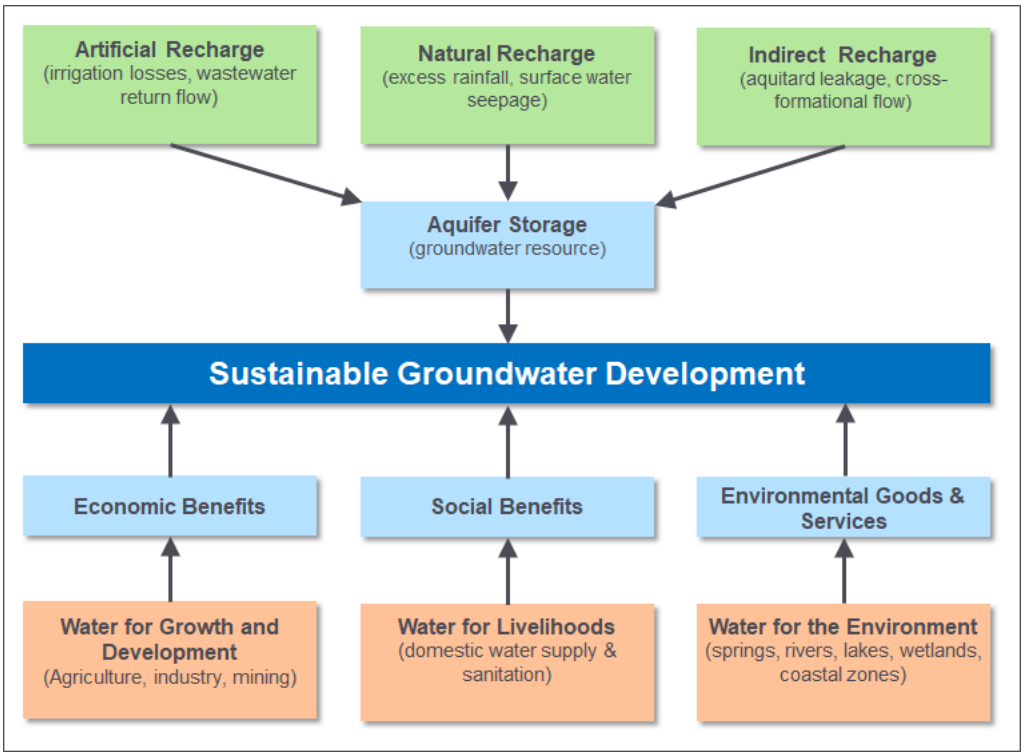


Figure 2: Sustainable groundwater development (modified from Hiscock, 2002 and Cap-Net, 2010).

Groundwater resources management is anchored on two primary objectives which entail balancing groundwater recharge against abstraction, and groundwater protection from pollution (Figure 2)

Following this understanding, the approach taken to groundwater management at any moment in time will depend, to a considerable degree, upon information about, and interaction between, the following factors:

- the size and complexity of the groundwater resource;
- the degree of climatic aridity and the rate of aquifer recharge and resource renewal;
- the scale of groundwater abstraction and the number and types of groundwater users;
- the ecological role and environmental services dependent upon groundwater;
- the susceptibility and vulnerability of the aquifer system to degradation;
- natural groundwater quality concerns (trace element hazards and saline water presence); and
- Other available water resources.

Groundwater management must be based on a good understanding of the groundwater characteristics at the scale of the total groundwater system (or river basin if necessary). Depending on the specific situation, groundwater systems may be of relatively small, localised scale (a few hectares or square kilometres) or of regional scale (up to ten or hundred thousands of square kilometres). This understanding requires substantial amounts of data from groundwater investigations and monitoring, interpretation by hydrogeologists, and generally also some groundwater flow modelling. This needs to be supported by information management tools that enable capture of, and access to, this data and information.

The groundwater component of national IWRM plans, to give effect to strategy, may be developed from specific aquifer management plans as illustrated in Figure 3. First, all available information on national aquifers needs to be compiled, the groundwater systems classified according to their hydrogeological characteristics and management issues, and key focus areas identified. This process can be refined with feedback from local aquifer level and will facilitate the assessment of groundwater management needs at national level. As such, this will require the coordinated input of institutions at a range of spatial scales and equally recognises the importance of phased and progressive approaches.

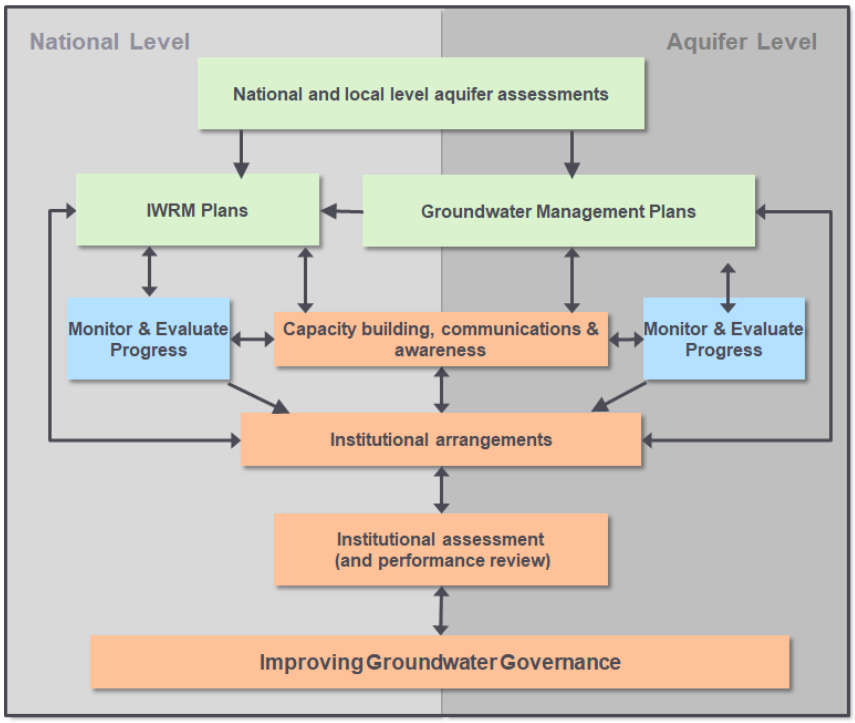


Figure 3: The groundwater management planning and implementation process (source: adapted from Cap-Net, 2010)

There are significant challenges in ensuring that groundwater use is appropriately authorised. Ideally water use authorisation systems for surface water and groundwater use should be consolidated, in support of enabling conjunctive use. However, there are very specific requirements and criteria that are required in authorising groundwater use. Similarly, these need to be integrated into compliance approaches. Noting that compliance monitoring for groundwater use can be complex, there is a need to be clear on institutional roles and capacity requirements to enable this.

Understanding how the operational management framework functions across the differing spatial scales is important, noting the importance of an integrated approach to groundwater management at these various scales. In this context, the need for cooperative approaches between the various institutions is essential and requires alignment to an agreed upon strategic intent (Table 3).

Table 3: Basic requirements for the operational management of groundwater resources at various spatial scales

Elements	Regional	Transboundary	National	Local
Resource assessment	▪ Regional assessments to support improved groundwater management approaches and support strategic intent	▪ Basin or aquifer studies to support planning and improved approaches to management ▪ Specific technical studies to develop common understanding between Member States	▪ Assessments to support national strategies, largely at basin, aquifer or system level ▪ Assessments to support the development of basin plans ▪ Specific technical studies to support innovation	▪ More localised assessments to support local planning
Data & information management	▪ Limited role	▪ Key interlocular role in the exchange of data and information ▪ Support Member States in gaining a shared understanding of data and information ▪ Develop information management system for data and information needs common to the transboundary context	▪ Maintain national monitoring networks ▪ Develop protocols for data and information management collection ▪ Manage national information management system ▪ Ensure availability of data and information ▪ Establish integrated monitoring and information committee (often inter-governmental)	▪ Monitor local groundwater use and quality ▪ Maintain local records of water use and water quality ▪ Regular submission of data and information to relevant authority
Strategy & planning	▪ Develop regional water strategy as well as a regional action plan to support the strategy ▪ Support linkages between sector strategies and plans	▪ Develop strategy and plans for the basin/ aquifer ▪ Ensure linkages to national strategies and plans	▪ Development of national strategy and planning instruments for IWRM ie national water resources strategy and associated masterplans ▪ Develop national groundwater management strategy and associated implementation plan ▪ Support the development of strategies and plans for water supply systems and for basins ▪ Ensure engagement with other sectors	▪ Develop integrated development plans at local govt ▪ Develop water management plans for water user associations ▪ Develop aquifer specific management plans
Groundwater use authorisation	▪ No role	▪ No role	▪ Develop water use authorisation processes and manage associated systems ▪ Delegation of associated roles and responsibilities to basin/ aquifer levels to enable efficient administration ▪ Ensure authorisation processes enables conjunctive use ▪ Where appropriate link authorisation processes with other natural resource authorisations (e.g. environmental impact, land)	▪ Link local government bylaws to water management requirements ▪ Provide feedback on authorisation processes and challenges

Elements	Regional	Transboundary	National	Local
Compliance & enforcement	▪ No role	▪ No role	▪ Develop the systems and procedures to ensure effective compliance monitoring and enforcement ▪ Build staff capacity to undertake compliance monitoring and enforcement actions ▪ Develop information management systems to support effective compliance monitoring and enforcement ▪ Coordinate with other sector enforcement officers ▪ Issue directives to correct non-compliance	▪ Ensure compliance and enforcement of bylaws ▪ Support compliance monitoring at the local level, especially within water user associations ▪ Undertake localised actions to ensure compliance

2.4. Groundwater Supply

Sub-Saharan Africa faces significant development challenges with access to water being a key dimension of the poverty that exists across the region (Cobbing and Hiller, 2019). In many rural contexts, where infrastructure challenges exist, access to groundwater most often through shallow wells, provides access to water supply for domestic purposes as well as for food production. The use of groundwater across the globe has increased significantly in the last two decades (UNESCO, 2012, Cobbing and Hiller, 2019) and groundwater is a key dimension to ensuring water security in sub-Saharan Africa (Pietersen and Beekman, 2016). In fact, groundwater provides drinking water to as much as 50% of the world's population and supports about 43% of the water used in the world's agricultural development (UNESCO-IHP, 2015). Groundwater resources as a "local" resource will play a critical role in ensuring resilience to the impacts of climate change, both within urban centres as well as rural communities.

Despite the recognised role that groundwater will play in addressing localised water risks, there are concerns about the impact of climate change and anthropogenic factors on groundwater resources. Hence, there is growing concern regarding the depletion of groundwater reserves combined with increased concern about the pollution impacts upon these resources (UNESCO, 2012).

The *Groundwater Diagnostic* study (FAO, 2015) reflected upon the key management drivers for improving groundwater governance across significant regions of the world; finding that the need to improve levels of domestic and public water supply is the most significant issue across sub-Saharan Africa. Core constraints to addressing this were found to be a lack of awareness and knowledge, insufficient political commitment, poverty and lack of funding and weak institutions (FAO, 2015).

Case Study 2: The importance of groundwater in water supply

Groundwater resources provide a range of beneficial uses across the region, and at various spatial scales. Pietersen *et al*, (2010) provided a valuable overview of the beneficial uses of groundwater, listing these as providing for rural and urban water, improving water security through conjunctive use, supporting food security, underpinning environmental goods and services and supporting the development of economic value-add. As such, the development of groundwater resources is increasingly important in terms of attaining a number of the sustainable development goals. There are valuable case studies around SADC of how groundwater is becoming increasingly important to ensuring water supply in both rural and urban contexts.

Rural water supply

Many rural communities in SADC obtain their water supply from groundwater resources. Assessments of this are difficult due to the rapid development of these resources in a localised manner. Some studies provide useful anecdotal evidence:

- About 60 per cent of the Mozambican, population mostly rural, relies on groundwater resources (Pavelic, Keraita and Giordana, 2012);
- A significant number of rural communities in Zambia are dependent on groundwater resources with groundwater being the main source of drinking water outside the larger towns (Pavelic, Keraita and Giordana, 2012). In some areas, where the reticulation systems are not reaching communities, particularly in more rural areas, water kiosks have been established to ensure access to groundwater. However, this is not always at a reliable pressure causing some supply challenges (GeoSFF, 2019) ;
- In the Democratic Republic of Congo (DRC), more than 90 per cent of the rural population relies on groundwater resources (Partow, 2011); and
- Botswana and Namibia, in rural areas, are even more reliant on groundwater resources due to the scarcity of surface water (Krugman and Alberts, 2012; Republic of Botswana, 2016).

Urban water supply

Several SADC's large urban centres are becoming increasingly reliant on groundwater resources to ensure adequate water supply that underpins a broader social economy. In many instances this requires the conjunctive use of surface and groundwater resources, but estimates have reflected that in the order of 36% of the urban population of SADC is dependent on groundwater (Braune and Xu, 2008).

- Groundwater has played a crucial role during droughts in Bulawayo, the second largest city in Zimbabwe (Mukuhlani and Nyamupingidza, 2014);
- Dodoma, the capital city of the Tanzania, mainly depends on groundwater (Elisante and Muzuka, 2017);
- Lusaka, the capital of Zambia, obtains about 60 per cent of its water requirements from groundwater resources (Nussbaumer, Sutton and Parker, 2016). Current abstraction of groundwater in Lusaka is estimated at 90 million cubic metres per annum (m3/annum) (Bäumle and Kang'omba, 2013).
- The City of Tshwane in South Africa obtains a significant portion of its water supply from boreholes and springs, which is blended with surface water within the bulk water distribution system (Dippenaar, 2013).
- In Windhoek, the capital of Namibia, groundwater contributes about 10 per cent to the water supply (Christelis and Struckmeier, 2011). A system of artificially recharging groundwater resources has been put in place (Murray *et al.*, 2018). The aim is to make available up to 8 million m^3/annum of groundwater for abstraction (Tredoux, Van Der Merwe and Peters, 2009). The present Windhoek water demand is about 20 Mm^3/annum (Christelis and Struckmeier, 2011)

Enabling the sustainable supply of water from groundwater resources requires the following key processes:

- **Availability assessment**: Although in many instances there is limited assessment of the ability of the aquifer to sustainably supply water, these analyses are important to ensure effective management of the resource and includes mapping and aquifer delineation, piezometric analysis and monitoring, groundwater quality analyses, pump testing, and yield analysis.

- **Infrastructure development**: Depending on the scale of development there will be a need to develop storage, as well as pumping and transmission lines to connect with the wider water distribution networks.
- **Operations & maintenance (O&M)**: This includes various routine tasks which need to be carried out to keep a groundwater source or well-field functional such as servicing, repairs, monitoring, replacement of parts, complying with pump duty cycles or maximum yields, testing, and so on. Many of these tasks are routine and can be planned and budgeted for, but O&M programmes also need to be able to respond to breakdowns and other unforeseen events. This O&M function should generally be conducted by technical staff within municipalities, or alternatively, trained community members who are selected/volunteer to act as community champions in looking after this infrastructure. A small stipend could be paid to incentivise that the O&M is conducted regularly, through regular inspections, noting that preventative maintenance results in fewer breakdowns and is more cost effective.
- **Monitor regulatory compliance**: Maintaining records of water use as well as water quality are important in terms of compliance, as well as to support localised groundwater management. Submission of data to regulatory authorities is important for these authorities to understand the status of the resource.

The institutional frameworks for water supply are complex and vary considerably, but often involve water utilities and water user associations. Ministries should be providing strategic guidance, oversight as well as regulatory instruments. Noting the more localised nature of groundwater resources the institutional arrangements become responsive to these local contexts and often community level interventions take place. The need for cooperative approaches between the various institutions is essential and often requires alignment that is underpinned by contractual agreements towards supply standards, but at the more local levels these development can be much more organic (Table 4).

Table 4: Basic requirements for groundwater supply at various spatial scales

Elements	Regional	Transboundary	National	Local
Availability assessments	▪ Regional assessments to support improved groundwater management approaches and support strategic intent	▪ Basin or aquifer studies to support planning and improved approaches to management ▪ Specific technical studies to develop common understanding between Member States, especially for transboundary aquifers	▪ Assessments to support national strategies, largely at basin, aquifer or system level ▪ Assessments to support the development of basin plans ▪ Specific technical studies to support innovation ▪ Development of guidance tools and manuals	▪ More localised assessments to support local planning and local developments ▪ Often site-specific assessments
Infrastructure development	▪ Strategic planning for priority interventions across the region	▪ Planning for strategic interventions across the region ▪ In some instances, facilitate studies to develop infrastructure	▪ Support infrastructure development for strategic water supply ▪ Undertake supporting studies for priority basins/aquifers	▪ Development of local infrastructure to support local water supply needs ▪ Local government and water user associations will

Elements	Regional	Transboundary	National	Local
			▪ Support in finding appropriate financing mechanisms	develop infrastructure for wider area supply
Operations and maintenance	▪ No role	▪ No role	▪ Provision of standards and guidance materials ▪ Develop regulatory instruments to support ▪ Larger utilities will support O&M programmes for strategic and larger well fields and associated distribution networks	▪ Routine operations and maintenance schedules and implementation ▪ Maintenance of local distribution networks
Monitoring for regulatory compliance	▪ No role	▪ No role	▪ Develop compliance requirements ▪ Regulate drillers ▪ Build staff capacity to undertake compliance monitoring and enforcement actions ▪ Coordinate with other sector enforcement officers ▪ Issue directives to correct non-compliance	▪ Users to monitor compliance with water use authorisations and bylaws ▪ Support compliance monitoring at the local level, especially within water user associations ▪ Undertake localised actions to ensure compliance

2.5. Groundwater Research and Development

Information, knowledge and science are essential in supporting effective groundwater management and development. As pressures increase on what are limited resources, the need to undertake research and development intensifies, and the need to better understand groundwater resources as well as develop improved and innovative approaches to the governance, operational management and water supply systems, also increases. Broadly, research and development comprise of:

- **Innovation**: Undertaking a range of research interventions to develop new approaches and techniques that can strengthening our ability to manage groundwater resources more sustainably and improve climate resilience;
- **Capacity development**: Utilising structured and focused interventions to build institutional capacity as well as train individuals regarding the various dimensions of groundwater management and development; and
- **Knowledge and information exchange**: Developing appropriate knowledge products to strengthen awareness regarding groundwater management and development, as well as support capacity building initiatives, and constructing the various information portals to enable accessibility of this knowledge and information.

Research and development activities to drive innovation will become increasingly important. The need to improve the effectiveness of adaptive responses to groundwater management in the face of climate change and hydrological variability needs to be understood across spatial and governance scales. Similarly, there is a need to further explore the effective management of groundwater recharge methods and introduce approaches and technologies to maximize groundwater storage capacity and resource availability. Concerns regarding the deterioration of groundwater quality will require redress and developing new technologies and management systems to manage water quality and enable treatment and reuse of contaminated water will be required.

For island states and coastal cities and towns, the protection of island and coastal aquifers from effects of sea level rise is equally important. Further research and exchange of experiences will be needed to support the introduction of new approaches to groundwater management and development in these contexts.

Finally, the pressure from growing populations, migration, climate change and urbanisation exacerbate the need for managing demand for groundwater. This requires the unpacking and exploration of technologies and management practices that improve the efficiency of urban and agricultural uses of water, reduce water quality requirements of non-potable uses or reduce the need for water altogether.

Together with the development of new and innovative approaches, is the need to be continually developing institutional capacity. The need to construct structured capacity development programmes is an ongoing challenge and should not be understood as a once-off intervention, but rather as something that needs to be planned to take place continuously. With specific regards to groundwater management and development there is a dearth of skilled practitioners which requires redress. In addition, there is a need to ensure that water resource managers also develop a deeper understanding of groundwater management and how this resource is used conjunctively with surface water resources.

Governance also requires good information and science provided through dedicated information services. Whilst there is a need to share data and information, there is a dire need to develop knowledge products that support in translating this data and information into tools and guides that support awareness as well as guiding management decision making. The interpretation and analysis of this information does need to be fed into policy formulation and planning and often requires the support academia and research and development organisations to support this.

Information and awareness programmes should ensure that the information is disseminated among the stakeholders to the extent needed.

The institutional frameworks for water research and development vary considerably, and the needs at the various spatial scales differ (Table 5). There is often a gap between government and the various academic and research institutions, where there is a need for discourse regarding sectoral research and development requirements and priorities. Ministries should be providing strategic guidance, as well as providing technical inputs and oversight. Noting the more localised nature of groundwater resources the need to be more responsive to these local, community level contexts requires more coordinated action research, with

government actors involved in these types of projects. The need for cooperative approaches between the various institutions is, therefore, essential.

Table 5: Basic requirements for groundwater research and development at various spatial scales

Elements	Regional	Transboundary	National	Local
Innovation	▪ Regional research and development to support regional policy and strategy development as well as guide transboundary, national and local level challenges ▪ Leverage global research into the region ▪ Coordinate groundwater research across the various academic and research organisations towards a structured research agenda	▪ Specific research studies to develop common understanding between Member States, especially for transboundary aquifers ▪ Ensure linkages to regional research programmes and leverage these to support basin/ aquifer	▪ Coordinated national research agenda to support improved groundwater management and development ▪ Coordination across academic and R&D institutions ▪ Specific research studies to support national policy and strategy development, largely at basin, aquifer or system level ▪ Technical research studies to address key identified issues	▪ Coordination between local academic and R&D institutions with local groundwater management and development institutions (local govt, WUAs, catchment forums etc) ▪ Site specific and community level studies
Capacity development	▪ Facilitate structured capacity development opportunities through regional structures such as Water Resources Technical Committee and specialist hydro-geology sub-committee ▪ Coordinate development and delivery of capacity development interventions through various regional and national level academic and R&D institutions (workshops, training sessions, targeted courses etc) ▪ Focus of capacity development more on strategic groundwater management and support to regional development	▪ Coordinate capacity development interventions with regional institutions and national level institutions ▪ Facilitate structured capacity development opportunities with Member States (workshops, training events etc) ▪ Focus more on strategic groundwater management and aspects of operational management in transboundary contexts	▪ Develop capacity development programmes to meet national needs and support policy and strategy ▪ Coordinate capacity development opportunities across national and basin /aquifer level institutions ▪ Integrate capacity development opportunities across different sectors (agric, industry, energy, human settlements etc) ▪ Capacity development to focus more on operational groundwater management	▪ Facilitate capacity development interventions at local levels through local govt. and WUAs ▪ Capacity development partnerships between local institutions and communities ▪ Focus on technical training such as O&M to support sustainable water supply
Knowledge and	▪ Development of products of regional significance as well as	▪ Information and knowledge products to support	▪ Share information and develop products to provide guidance and	▪ Share information and knowledge products (developed nationally)

Elements	Regional	Transboundary	National	Local
information exchange	specific technical products to support improved regional approaches to groundwater management and development ▪ Develop products that support senior officials and politicians to better understand regional groundwater importance and challenges ▪ Leverage global information and knowledge products into the region using websites as well as utilising technical committees ▪ Supporting exchange of regional good practice through websites and technical committees	groundwater management and development within transboundary basins and aquifers ▪ Products to support Member States to strengthen groundwater management and development in the national and local contexts, to support the transboundary basins/ aquifers ▪ Hosting of targeted workshops to support knowledge exchange ▪ Develop and maintain information and knowledge products websites and portals for exchange and awareness creation	standards for operational groundwater management nationally ▪ Share information and develop products to support sustainable groundwater supply ▪ Develop products to guide regulatory instruments and to support users in terms of compliance ▪ Develop products for awareness creation across broader public and to support local level institutions ▪ Develop and maintain websites and other portals for information and knowledge product exchange focused on groundwater	to encourage good practice in terms of groundwater supply, especially focusing on O&M practices ▪ Develop internal networks for sharing information ▪ Hosting of targeted exchange session to support communities

3. REGIONAL FRAMEWORK FOR GROUNDWATER MANAGEMENT

SADC, through the Water Division, provides the regional framework for water and provides ongoing guidance to support the various Member States in collectively supporting and attaining the objectives within this regional framework. This framework is comprised of a few key pillars, as described earlier, and include the policy, legislative and institutional instruments that are given effect through the various strategies and plans. The SADC-GMI play a key role in supporting and promoting sustainable groundwater management and development across the SADC region (Figure 4).

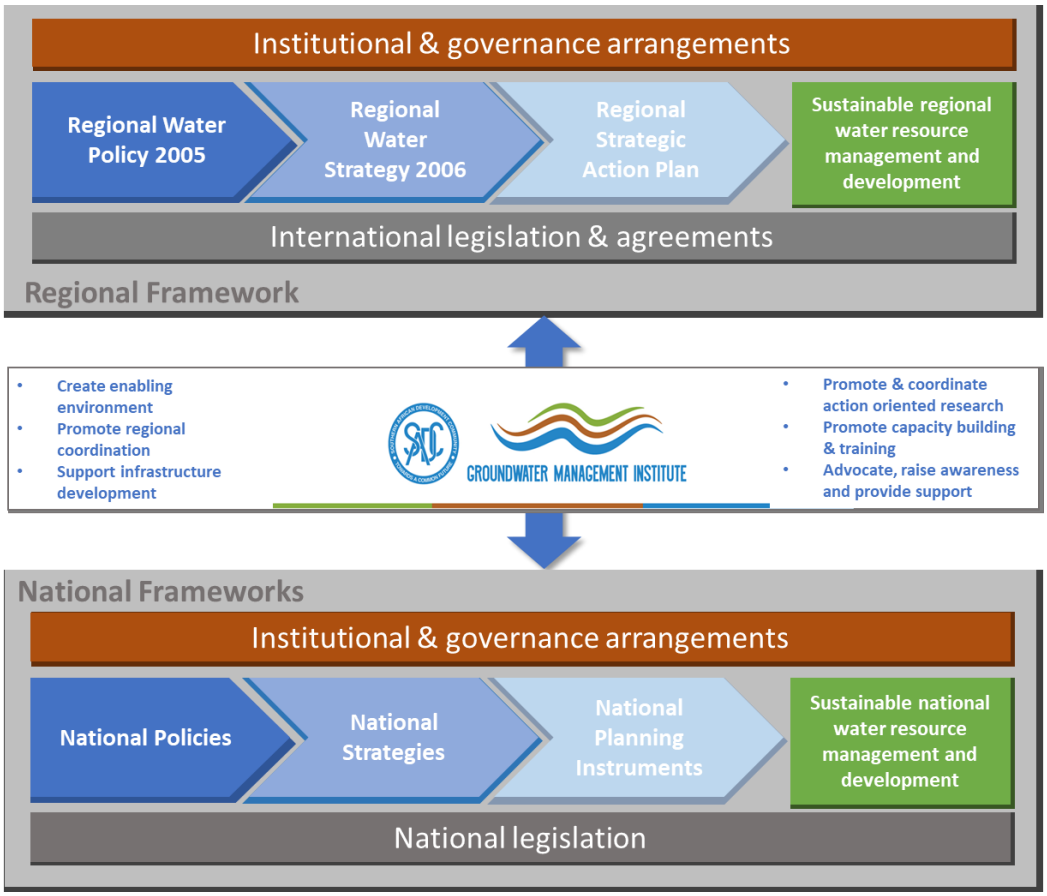


Figure 4: SADC GMI support to the regional and national water frameworks

Whilst, the broader regional framework is guided by the Revised Protocol on Shared Watercourses in SADC (SADC, 2000), there are numerous bilteral and mulitlateral agreements between Member States that pertain to the management and development of specific resources.

These pillars are mirrored at the national level and at provincial and local levels, within Member States. SADC supports interventions to harmonise approaches to manage water resources and provides support in technical aspects, institutional development, knowledge exchange and building capacity. SADC also has a key role to further develop and review the regional framework based upon lessons learned and experience from across the region and the various SADC states. In this regard, SADC Water Division and SADC-GMI have a central role to play (Figure 4).

The key instruments of the regional groundwater management framework are provided in Table 6, below.

Table 6: Key pillars of the regional groundwater management framework

Pillar	Instruments	Intent
Legal	SADC Revised Protocol on Shared Watercourses in the Southern African Development Community (SADC, 2000)	Legal framework governing transboundary water in SADC.
Policy	SADC Regional Water Policy (SADC, 2005)	Policy framework for the management and development of water resources across SADC.
Strategy	SADC Regional Water Strategy (SADC, 2006)	Strategy for achieving development and poverty reduction within SADC, through integrated planning, development and management of water.
Planning	SADC Regional Strategic Action Plan (various phases) (SADC, 2016)	Plans to unlock the potential for water (and related resources) to play its role as an engine and catalyst for socio-economic development.
Institutional	AMCOW (Groundwater Committee) SADC Groundwater Management Institute Water Resources Technical Committee Water Resources Technical Committee hydrogeology sub-committee SADC Water Division River Basin Organisations	Institutional framework providing for policy and strategic guidance, operational water resource management and development, as well as oversight in terms of implementation of policies, strategies and programmes.

3.1. Regional Institutional Framework for Groundwater Management

The SADC institutional landscape is characterised by layered and inter-connected relationships as illustrated in the Figure 5, and provides for policy and strategic guidance, operational water resource management and development, as well as oversight in terms of implementation of policies, strategies and programmes. The SADC Council of Ministers provides policy direction and oversight regarding the implementation of SADC programmes, with the sectoral ministers responsible for water providing an important linkage between SADC and the African Ministers Council on Water (AMCOW), which functions at a continental level. The SADC water sector ministers are tasked with the following responsibilities through the Protocol on Shared Watercourses:

- Oversight on the **implementation** of the Regional Strategic Action Plan;
- Resolution of potential **conflicts** in transboundary watercourses; and
- Advising the SADC Council regarding matters of **policy**.

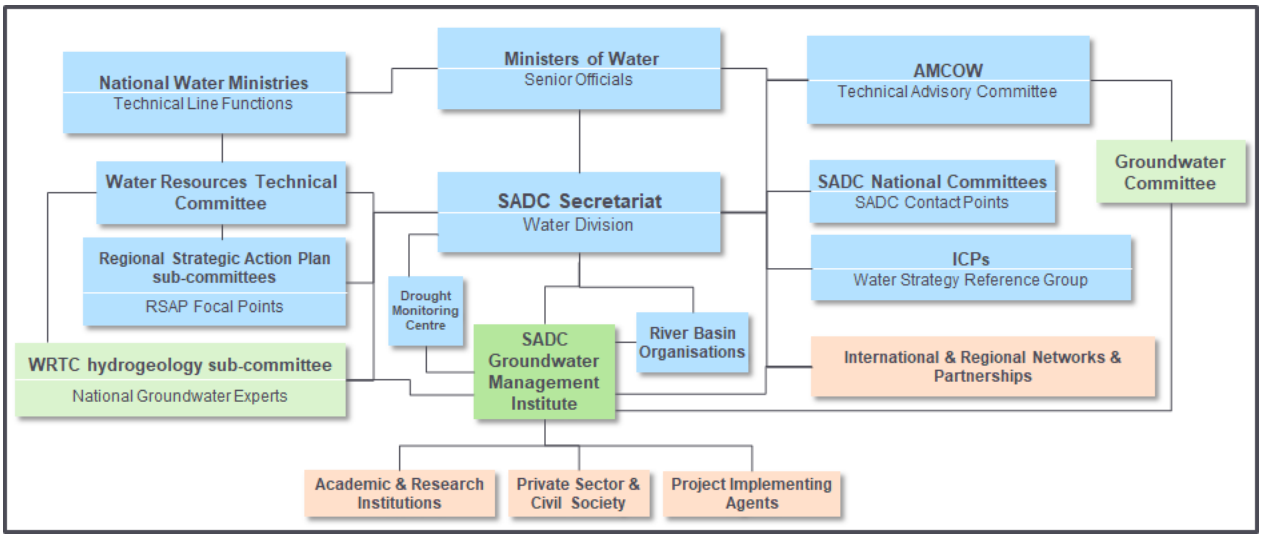


Figure 5: SADC water sector institutional framework (adapted from RSAP IV (SADC, 2016))

Within the SADC secretariat, the Water Division falls under the Directorate for Infrastructure and Services and is responsible for coordinating, monitoring and facilitating regional water-related initiatives in collaboration with Member States under the guidance of the Revised Protocol on Shared Watercourses. The Regional Water Policy provides the outline for the SADC Secretariat and the Water Division that has the role to promote, coordinate and monitor the implementation of the Revised Protocol for Shared Watercourses. Importantly, this role includes the promotion and guidance of members states towards regional harmonisation of national policy and legislation. The achievement of SADC's goals, objectives, strategies and programmes require monitoring and evaluation and as such, this falls to the SADC Secretariat and Water Division to assess.

Water Resources Technical Committee (WRTC) is established as part of the Water Sector Organs in the Revised Protocol and provides technical oversight and guidance for the SADC Water Sector. The respective groundwater focal persons, who also serve as part of the Sub-committee on Hydrogeology, report to the WRTC. The WRTC has the responsibilities to:

- Provide strategic guidance to the Regional Strategic Action Plan;
- Assess and approve projects under the RSAP banner;
- Advise with regards to RSAP project governance; and
- Oversee RSAP operational activities and projects (SADC, 2016).

The SADC-GMI beneficiaries are represented by member state representatives in the SADC sub-committee on hydrogeology with project steering committee functions and reports to the SADC Water Resources Technical Committee.

3.2. SADC-Groundwater Management Institute (SADC-GMI)

Noting that the regional institutional framework is constructed around the concept of an integrated water resource, the establishment of the SADC-GMI has been important in recognising the critical role that groundwater plays. The SADC-GMI was established as a regional centre of excellence for groundwater management under the strategic guidance of the SADC Secretariat, Directorate of Infrastructure and Services – Water Division. SADC-GMI's core mandate is to promote sustainable groundwater management and providing solutions to groundwater challenges in the SADC region through creating an enabling policy, legal and regulatory environment, capacity building, advancing research, supporting infrastructure development, and enabling dialogue and accessibility of groundwater information (SADC-GMI, 2017).

The current key strategic objectives of the SADC-GMI are reflected in Figure 6.

Valuably, the SADC-GMI is supported by a range of organisations and institutions (see Figure 5) that provide a range of useful research, thought leadership, advocacy and capacity development roles. Equally important is SADC-GMI's engagement with the private sector and civil society.

Figure 6: SADC- GMI Strategic Objectives

4. INSTITUTIONAL ARRANGEMENTS FOR TRANSBOUNDARY AQUIFER MANAGEMENT

4.1. The SADC Protocol in terms of Transboundary Aquifers

The governance framework for transboundary water in SADC is given effect through the Revised Protocol on Shared Watercourses in the Southern African Development Community (SADC, 2000). The scope of the Protocol includes shared "watercourses," which are defined as systems of "surface and ground waters consisting by virtue of their physical relationship a unitary whole normally flowing into a common terminus such as the sea, lake or aquifer." (Art. 1(1)). While this phrasing accepts the hydrological relationship between surface and groundwater, and supports the concept of conjunctive use, it also imposes limitations on the ways in which internationally shared aquifers and aquifer systems can be regulated. In focusing on "systems" of surface and ground waters, the Protocol effectively restricts consideration to aquifers that are hydrologically connected to surface water – such as a river or lake. This potentially excludes solitary, non-recharging and fossil transboundary aquifers from consideration. The Protocol places significant focus on surface waters for most of the body of the text and raises further questions about whether aquifers, in order to qualify as transboundary, must be connected to international rivers or lakes, or whether an entirely domestic surface body of water connected to a transboundary aquifer is covered by the Protocol.

The issues related to the scope of the Protocol are exacerbated by the fact that groundwater also has several unique physical characteristics that need to be considered when creating a transboundary regulatory framework (Eckstein, 2017). Thus, while many of the core principles that have evolved to govern internationally shared surface waters also apply to shared aquifers, there are additional and unique considerations that must guide the creation of any effective international legal regime governing shared aquifers and aquifer systems. These include:

- Aquifers are often more vulnerable to surface pollution and other forms of contamination as they generally flow more slowly, and this can result in contamination (and other problems) manifesting at equally slower rates and a reduced ability of the resource to recover from contamination;
- Reclamation of a polluted aquifer is extremely difficult and can take years and come at great expense due to the underground location and difficulty in gaining access;
- Some aquifers are non-recharging and require specific protections; and
- Monitoring of groundwater is particularly costly and difficult (Eckstein, 2017).

These considerations require specific management regimes and regulatory interventions tailored to the context of groundwater that represent major gaps in current international, regional and basin-specific legislation governing shared watercourses.

The SADC Protocol was drafted as a framework agreement, meant to provide guidance to Member States in concluding basin-specific agreements and creating joint institutions to govern their shared watercourses. Very few of these agreements specifically mentions groundwater as part of the scope of the agreement. This will be an important factor for SADC to consider in providing guidance to Member States

on how to effectively address transboundary groundwater management concerns within the context of existing legal frameworks. These agreements formulate the scope of their agreement in such a way as to enable the inclusion of groundwater without amendment, often referring to "waters (or water resources) of common interest" or including reference to "all water resources in the system." However, effective governance of shared aquifers and aquifer systems will require specific attention to the unique physical characteristics of those bodies.

Despite the increasing awareness of the critical role of groundwater in sustainable development, aquifers and aquifer systems have long been neglected, not just in the SADC region, but in international water law more broadly. Unlike surface water, there is no internationally agreed, global instrument or even set of customary norms that can be said to represent the rules governing States' conduct on shared aquifers (Eckstein, 2017). However, there is a growing interest and understanding of the need for such rules, as well as a number of emerging formal agreements between States that can be used as evidence of practice or custom in governing transboundary aquifers.

4.2. Institutional arrangements for the management of Transboundary Aquifers

Importantly, the Regional Water Policy provides for the "negotiation" of shared watercourse institutions in all shared watercourses, between the watercourse states. The legal definition of watercourse does include groundwater but is restrictive to those aquifers hydrologically connected to surface water systems. Whilst, the SADC region currently consists of 15 major shared river basins and 29 transboundary aquifers, there are currently only nine River Basin Organisations (RBOs) and none established specifically for the management of a transboundary aquifer. These RBOs are established to advise and coordinate the sustainable development and equitable utilisation of the relevant water resources, to enable mutual benefit and integration. The specific roles and organisational arrangements are negotiated and specified within each agreement. Whilst, there is without doubt a surface water emphasis in the establishment of these RBOs, they are increasingly recognising the importance of groundwater and that they have an important role to play in the management of these resources.

The regional institutional framework does allow for the establishment of bi-lateral or multi-lateral water institutions in order to support specific purposes. These have been utilised in a significant number of shared river basins to support the development and operation of joint water projects. In many instances these have taken the form of Joint Water Commissions and technical committees. Broadly, at the transboundary scale, there are typically four distinct, but not mutually exclusive, types of institution that practically reflect the types of transboundary agreements that are observed:

- **Water (basin) infrastructure authorities**: Typically established under treaty between the parties for the development, financing and/or operation of joint water resources infrastructure between two or more countries.

- **Bi-lateral issue-based bodies**: Established under agreement between two countries to engage water issues of common concern, such as water sharing, infrastructure planning, aquifer management, hydropower, water quality and/or flooding.
- **Multi-lateral basin committees**: Established under agreement to advise the parties on a range of transboundary water management issues and priorities, including the development of a basin agreement/plan concerning the allocation of water, transboundary objectives and institutions to be established to foster cooperation in the basin.
- **Multi-lateral basin organisations**: Established with a permanent secretariat by transboundary agreement, in order to advise the parties on water resources related issues of common concern at a transboundary level (DFID and WWF, 2010).

It is important to note that institutional arrangements do develop iteratively over time (Blomquist et al., 2005). The Revised Protocol for Shared Watercourse in SADC (SADC, 2000) provides strategic guidance as to how transboundary aquifers should be managed and developed. Under Article 2 the objectives of the Protocol include:

- promote and facilitate the establishment of shared watercourse agreements and Shared Watercourse Institutions for the management of shared watercourses;
- advance the sustainable, equitable and reasonable utilisation of the shared watercourses;
- promote a co-ordinated and integrated environmentally sound development and management of shared watercourses;
- promote the harmonisation and monitoring of legislation and policies for planning, development, conservation, protection of shared watercourses, and allocation of the resources thereof; and
- promote research and technology development, information exchange, capacity building, and the application of appropriate technologies in shared watercourses management.

To date, in the SADC region the establishment of the basin commissions has been focused upon the role of facilitation, advice and the promotion of approaches to strengthen the strategic and operational management of transboundary waters, with the focus largely being upon surface water. Noting that roles and responsibilities will vary according to context, the broad roles of transboundary institutions with regards to transboundary aquifers are to support the operational management of these aquifers through advising the Member States (see Stampriet TBA in Case Study 4).

In order to advise the Member States the core roles could include:

- Undertaking studies to fully understand the aquifer, adjoining surface waters and associated ecological infrastructure and advise Member States as to the potential yields and developmental opportunities;
- Assess the requirements for environmentally sustainable flows and water quality within and between countries that consider the ecosystems services provided by the aquifer and adjoining rivers for communities and society;

- Support in achieving equitable and efficient allocation of the available water between Member States to support economic growth and pro-poor livelihoods of people throughout the basin;
- Develop planning instruments that support the management of the shared aquifer;
- Support the development of improved management regimes through the harmonisation of policy and approaches across Member States;
- Develop systems to support the collection, processing, management and dissemination of data and information to provide a commonly accepted and standardised suite of data and information;
- Undertake stakeholder engagement and implement communication strategies to support effective aquifer management;
- Act as a conduit for notification of national development plans that may impact upon shared aquifers;
- Support the Member States in dispute resolution; and
- Support Member States in responding to emergency conditions such as floods, droughts and pollution events.

Whereas the establishment of authorities and bi-lateral (or sometimes multi-lateral) issues-based bodies has focused upon coordinated efforts to develop water resources of common concern, to support water supply. Hence, the focus of these institutions has been upon:

- Agreement to develop a specific resource;
- Undertake studies to understand the resource and to support the necessary infrastructure design, as well as outline the allocation of water;
- Development of an implementation plan to guide the resource development and infrastructure build;
- Oversee infrastructural operations and maintenance, as well as manage regulatory requirements;
- Manage the financial aspects; and
- Building the necessary institution capacity in order to perform the associated powers and duties, to support the Member States in terms of their obligations, and to support in dispute resolution.

Noting the importance of groundwater in terms of conjunctively supporting surface water development, these institutions become important in supporting groundwater development (see Ramotswa TBA in Case Study 4).

4.3. Framework on Institutional Arrangements for Transboundary Aquifer Management

Institutional arrangements for groundwater management within transboundary contexts are complex in that this represents the meeting point of regional and national policy and legislation, as well as an array of various agreements. Often political and economic factors play some form of role in the institutional development, but equally important is the history of engagement between riparian states, often at a more technical level (Smith, Cross, Paden and Laban, 2016) (see Case Study 4).

Case Study 4: Institutions for managing and developing Transboundary Aquifers

Institutions need to respond to the context within which they function and as such a "one-size-fits-all" approach is not necessarily conducive to ensuring institutional efficacy. Thus, being adaptive and responsive in the institutional development process can result in more sustainable outcomes. In addition, it is often recognised that utilising existing institutional arrangements can be effective in ensuring swifter response (establishment of a new institution can be lengthy) and in some instances can reduce the transaction costs that emerge from having multiple institutions. Lastly, there is an understanding that new institutions do require time to develop institutional legitimacy in an already established institutional environment. There is complexity in managing the levels of expectation in terms of delivery and finding that balance is challenging (Blomquist et al., 2005). In transboundary situations, where issues of sovereignty are important, this becomes even more complex.

Stampriet TBA

The Orange Senqu Watercourse Commission (ORASECOM) Agreement (ORASECOM, 2000) outlines the roles and responsibilities of this commission established to act as a technical advisor to the parties on matters relating to the development, utilisation and conservation of the water resources of the Orange Senqu basin. ORASECOM has progressively undertaken studies to strengthen the understanding of the water resources of the basin, culminating in the development of an IWRM plan. This plan provides an integrated response but also provides for more detailed groundwater assessments to better understand the groundwater resources in the basin, as well as strengthened groundwater monitoring.

ORASECOM established a Groundwater Hydrology Committee in 2007 in order to facilitate discussions regarding the management of transboundary aquifers. Building from this experience and through engagement with the UNESCO-IHP-executed project on 'Governance of Groundwater Resources Governance in Transboundary Aquifers' (UNESCO-IHP and IGRAC, 2016) the Groundwater Hydrology Committee developed capacity.

Whilst these structures are advisory and support the development of capacity, they have no designated managerial function, and in recognising the importance of the Stampriet Transboundary Aquifer System (STAS) it was agreed to establish a Multi-Country Cooperation Mechanism (MCCM) for the governance and management of the aquifer, between Botswana, Namibia and South Africa. There have been limited documented agreements of this nature to date, worldwide, and this is the first institutional mechanism of this nature to be housed within an RBO, thereby supporting a more comprehensive approach to IWRM. Not only does this address the typical "start-up" challenges that institutions face, but by linking this to the roll-out of the basin IWRM plan the mechanism gains the advantage of the establishment implementation and reporting processes.

In the short-term the MCCM intends to transition from the project-driven approach (under the banner of the Governance of Groundwater Resources in Transboundary Aquifers programme) to one of permanent institutionalised cooperation. In the longer term the MCCM will transition from data and information exchange and advisory to more strategic management of the aquifer.

(Source: UNESCO/IHP/ ORASECOM. 2018. Operationalization of the Stampriet Transboundary Aquifer System (STAS) Multi-Country Cooperation Mechanism (MCCM): Terms of Reference)

Ramotswa TBA

The four Limpopo riparian states of Botswana, Mozambique, South Africa and Zimbabwe signed the agreement to establish the Limpopo Watercourse Commission (LIMCOM) in 2003. This agreement was founded in years of technical cooperation through technical committees. Whilst the progress towards the fuller institutionalisation of LIMCOM has taken time, the undertaking of programmatic studies, has continued to support the riparian states with the ongoing management of the basin.

There are also a number of bilateral and multi-lateral agreements that support the management and development of the basin's water resources. The Ramotswa TBA is situated between Botswana and South Africa and whilst this aquifer is rurally located in South Africa, it is located in Botswana's socio-economic hub. These two countries had signed a bilateral agreement in the 1980's to establish a Joint Permanent Technical Committee (JPTC) as a platform for discussing transboundary water matters. This was supplemented in 2008 by a water supply agreement that provides a framework for more operational cooperation to ensure water supply.

In 2016 the JPTC agreed to engage more actively in the Ramotswa TBA by engaging project activities to develop a Strategic Action Plan for the TBA. Equally the JPTC was supportive of the need to institutionalise the cooperative management of the TBA. It has been recognised that the JPTC provides an already operational institutional platform through which this can take place.

(Source: RESILIM. 2016. Joint Strategic Action Plan for the Ramotswa Transboundary Aquifer Area – Roadmap.)

From these two SADC-based case studies emergent lessons include:

- Use project initiatives to support in unlocking engagement on TBA. These projects often have access to data and information that underpin the technical discussions regarding the TBA, but equally important is that projects often having the funding required to support the engagements and discussions required.
- Use current institutional structures rather than establish new institutions that take time to set-up and develop. This enables swifter interventions towards improved understanding of the aquifer through joint studies.
- Understand that institutional development takes time and progressively develop the roles and responsibilities together with the development of capacity. Therefore, gain a common understanding through studies before progressing to making joined-up management decisions.
- Hosting of the emergent institution or structure can be a very useful mechanism to quickly gain management and implementation traction, by providing the structures and systems that support the fledgling institution.

In looking to develop institutional arrangements to support the improved management and development of transboundary aquifers, there are some steps that are useful to consider in guiding the process. These steps are reflected in Figure 7 and are described in some detail below.

Figure 7: Steps to consider in strengthening the management and development of TBA.

Strengthen shared watercourse agreements: Very few bilateral or multilateral agreements specifically mention groundwater and most treat groundwater as part of the water resource. Whilst this important for understanding the possibilities of conjunctive use, a need that is generally requiring improvement, but these agreements may miss the nuances that are specific to managing aquifers. Noting the importance of groundwater across the region, it is important to strengthen these agreements to address these various nuances. The development of specific, groundwater focused agreements for the management of transboundary aquifers should be considered where appropriate but strengthening current agreements may be more effective.

- Assess & strengthen current bilateral & multilateral agreements with regards to GW management
- Develop agreements where none exist & where relevant
- Ensure the importance of conjunctive SW and GW use is promoted

- **Strengthen existing shared watercourse institutions:** Based upon the agreements in place various formats of institutions are possible. Establishing transboundary institutions does come with an array of challenges and lengthy and complex administrative processes, so strengthening existing shared watercourse institutions enables quicker uptake of roles and responsibilities. Once established, the ongoing support by the Member States is critical in assisting the institution to develop the capacity needed. These institutions will require staff that have the necessary strategic, institutional, financial and technical skills. The management of groundwater resources does require technical expertise and the appointment of a groundwater advisor in these institutions is important. Likewise, the development of procedures and processes will be essential, and the Member States must agree upon these.

  The funding of institutional development, operation and basin level projects remains a core challenge to transboundary institutions, particularly in resource limited countries and regions such as SADC. In many instances, the institutional and legal development process has been externally supported (through DFIs), with operations being funded by country contributions. Project support is a useful way to kick-start the institutional process and is worth investigating. In the longer term these institutions should be funded by the founding parties. Hence, the approach to the long-term sustainability of these initiatives must be refined, noting the various financial challenges. This must consider the need to progressively build institutional competency.

  Access to information and the willing exchange of data and information become imperative for the new institution to support its ability to provide advice and to support decision making. Acting as a broker for data and information management is a key role for transboundary institutions and creates the platform for a shared and agreed understanding of the resource. The willingness of States to provide that data and information is often prohibitive and can be a cause for conflict, rather than providing the basis for an open and transparent discourse.

  Lastly, engage in the support of other institutions, as well as the private sector and civil society. These partnerships are important in not only providing support to the institution and its interventions, but also support the institution is building its legitimacy with regards to groundwater management and development. When new institutions are short of the appropriate skills, these partnerships can provide invaluable support.

- Ensure support by Member States to enable the institution to deliver on its mandate
- Improve staffing with appropriate skill sets to undertake core functions especially regarding the technical dimensions of groundwater management
- Develop procedures and processes to enable the effective functioning of the institution
- Enable financing arrangements that are sustained & sufficient to support the delivery on mandate
- Develop information systems and protocols for data and information exchange to support strategies, functional delivery and decision making
- Encourage partnership with key sector institutions, the private sector and civil society to support initiatives

- **Develop targeted groundwater management and development strategies:** Most transboundary river basin organisations have developed IWRM strategies and plans that have included groundwater as part of the water resource management regime. There is a need to strengthen these or develop more targeted groundwater management and development strategies that more effectively explore conjunctive use. On the other hand, there may still be the need to develop this strategy from first principles. Whether, strengthening existing strategies or plans, or developing new ones, there will be a need to engage with stakeholders. This provides the opportunity to provide stakeholders with your institutional vision and mandate, as well as support in guiding the development of the strategy to realise that vision.

  The development of the strategy or plan will enable all actors to develop a shared and common understanding of the groundwater resources and their status as well as the various developmental needs within each Member State. This provides the basis for developing sub-strategies that ensure sustainable resource development as well as the conjunctive use of all water resources. These sub-strategies will need to be underpinned by a monitoring and evaluation framework that enables the tracking of progress in the delivery of the strategy or plan.

  - Develop a common understanding of the status and the challenges that face the groundwater resources
  - Develop sub-strategies that find a balance between the effective management of these resources with sustainable development
  - Outline sub-strategies that ensure the effective application of conjunctive surface and groundwater approaches
  - Establish a clear monitoring and evaluation framework that enables the effective tracking of progress

- **Undertake pathfinder projects:** Undertaking initial projects towards the implementation of the groundwater management and development strategy or plan, is important in terms of jointly (between the Member States) acting and working collectively. These may be new or existing projects but create the opportunity to establish technical teams that develop a common understanding of the resource and the requirements for managing and developing the resource. Noting that in transboundary contexts there are often political, technical and economic imbalances, the creation of these teams and shared capacity is necessary. Donor support for these projects is often important to get these projects initiated.

  It is important to use these projects to test the institutional processes and procedures, and to improve these incrementally. Likewise, the sharing of lessons learned through these projects can support the institutional development process, and guide future projects.

  - Identify pathfinder projects to enable the institution to progress implementation of the strategy/ plan
  - Build teams and joint capacity across Member States and institutions
  - Improve processes and procedures with experience
  - Communicate lessons learned

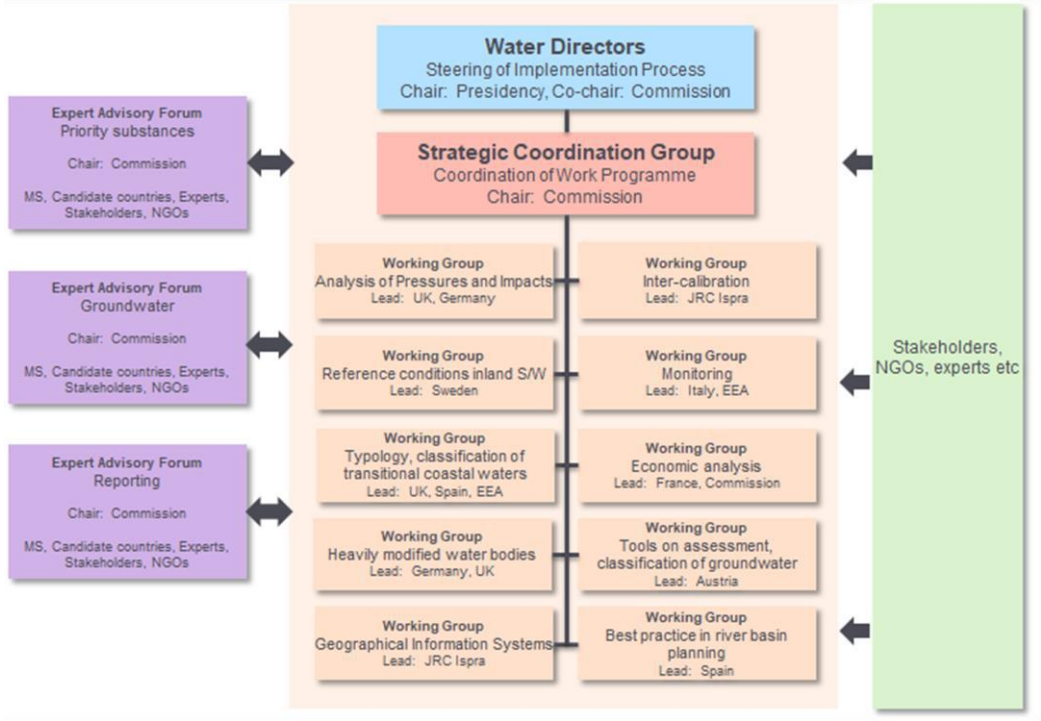
4.4. Framework on Strengthening the Regional Framework for Groundwater Management

The *Global Diagnostic on Groundwater Governance* (FAO, 2015) provides useful insights, but notes the difficulty in obtaining a systematic view and description of groundwater governance across regions and countries. This is in part because conditions across the regions vary so considerably that the response to these contexts is varied. The study therefore makes a case for the fact that there is no blueprint for good governance that would suit all regions of the world. Nonetheless, there are lessons that can be learned.

From a desktop review, the SADC region is well positioned in terms of developing a useful institutional framework for water governance across the region, and that links to continental structures such as AMCOW. Not all regions have developed this level of structured support, but then it is equally clear that the pressures upon SADC in terms of water resource pressures, and the impacts of water scarcity on the regional social economy are significantly different to East and West Africa, for example.

However, there are interesting lessons that can be gleaned from the efforts of the European Union (EU) to implement the Water Framework Directive (WFD), see Case Study 3, below.

Case Study 3: Governance for European Union Water Framework Directive



It was recognised that the implementation of the European Water Framework Directive (WFD) would be challenging for many of the Member States due to scientific, technical and implementation complexities. This being further exacerbated by a range of capacity constraints that would require redress to enable states to move practical implementation (EU, 2001).

Implementing the WFD is the responsibility of each individual Member State. As such, the development of a common strategy to support implementation could not challenge the principle that each state does work within the confines of sovereign law. Therefore, each Member State will face specific questions and challenges in the implementation process of the WFD, related to national, regional and/or local situations and conditions, which can only be resolved by that Member State (EU, 2001).

Nevertheless, a Common Implementation Strategy was developed to support a more coherent approach to implementation of the WFD. Much of the focus was on developing technical guidance on methodological questions, supported by cooperative activities to enable exchanges of experience. This strategy recognised importance of:

- involving the public and promote public awareness;
- ensuring coherence between the implementation of the WFD and other sectoral and structural policies;
- integrating activities on different horizontal issues for the effective development of river basin management plans and implementation of the WFD;
- building capacity in Member States for an effective implementation of the WFD;
- involve stakeholders and the civil society in the implementation of the WFD; and
- establishing working groups and developing guidance documents on key aspects of the WFD (EU, 2001).

A Strategic Co-ordination Group was established for the co-ordination of the different working groups and activities under the Common Strategy, such as work in pilot basins. The Strategic Co-ordination Group evaluated the outcome of the different working groups and prepared documents and reports for the Water Directors' meetings and gave guidance to the key activities. Working groups were created for the different activities and projects, and special advisory forums were established to address specific issues, such as groundwater management.

The importance of an active involvement of stakeholders, NGO's and the civil society was identified. Stakeholders could be involved both in the work of the Strategic Co-ordination Group (as observers) and as participants in the specific working groups and other activities under the Common Implementation Strategy (EU, 2001).

European Union (EU). 2001. Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Strategic Document as Agreed by The Water Directors (under Swedish Presidency), 2 May 2001

Key lessons that emerge from the EU include:

- The importance of building capacity in the Member States is important in developing coherent approaches to regional policy and legal instruments;
- Establishing technical working groups provides a useful platform for exchange of technical and practical insights, and having these lead by specific countries creates some accountability to drive the process forward;
- Actively promoting the engagement of stakeholders is important to provide a richness of inputs, but also supports to build awareness on specific aspects; and
- Noting the importance of groundwater regionally and locally, the establishment an advisory forum for groundwater that includes Member States, experts, stakeholders and NGOs provides a useful platform for the improvement in approaches to groundwater management and development.

Through the SADC-GMI's GMI-PLI project the validation workshop (held on the 30th January 2019, in Johannesburg, South Africa) provided an opportunity for Member State representatives to provide insight on how to strengthen the regional framework, towards improved groundwater management and development. From this, and the lessons from the EU, several considerations emerge.

The complexity of this task is understood, but noting the pressures being placed on groundwater resources (as well as surface water resources) it would be useful to revisit this framework. These elements also provide a useful framework for re-thinking groundwater governance at various spatial scales i.e. nationally and locally (

Figure 8).

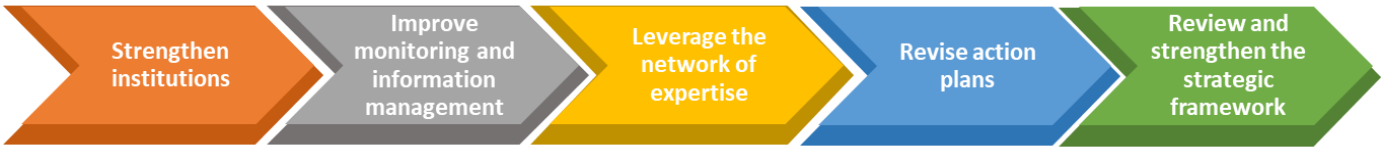


Figure 8: Steps towards strengthening the regional framework for ground water management

Strengthen institutions: There is a tendency to restructure institutions to solve what are often systemic issues. The regional institutional frameworks provide a useful platform to manage and develop water resources. However, there are very significant internal and systemic issues that require resolution towards improving the management and development of groundwater. This includes strengthening existing institutions, focal points to n, drive awareness and capacity building programmes (staff and skills) and support the sourcing of sustainable funding for these institutions to undertake studies that support improved groundwater management.

- **Improve data and information exchange**: Part of the process to develop capacity is ensuring that water resource experts have access to data and information, with which they can make management decisions. It is equally essential, in terms of supporting transboundary discourse, to have shared and agreed-upon data sets and information. Whilst the SADC-GMI website is excellent and several the transboundary watercourse commissions have established information portals there is still much to be done to strengthen the collation, updating and exchange of data and information to support management decision making. In addition, the need to utilise other media as a means for information exchange is critical, especially to support the regional network of experts. SADC-GMI should play a key role in this.

  - Develop protocols for data & information sharing
  - Strengthen systems to enable data & information sharing
  - Develop alternative and innovative mechanisms for data & information sharing

- **Leverage the network of expertise**: The WRTC Hydro-geology sub-committee is important for the member states to strengthen their regional approach to groundwater management and development, but there is not enough funding to enable more regular engagements and exchange between these focal points, and often, their roles are often seen as an "add-on" to their full-time positions within the Member State ministry. These issues are not quickly resolved, but allocation of more time for this role by the respective ministries will support more engagement and information exchange. There are resource constraints that inhibit the functioning of this network, but within these constraints there is a need to develop a programme to enable their ongoing development and the exchange of information and knowledge. SADC-GMI must play a key role in this. Engaging key experts and identified stakeholders through conferences and national focal groups will aim to further build capacity and enable more robust discussions. Whilst the strategic regional issues may take time to resolve, there is opportunity for these focal points to start assisting in shifting national thinking about groundwater management and development. The development of regional knowledge products to support this will be invaluable, and SADC-GMI must be a lead agent in this.

  - Member States allocate more time to focal points to generate & share knowledge
  - Source additional funding to enable more engagement between focal points
  - Further strengthen the network by introducing key experts & stakeholders into interactions
  - Develop knowledge products to support groundwater focal points to improve awareness

- **Strengthen groundwater planning**: The earlier editions of the RSAP had a strong focus upon the strengthening governance whilst driving other water resource management and development interventions. There has been an increasing focus upon the development of infrastructure towards improved climate resilience. Whilst these solutions are important, there is a need for ongoing focus upon institutional strengthening, particularly with regard to groundwater management and its integration with the water-energy-food-environment (WEFE) nexus. In the review and development process of the various iterations of RSAP, SADC-GMI has a pivotal role to play in elevating groundwater and its management in the Plan, and effectively guide the regional groundwater management and development agenda. Through this, regional planning must promote conjunctive surface and ground water management and development.

  - Planning interventions need to continue to support institutional development
  - Noting institutional constraints there is a need to continuously drive pragmatism in planning
  - Planning instruments need to drive more targeted conjunctive water use interventions

- **Review the SADC regional framework**: There is no clarity as to how often the key elements of the SADC Regional Framework for water resources should be reviewed and updated. A protocol for this process of review would be useful to enable adaptive responses. Noting the increasing pressures upon water resources to support socio-economic development, there is a need to look for improved approaches that will enable effective and efficient conjunctive use of surface water and groundwater, as well develop improved resilience to climate impacts. The SADC Regional Water Policy and SADC Regional Water Strategy, for example, could be reviewed and revised. This does need to be supported by an evaluation process. This task should not be underestimated and would require considerable commitment from the regional water sector. However, there are useful and progressive first steps that can be taken to strengthen the framework that exists. Thus, the use of Memoranda of Understanding (MOUs) and Policy Addendums can provide pragmatic steps to improve the approach to the management and development of groundwater. Gleaning lessons from the broader international arena will prove extremely valuable.

  - Develop a protocol for review of the regional framework
  - Undertake an evaluation of the SADC regional framework for water and revise as needed
  - Develop shorter term interventions to strengthen the framework where needed using MOU's, policy addendums etc
  - Leverage international experience to strengthen the regional framework

5. INSTITUTIONAL ARRANGEMENTS FOR GROUNDWATER MANAGEMENT AT NATIONAL LEVELS

5.1. Governance at the National Level

At a national level, there is a requirement to ensure effective water governance and, in most countries, this is underpinned both by the Constitution of the country and by legislation and policy that recognises water as a national resource under the custodianship of national government. The Global Water Partnership (GWP) defines water governance as "the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society" (GWP, 2002). This places emphasis on the need to construct policies, legislation and institutional frameworks that enable both the operational management of water resources and the development of these resources to provide water services. The nature of water resources, and specifically groundwater resources, requires that the various dimensions of water management need to take place at varying spatial scales whilst considering a range of policy and strategic issues that have varying impact across these spatial scales.

Water resources and their management are also dependent upon a range of connected sectoral governance frameworks including environment, land, agriculture, mining and industry. Whilst these sectors are often dependent upon water resources, they also have impact upon these very same resources. Groundwater is often significantly impacted upon by land use practices and hence, the nature of these governance frameworks can be important in terms of sustainable groundwater development. Ensuring effective alignment between these governance frameworks and the strategic intent of these various sectors is essential. This must be guided at a national level by Ministries but is often realised at the more localised levels through integrated planning and coordinated action.

In addition, there is recognition that several principles are important in guiding these frameworks (see GWP, 2003). These include:

- **Open and transparent**: Institutions need to be accessible and available and be a transparent in a manner that supports more engaged discourse with its stakeholders.
- **Inclusive and communicative**: Institutions should encourage active participation of stakeholders. This provides for more robust outcomes as well as trust in the institution and its intent. This is supported by the exchange of information and knowledge that is accessible and appropriately pitched for the various stakeholders, and that encourages feedback and input into issues.
- **Coherent and integrative**: With increased complexity and pressure being placed upon water resources the need for improved coherence across sectors and geographies becomes increasingly important. The connectivity of water to socio-economic development requires increased levels of integration in planning and this must be supported by institutions that not only show clear leadership but also drive more rigorous engagements with stakeholders.

- **Equitable and ethical**: Aligned with national imperatives to support equitable access to water, noting gender and socio-economic aspects, institutions need to apply ethical principles as well as the law. This is supported by institutions that are transparent and communicative, and actively engage with their stakeholders. It also requires that institutions are accessible when stakeholders need to raise issues of concern.
- **Efficient and effective**: Institutions need to deliver on their mandate in support of broader water management goals. Often financial resources and capacity is constrained so being efficient with resources, whilst still being effective is key for institutions. At the same time, this needs to be balanced with political, social and environmental requirements.
- **Responsive and sustainable**: Institutions must find a balance between being responsive to the current demands whilst working towards longer term objectives. Being responsive is important and supports institutions in developing legitimacy, but also policies do need to be implemented, with short-term and longer-term objectives and as such the institution needs to ensure that it can deliver on these objectives. Thus, the sustainability of the institution is important.
- **Accountability**: Taking responsibility for the delivery of its mandate is an important part of institutional governance. This accountability for implementation is critical to drive delivery as well as direct actions as goals and objectives are progressively achieved. The nature of accountability may vary from institution to institution and with the processes being undertaken, but nonetheless it is an essential part of ensuring water resources are effectively managed and developed. Effective reporting is important in underpinning accountability and should be structured against a monitoring and evaluation framework.

Ministries are typically responsible for developing, in conjunction with its stakeholders, the appropriate institutional framework to deliver on national policy whilst taking into consideration the principles outlined above. This framework would cover operational management of water resources, the provision of water supply as well as the water research and development arena, and therefore, this Ministry would be understood as the sector leader.

Increasingly, there has been the recognition that these Ministries need to not only delegate powers and duties to other institutions (that are more locally based), but also that the nature of water requires that effective partnerships be developed with other sector Ministries, with the private sector and with civil society to support the management and development of water resources. In effect, the job is too complex for a singular lead Ministry to undertake alone. As a result, there has been in recent much emphasis placed upon the importance of stewardship and other forms of collaborative partnership (see Case Study 5).

As sector leader, the Ministry has the important role of supporting and directing the institutional evolution of the sector. With a focus, upon groundwater there is a need to strengthen the institutional frameworks for the operational management of groundwater (to ensure its sustainability), for the development of groundwater resources (to provide water supplies) , and for groundwater research and development (to develop innovative and resilient approaches to groundwater management and development).

Case Study 5: Partnerships to Support Improved Water Sector Management and Development

Water management is becoming increasingly complex as water demands increase, as resources dwindle and as the ravages of climate uncertainty start to have impact. The solutions of the past will not suffice as our ability to access new surface and groundwater resources are often no longer viable. In many cases these resources are already allocated or over-allocated. Nevertheless, there is a need to strive for the attainment of the sustainable development goals, and specifically that of Goal 6, which targets safe and affordable water, access to adequate and equitable sanitation, improved water quality, increased water use efficiency, implementation of IWRM at all levels, protection and restoration of water-related ecosystems, and support to developing countries as well as the participation of local communities.

Ministries and governmental organisations cannot resolve these challenges on their own and the support of the private sector and civil society is becoming increasingly imperative. Partnerships are an essential part of the water sector institutional landscape for the future.

These partnerships can leverage support from development support partners…

2030 Water Resources Groups (2030WRG)

Launched at the World Economic Forum in 2008, and hosted by the International Finance Corporation since 2012, the 2030WRG is a collaborative effort between the public sector, the private sector and civil society. The aim of the partnership is to facilitate transparent discourse towards water sector reform in developing and water-stressed countries. The objective of these partnerships is to support the attainment of water security through collective action and to catalyse transformative change to water resources planning to close the water-supply gap. The 2030WRG focuses its efforts at national, regional and global levels.

These partnerships can be established nationally…

Strategic Water Partners Network (SWPN)

This partnership between the South African Department of Water and Sanitation (DWS), private sector and civil society was established in 2011 as an innovation platform to contribute to the achievement of efficient, equitable and sustainable water supply and access for all South Africans. Despite being led by the DWS, a significant number of other government departments and public entities are represented, together with close to 30 private sector companies and a number of large civil society organisations. Noting that South Africa is predicted to have a 17% water deficit by the year 2030, with significant socio-economic impacts, the SWPN pulls together collective resources to develop new and cost-effective solutions to the various water sector challenges. Hence, the initial focus of the SWPN has been upon effluent and wastewater management, water efficiency and leakage reduction, and agricultural supply chains. Working groups have been established for each of these focus areas, which undertake collaborative projects.

These partnerships can be focused on specific challenges…

Lake Naivasha Imarisha Board

Kenya's Lake Naivasha is not only a recognised RAMSAR wetland of international importance, it is also home to a multi-million dollar international flower and vegetable industry. The 2009 drought had significant socio-economic impacts and presented a range of challenges that required collective action. The World-wide Fund for Nature (WWF) facilitated a process to bring together the various public sector, private sector and civil society groups to develop an action plan towards a more sustainable water resource management and development approach. The establishment of the Imarisha Board, by government, has created an institutional vehicle to coordinate the various activities in the plan, and as such fosters continued engagement. Noting the concerns with regards to the levels of groundwater abstraction in the region, initial attention was focused on assessing the levels of groundwater abstraction and placing a moratorium on new abstraction licenses. This was supported by the strengthening of Water User Associations to manage local resources.

(Sources: High Level Panel on Water: Partnerships for Cooperation (https://sustainabledevelopment.un.org/content/documents/hlpwater/14-PartnershipForCooperation.pdf); WWF. 2013. Water Stewardship: Perspectives on business risks and responses to water challenges.)

5.2. Framework on Strengthening the National Framework for Operational Groundwater Management

Whilst, it is well understood that groundwater is critical to water supply in urban and rural contexts, and longer-term resilience, there are equally growing concerns about being able to sustainably manage this important resource. Issues such as increased depletion, reduction in rates of recharge, degradation of resource quality due to pollution and concerns regarding the impacts upon groundwater dependent ecosystems are all part of a need to strengthen the operational management of this resource. Due to most pieces of legislation recognising groundwater as being a 'national' resource (of which government is custodian) there is a need for government to lead the strengthening of the institutional framework, and the building of capacity across these institutions (GW Mate, 2006).

There is no blue print for these institutional frameworks, but there is a trend towards frameworks as illustrated in Figure 9.

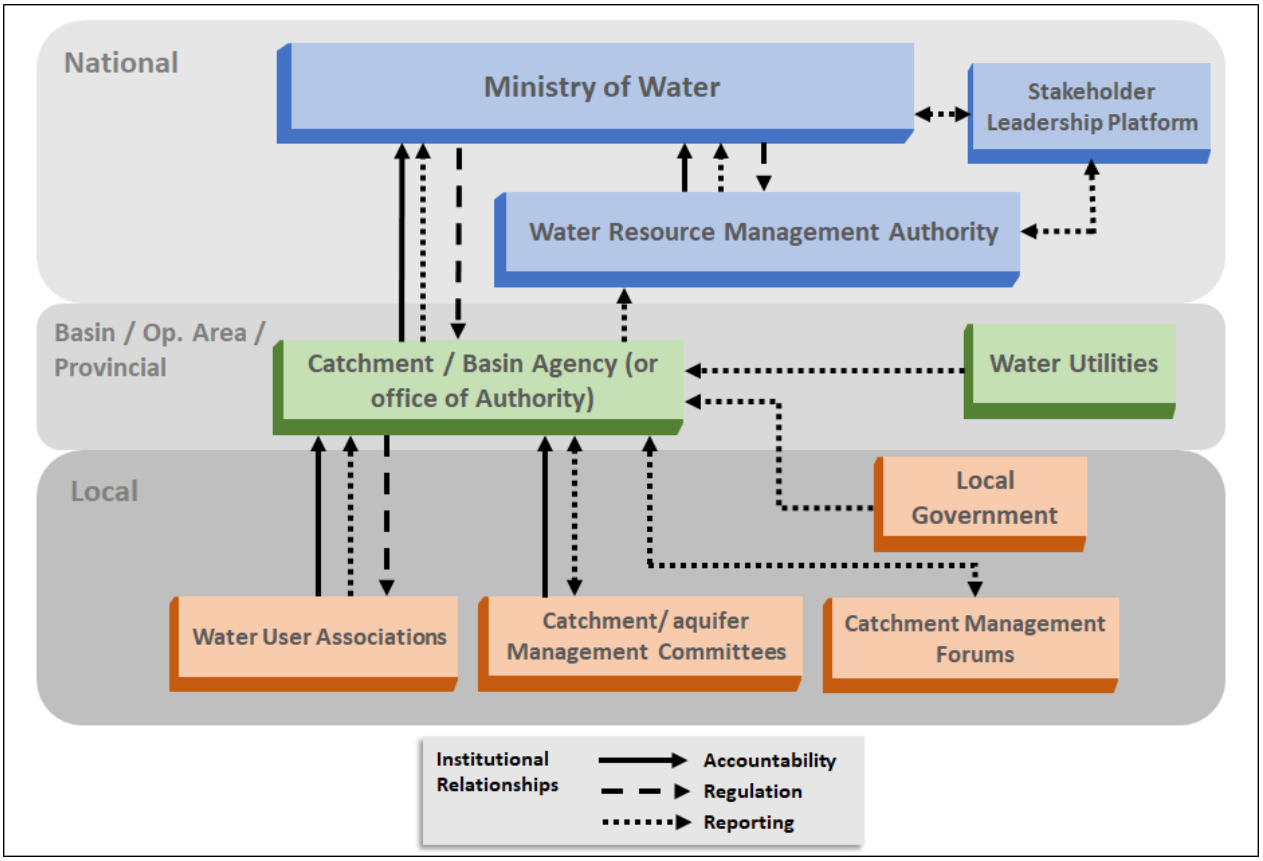


Figure 9: Institutional arrangements to effect operational groundwater management across different spatial scales

The functions of operational groundwater management, that these institutions are responsible for, are as follows:

- **Policy & legislative instruments**: Develop national policy and supporting legislative instruments, as well as oversee the implementation thereof.

- **Resource assessments**: Undertaking studies to better understand resource quantity and quality and the various environmental linkages and dependencies, which could include classifying resources and setting resource quality objectives.
- **Strategy development & planning**: Developing strategies to support the sustainable management and development of water resources, supported by plans to direct implementation towards attainment of these strategies.
- **Authorisation & regulation**: Developing and implementing water use authorisation frameworks and systems and develop the appropriate regulatory instruments to support this.
- **Monitoring and information management**: Establishing, developing and maintaining monitoring networks as well as the data and information management systems to support management decision.
- **Compliance monitoring and enforcement**: Developing the frameworks and supporting systems to monitor compliance with water use authorisations and other regulatory instruments, as well as establishing the mechanisms to enforce these.

Institutions across this framework play various roles in supporting the delivery of these functions, and certain institutions are vested with powers and duties that may be delegated to them. These roles and responsibilities are broadly summarised in Table 7.

Table 7: Institutional roles and responsibilities in terms of operational groundwater management

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
Ministry of Water	As sector leader the Ministry sets policy, legislative and institutional frameworks and oversees implementation. Leads revisions to these when needed. ▪ Develop policy and legislative frameworks too effect sustainable groundwater management, and oversee implementation ▪ Develop national strategy for groundwater management and guide implementation, as well as monitor progress ▪ Develop national planning instruments and guide approaches to improved conjunctive use of groundwater and surface water, as well as facilitate intersectoral planning in support of the WEFE nexus ▪ Undertake strategically important groundwater studies and assessments to support improved understanding regarding the WEFE nexus ▪ Develop and strengthen groundwater use authorisation framework and regulatory instruments ▪ Ensure groundwater resources are monitored nationally and data and information are available ▪ Ensure improved compliance monitoring and enforcement for groundwater use through the development of procedures and tools	National
Water Resources Management Authority	Where established these authorities may take up certain functions listed as Ministry functions above. Often these authorities have a focus on the regulatory aspects.	National

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
	▪ Develop national strategy for groundwater management and guide implementation, as well as monitor progress ▪ Develop and strengthen groundwater use authorisation framework and regulatory instruments ▪ Ensure improved compliance monitoring and enforcement for groundwater use through the development of procedures and tools	
Stakeholder leadership platform	Stakeholder input into matters of national policy, legislation and institutional frameworks as well as operational management of groundwater is essential. Establishing such a national leadership group or water caucus is essential in developing robust and resilient approaches. ▪ Engage with the Ministry and key water sector institutions on new strategic developments regarding groundwater management and development ▪ Provide input into new policies, legislative and regulatory amendments, strategy and planning developments and other developmental aspects that support groundwater management ▪ In an ongoing manner, raise issues of concern regarding groundwater management and the status of groundwater and associated resources	National
Catchment/ basin-based Agencies	These could be basin or regional offices of a Ministry or Authority, or standalone agencies. These institutions are the linkage between national policy and more locally based groundwater management and stakeholders. ▪ Develop catchment or basin level groundwater management strategy including approaches to protect resources, to use and develop resources as well as supporting interventions to ensure effective management ▪ Undertake specific studies to improve understanding of local groundwater resources including issues of water quality and linkages to groundwater dependent ecosystems ▪ May issue water use authorisations or act as conduit to national authority or Ministry ▪ Drive catchment and aquifer-based monitoring ▪ Undertake compliance monitoring and enforcement actions	Catchment, basin or water management area
Water Utilities	Utilities primary functions is to support water supply, but many provide supporting catchment and aquifer management services including monitoring, communications and awareness and some stakeholder engagement. ▪ Undertake monitoring of key groundwater resources (groundwater levels and abstraction, water quality) ▪ Maintain database and manage and share groundwater information with catchment agencies/ authorities, or Ministry ▪ Drive communications and awareness in their areas of jurisdiction regarding groundwater management ▪ Support, and in some cases drive, stakeholder engagement	National or regional areas of operation
Local Government	Local government has a primary function is to provide water services but can also provide supporting catchment and aquifer management services especially through the use of municipal bylaws. They have responsibilities regrading local land management that have direct impact upon groundwater resources.	Administrative municipal areas

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
	▪ Liaise with catchment agencies/ authorities, as well as water utilities, regarding groundwater usage in municipal areas, as well as land use planning ▪ Develop and strengthen municipal bylaws to support improved groundwater management (includes identification and protection of recharge zones, drought response planning and emergency actions etc) ▪ Report to catchment agency/ authority on emergency or pollution incidents as well as issues of concern regarding spatial planning ▪ Undertake monitoring of key groundwater resources (groundwater levels and abstraction, water quality) ▪ Maintain database and manage and share groundwater information with catchment agencies/ authorities, or Ministry ▪ Drive communications and awareness in their areas of jurisdiction regarding groundwater management, particularly through municipal engagement structures	
Water User Associations	These institutions bring together local water users and can be focused only upon groundwater use, in some cases. They have an important role in managing local groundwater resources. ▪ Undertake monitoring of key local groundwater resources (groundwater levels and abstraction, water quality) ▪ Maintain database and manage and share groundwater information with catchment agencies/ authorities, or Ministry ▪ Support local compliance monitoring and enforcement ▪ Drive communications and awareness in their areas of jurisdiction regarding groundwater management	Local areas of operation
Catchment/ Aquifer Management Committees	These institutions bring together staff from the catchment agency/ authority with key stakeholders to undertake groundwater management related activities. The committee is funded and therefore can undertake projects and studies. The committee can be technically based (e.g. groundwater) or geographically based (e.g. water resource management in a sub-catchment or defined area) ▪ Undertake specific studies to improve understanding of local resources ▪ Implement local groundwater management projects ▪ Make recommendations to catchment agency/ authority on water use and authorisations ▪ Undertake and support monitoring of key local groundwater resources (groundwater levels and abstraction, water quality) ▪ Support local communications and awareness in their areas of jurisdiction regarding groundwater management	Broader catchment or basin focused on technical issues or sub-catchment/ aquifer focus
Catchment Management Forums	Not always formally recognised by legislation, most water policy instruments support the establishment of forums as a key platform for stakeholder engagement. These are largely advisory and can be established at various spatial scales. ▪ Provide advisory support to identified groundwater projects and interventions ▪ Act as “watchdog” for issues relating to groundwater management	Catchment, basin or even sub-catchment

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
	▪ Undertake discussion to share information and improve understanding of local resources ▪ Make recommendations to catchment agency/ authority on groundwater related issues ▪ Support local communications and awareness regarding groundwater management ▪ Make recommendations on issuance of permits for water abstraction both ground and surface water ▪ Advocate for equitable distribution of the Water Resources.	

In looking to develop institutional arrangements to support the improved operational groundwater management at national to local levels, there are some steps that are useful to consider in guiding the process. These steps are reflected in Figure 10 and are described in some detail below.

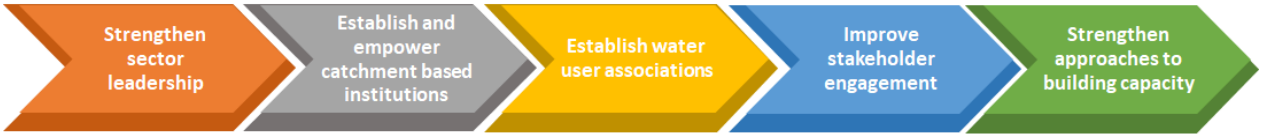


Figure 10: Steps to consider in strengthening the institutions for operational groundwater management at a national level

- **Strengthen sector leadership:** The leadership of the Ministry of Water is essential in developing clear and stable policy positions for sustainable groundwater management and to guide implementation by sector institutions. This will require the Ministry to devolve responsibilities for management functions, to appropriate institutions, thereby enabling themselves to provide the strategic leadership needed. There is a need to develop improved systems for the monitoring of progress in terms of achieving policies, strategies and plans and this needs to be supported by reporting systems. Noting the importance of adaptive management, these reporting systems will guide the more regular improvement of policies, strategies, plans and regulatory instruments. In undertaking these improvements, stakeholder engagement is important and developing and maintaining national level engagement platforms will be necessary.

  - Establish and promote clear and stable policy positions
  - Ensure institutional framework is fully operationalised
  - Develop phased process to delegate functions to institutions
  - Monitor progress on national policy and strategy and report regularly
  - Engage stakeholders at a national level

- **Establish and empower catchment-based institutions:** The need to devolve the more operational management and catchment-based oversight to institutions within catchments is generally recognised as best practice. Often their areas of operation are based on hydrological boundaries, but these may also need to consider aquifer boundaries in some instances. These institutions not only enable an improved level of planning and coordination by supporting engagement across a range of sectors and levels of government, but also by enabling better stakeholder engagement. Developing a phased process to establish them and delegate powers and duties enables these institutions to develop legitimacy and competencies, as they develop the supporting tools and systems that will enable effective groundwater management. Support from Ministry staff as well as provision of structured training will be important and will assist with the need to develop a groundwater management strategy and implementation plan, that will guide structured management interventions.

  - Provide supporting staff capacity, tools and systems to develop and implement groundwater management strategy
  - Provide training and capacity building interventions to develop groundwater management competencies

- **Establishment of Water Users Associations:** Whilst there are a range of challenges in ensuring that these institutions are functioning effectively, they are recognised as being important in terms of ensuring localised management and undertaking operational water use management, as well as supporting effective compliance monitoring. In many instances, WUAs manage both surface water and groundwater resources, but there are instances where they are only focused on groundwater use. This does enable a more technically specialised and appropriate management of groundwater resources. It is, therefore, important to revisit policy and legislative instruments to clarify and strengthen the roles of WUAs in terms of local groundwater management. Whilst some countries, such as Kenya and Tanzania, have established WUAs swiftly, many have not, and it is important to develop a clear plan to systematically establish these institutions and delegate appropriate powers and duties. Ensuring that there is clarity in terms of communications and reporting to the local catchment agency/ authority is important. An early and important task for WUAs is to develop a water management plan for the area of operation. This plan must support broader catchment plans and technical support from the local catchment agency/ authority, or from Ministry, would be important in getting this alignment. The development of a structured groundwater management capacitation programme would assist the WUA to progressively develop its technical capacity.

  - Revisit institutional frameworks and clarify and improve roles of WUAs, especially regarding groundwater management
  - Develop a programme to systematically establish WUAs and delegate powers and duties
  - Establish more systematic engagement between local levels institutions and catchment-based agencies/ authorities
  - Provide technical support to WUAs in the development of water management plans
  - Develop programme of support to WUAs to develop capacity and competency

- **Improve stakeholder engagement**: Nearly all states reflect the value-add gained from stakeholder engagement processes, with many reflecting significant rooms for improvement. Developing appropriate institutional platforms to enable effective engagement is important. This needs to be underpinned by a complete stakeholder analysis, so that the structuring of these engagements can be appropriate. In some instances, the establishment of WUAs is seen as one of the platforms for this, however, a few countries have taken the step to more actively establish stakeholder engagement forums that meet on a regular basis and are open to attendance by a wide range of interested and effected parties. There are undoubtedly challenges in ensuring that these platforms are sustainable, but the use of such 'institutions' is immensely powerful in harnessing the collective wisdom of a range of stakeholders. Hence, the development of a clear and agreed-upon engagement framework, supported by a programme to build capacity is important. This must be underpinned by sufficient technical and financial support from the lead water sector institutions, to ensure technical direction as well as continuity.

  - Undertake thorough stakeholder analysis to understand how to ensure effective engagement
  - Develop a clear framework for stakeholder engagement across various spatial scales, ensuring clarity on roles and responsibilities of these structures
  - Develop a structured programme to build stakeholder capacity regarding groundwater management
  - Ensure adequate resourcing to maintain these stakeholder engagement platforms

- **Strengthen approach to build capacity**: There is a shortage of skilled groundwater expertise with many institutions having only limited skills or experience, and those trained staff are unable to handle the heavy workload. Whilst it is important to understand the integrated nature of water resource management, there is a need to have technical capacity regarding the complexities of groundwater management. There is a need to strongly promote this as a field of study and as career options. Sector lead Ministries need to actively promote this and work with Universities to also develop the necessary training programmes and fields of study to support broader groundwater management. Upon recruiting geohydrological staff there is a need to ensure these staff undergo structured and experiential training in the workplace. This should include developing experience across the various aspects of operational groundwater management to develop a more holistic understanding. There are a range of useful materials for training available from the African Groundwater Network, developed under the auspices of the UNDP Cap-Net programme[1]. Training programmes should be supported by the establishment of a "groundwater working group" that would allow staff across institutions to exchange on experience and share new

  - Work with key universities to promote, develop and strengthen training for geohydrologists
  - Develop groundwater staff induction and experiential learning programme as part of broader staff development
  - Establish national groundwater working group
  - Develop programme of staff exchange and circulation to ensure that institutions have access to geohydrological skills

[1] http://agw-net.org and http://www.cap-net.org. Also, see tools under GW-Mate developed with the support of the World Bank, the GWP and the Water Partnership Program http://www.worldbank.org/gwmate

approaches and lessons learned. These sessions could be held “virtually” with an annual conference event. This would develop a national community of practice that supports staff development and drives innovation. Lastly, while there is a shortage of skilled staff there is the need to develop a programme of staff exchange and circulation so that various institutions get access to these skills that can help resolve technical groundwater management challenges. These skilled staff can be used as mentors for some junior staff and support the development of the new generation of geohydrological experts.

5.3. Framework on Strengthening the National Framework for Groundwater Supply

Whilst the management of water resources at national and sub-national levels lie with the key Ministries and Departments, the groundwater development value chain to ensure water supply to the end user includes multiple and multi-layered actors. This varies by country, but generally includes the parent Ministry, Departments, water utilities and local government that function with a complex array of relationships that are contractual in terms of supply, but require supporting strategic coordination and communications too (Figure 11). In some instances, the responsible parent Ministry is not necessarily the same as that responsible for water resource management, which can create some challenges in terms of ensuring effective cooperative government. Developing water resources is an important dimension of the developing social economy (see successive “Global Risks” reports by the World Economic Forum) and within the African context particularly, this is particularly the case where water resources are either in abundance (floods), in short supply (droughts) or are of poor quality (pollution).

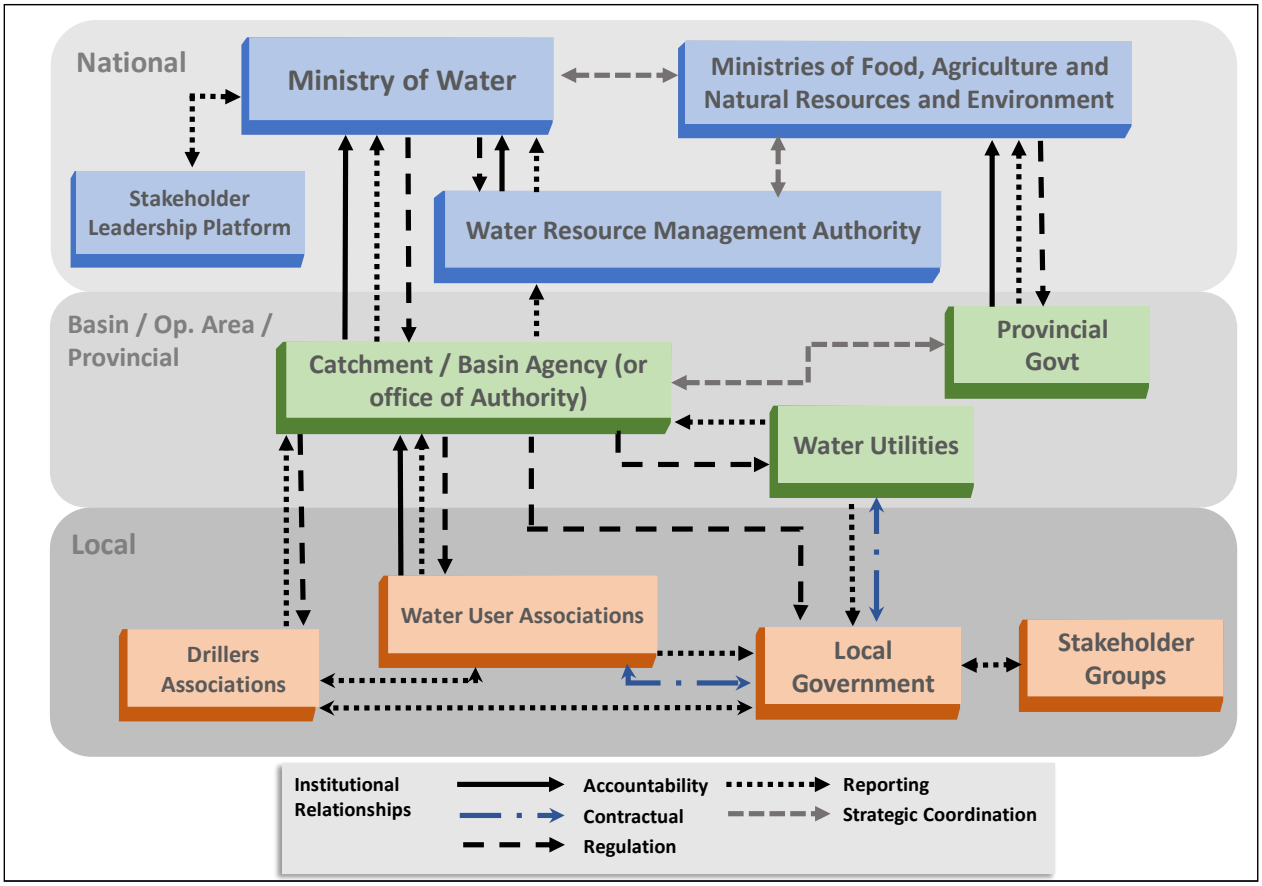


Figure 11: Institutional arrangements to effect groundwater supply across different spatial scales

In addition, rapid urbanisation is placing significant pressure on local authorities to be able to timeously undertake the required planning, develop the necessary infrastructure and ensure there is the capacity (technical skills and finance) to operate and maintain this infrastructure. This challenge is begging new questions of existing institutions in terms of being able to cope with these socio-economic pressures and meet the requirements of water supply as set out in national targets and international goals such as the SDGs. Therefore, groundwater resources become increasingly important in both urban and rural contexts. As noted by GWMate (2006), in terms of community water supply, groundwater has socio-economic benefits of:

- Enabling water supply coverage to be rapidly and economically expanded, noting the time and expense required to expand surface water-based supply systems,
- Decreasing the dependence on surface water sources that are sometimes unreliable and polluted, and
- Reducing the time spent on water collection, from distant water points, thereby enabling women to engage in productive activities and children to attend school.

It is also important to note that this water supply also underpins local economic activities including watering of livestock, local and subsistence level cropping as well as supply to local level industries and activities such as pottery, brick production, car washes and so forth. The effective management of

groundwater resources is important in the maintenance of ecological infrastructure which is also equally important for localised socio-economic activities. There is an important connectivity between this ecological infrastructure and that infrastructure required for water supply systems (Figure 12).

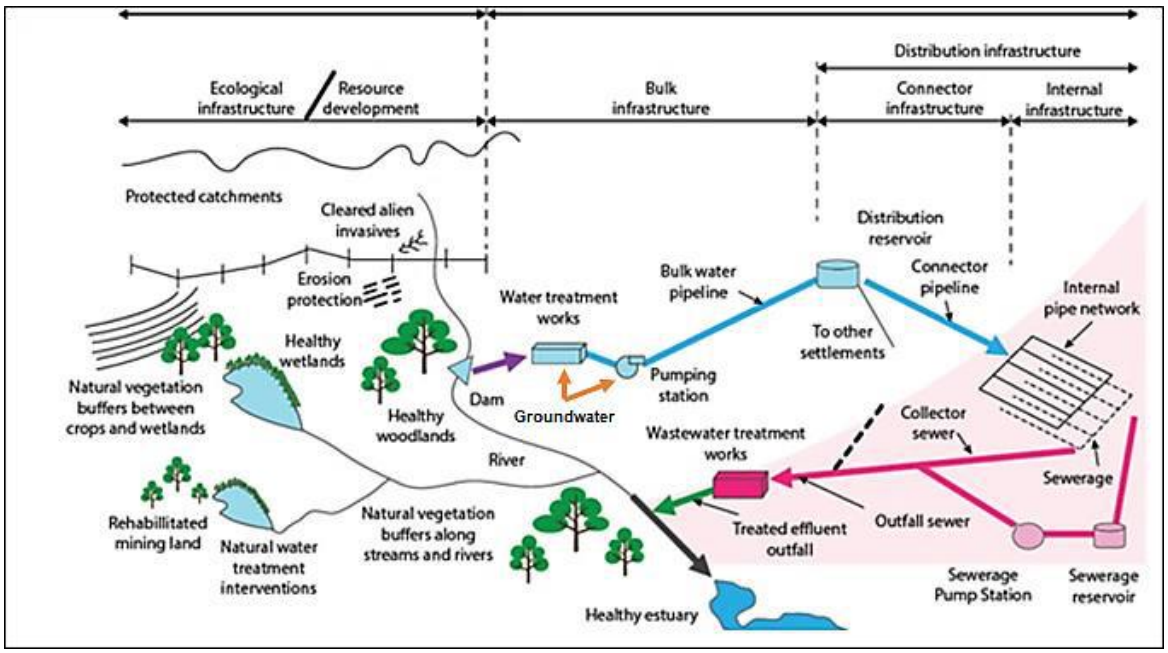


Figure 12: Developing the sustainable water supply chain must recognise the link between water supply systems and ecological infrastructure (after DEA, 2014)

These roles and multiple functions are summarised in Figure 12. It provides a summary of the value chain from the resource management and development to supply and back to the resource. The capacity of the organizations and institutions that are responsible for the various functions at different spatial scales is important to understanding the current and future management of water resources. This also calls for the need to the prioritization of services and functions by the utilities, municipalities and or councils, with the responsibility for service delivery. A good example is the Upper Manyame Sub-Catchment Council and the City of Harare in Zimbabwe.

There are various models and hybrids of partnerships between and amongst institutions especially between management authorities and service providers, and there is no blue-print for these institutional frameworks, but there is a trend towards frameworks as illustrated in Figure 11.

The functions of groundwater supply, that these institutions are responsible for, are broadly as follows:

- **Assessments**: Undertaking a range of exploratory surveys and resource assessments to understand what resources are available (linked to those studies undertaken by water resource managers) and how these can be developed to meet water supply requirements. These can range from very small, local level assessments to support community supply, through to larger system level assessments to support large urban developments.

- **Infrastructure development**: Commissioning a range of studies towards infrastructure development that could include more technically robust pre-feasibility, feasibility and design studies. These would be supported Environmental and Social Impact Assessments as well as working with financing institutions to take such projects to bankability. For smaller scale community level projects these studies can be less technically complex in nature. Also, for these less complex solutions, the process to construct and implement can be far swifter, with groundwater resources having the advantage of locality.
- **Operations and maintenance**: Ensuring the timely and daily operation of the components of a water supply system such as pumping, treatment, transmission and distribution of water as well as undertaking the various routine maintenance and responsive breakdown repairs to the supply infrastructure, pumps and machinery, and other equipment and facilities that are part of the water supply system.
- **Regulatory aspects**: Whilst incumbent on water resource management institutions to regulate water use and how the resource is impacted by development, the groundwater supply institutions should ensure they continue to adhere to regulatory requirements. In some instances, this will also be a matter of adhering to contractual requirements and hence, oversight will be needed to ensure adherence with these stipulations as well as other regulatory requirements. However, these institutions should regularly report on their progress in terms of adhering to regulatory requirements.

Institutions across this framework play various roles in supporting the delivery of these functions, and certain institutions are vested with powers and duties that may be delegated to them. These roles and responsibilities are broadly summarised in Table 8.

Table 8: Institutional roles and responsibilities in terms of groundwater supply

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
Ministry of Water	As water sector leader the Ministry sets policy, legislative and institutional frameworks and oversees implementation. However, in some instances other ministries take the lead for water supply. ▪ Undertake strategically important groundwater studies and assessments to ascertain allocable resources (quantity and quality) ▪ Engage with other water use sector Ministries regarding developmental requirements ▪ Undertake national master-planning to support water development and sanitation requirements ▪ Develop and strengthen groundwater use authorisation framework and regulatory instruments ▪ Ensure groundwater resources are monitored nationally and data and information are available ▪ Ensure improved compliance monitoring and enforcement for groundwater use through the development of procedures and tools	National

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
Sector Ministries	Various sector ministries lead and promote economic development that is dependent on water resources. In many instances these are conjunctive surface water and groundwater needs, but there are also specific sectors and geographies where groundwater development is imperative. ▪ Engage Ministry of Water on water supply requirements linked to sector development needs ▪ Engage with water sector master-planning to ensure alignment in water requirements ▪ Develop improved land management practices to protect groundwater quality ▪ Direct provincial government departments to ensure strategic coordination and linkage to catchment/ basin strategies and plans	National
Water Resources Management Authority	Often these authorities have a focus on the regulation of water use and therefore, should oversee groundwater development. ▪ Working with the Ministry of Water, support the development of a national water and sanitation masterplan ▪ Develop national strategy for groundwater management and guide implementation, as well as monitor progress, linking this to sectoral development needs ▪ Develop and strengthen groundwater use authorisation framework and regulatory instruments, and work with catchment/ basin-based institutions to ensure implementation ▪ Ensure improved compliance monitoring and enforcement for groundwater use through the development of procedures and tools	National
Stakeholder leadership platform	Stakeholder input into matters of national water supply and support to the national economy are important. Engagement through a national leadership group or water caucus is essential in developing robust and resilient approaches as well as enable raising of emergent issues. ▪ Engage with the Ministry and key water sector institutions on new strategic developments regarding groundwater development and water supply ▪ Provide input regarding processes to meet national and international water supply targets ▪ In an ongoing manner, raise issues of concern regarding water supply issues	National
Catchment/ basin-based Agencies	These could be basin or regional offices of a Ministry or Authority, or standalone agencies. These institutions are the linkage between national policy and more locally based groundwater management and stakeholders. Regarding groundwater supply, these agencies roles are more regulatory and play an important oversight role. ▪ Undertake strategic groundwater studies and assessments to ascertain allocable resources (quantity and quality) ▪ Outline strategic priorities for water supply and groundwater developments ▪ Develop and maintain a water allocation plan and supporting water use database ▪ Oversee water use and monitor status of groundwater resources, working with utilities and local institutions	Catchment, basin or water management area

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
	▪ Oversee practices of professional drillers associations and, with support from Ministry, develop standardised protocols for borehole exploration and drilling ▪ Undertake compliance monitoring and enforcement actions	
Provincial Government	Provincial government departments tend to support sector development and therefore need to strategically work with catchment/ basin-based institutions as to development priorities. Provincial departments of environment should support in terms of providing regulatory oversight. ▪ Align strategic development priorities with that of water strategies to develop improved resilience ▪ Support sectoral water development oversight and give development sectors guidance on sustainable and efficient groundwater use as well as land management aspects ▪ Work with industry bodies to develop improved water use efficient practices	Provincial
Water Utilities	Utilities primary function is to support water supply, often under contractual arrangements with local government. In some instances, these are bulk water supply arrangements as well as supporting reticulated supply, particularly where local government capacity is limited. ▪ Undertake exploratory and assessment studies to develop groundwater supply options ▪ Develop infrastructure to enable water supply, as well as operate and maintain this infrastructure ▪ Monitor water use and report to catchment agency/ authority and to local government as part of contractual arrangements (including groundwater levels and abstraction, water quality)	National or regional areas of operation
Local Government	Local government has a primary function to provide water services but also has responsibilities regarding local land management that have direct impact upon groundwater resources. ▪ Liaise with catchment agencies/ authorities, as well as water utilities, regarding groundwater usage planning in municipal areas, as well as spatial planning ▪ Arrange contractual bulk water supply agreements with water utilities or WUAs, as well as manage drilling and exploration contracts with professional drillers ▪ Build capacity in more rural areas so that communities can operate and maintain small-scale water supply infrastructure, supported by regular oversight ▪ Undertake monitoring of key groundwater resources (groundwater levels and abstraction, water quality) ▪ Maintain database and manage and share groundwater use information with catchment agencies/ authorities, or Ministry ▪ Drive communications and awareness in their areas of jurisdiction regarding groundwater management and water use efficiency, particularly through municipal engagement structures	Administrative municipal areas

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
Water User Associations	These institutions bring together local water users and can be focused only upon groundwater use, in some cases. Their primary function is too coordinate and manage water use and can in some instances support local government with bulk water supply. ▪ Undertake exploratory studies in conjunction with local government and catchment agency/ authority to expand water supply ▪ Manage contractual arrangements with professional drillers and report performance to professional drillers association ▪ Operate and maintain water supply infrastructure ▪ Provide bulk water supply to local government in some cases, requiring regular reporting on water supply to local government ▪ Undertake monitoring of key local groundwater resources (groundwater levels and abstraction, water quality) ▪ Maintain database and manage and share groundwater information with catchment agencies/ authorities, or Ministry ▪ Support local compliance monitoring and enforcement ▪ Drive communications and awareness in their areas of jurisdiction regarding groundwater management and water use efficiency	Local areas of operation
Drillers Associations	Some countries have established professional drillers associations to develop common and good practice as well as ensure technical quality of the services provided. ▪ Develop in conjunction with catchment agency/ authority, national Ministry of Water and identified experts, standard operating procedures and good practice for exploration studies and drilling ▪ Develop programme to build capacity on standard operating procedures and good practice ▪ Develop, with the support of catchment agency/ authority, national Ministry of Water and identified experts, knowledge products to build capacity and support awareness creation ▪ Maintain database of qualified and experienced professional borehole drillers and groundwater science professionals ▪ Undertake special studies to introduce innovative and improved practice ▪ Report to catchment level and local level institutions on new approaches as well as issues of concern regarding groundwater management and development ▪ Make recommendations to catchment agency/ authority on water use and authorisations and other aspects that support improved groundwater development	Broader catchment or basin focused on technical issues or sub-catchment/ aquifer focus
Stakeholder Groups	Whilst, these stakeholder engagement forums are largely advisory they provide a useful mechanism for stakeholders to raise their concerns regarding water supply issues including quality of services, assurance of supply, improving water use efficiency and matters of water quality. ▪ Provide advisory support to identified groundwater projects and interventions ▪ Act as “watchdog” for issues relating to groundwater supply ▪ Undertake discussion to share information and improve understanding of local water supply challenges	Catchment, basin or even sub-catchment

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
	▪ Make recommendations to local government on groundwater supply issues ▪ Support local communications and awareness regarding groundwater supply and approaches to water use efficiency	

In looking to develop institutional arrangements to support the improved groundwater supply across various spatial scales, there are some steps that are useful to consider in guiding the process. These steps are reflected in Figure 13 and are described in some detail below.

Figure 13: Steps to consider in strengthening the institutions for operational groundwater management at a national level

- **Strengthen national groundwater development and water supply strategies:** The Ministry of Water needs to look towards improved approaches towards ensuring water supply needs are met. At face value, the need to meet requirements for basic human supply is imperative but the broader economy is also dependent upon water resources and improved alignment in planning across these economic sectors is needed. Engagement across Ministries is a key first step, but this will require broader engagement at varying spatial scales with a focus upon economic resilience, water use efficiency as well as water supply requirements. This will provide the basis for an improved strategy to ensure meeting water supply needs. Noting that the most significant pressures will be in meeting supply needs in rural communities, there will need to be consideration of how these are met and the role that institutions at various levels play in supporting these communities. Part of the approach to meeting these needs will be the development of improved operational approaches to enabling conjunctive use of water from surface water, groundwater, rainwater harvesting and other innovative supplies. However, meeting rural water requirements will need innovative institutional approaches that include engaging more effectively with the private sector and communities themselves. Engagement with civil society will be important in shaping these approaches.

  - Ensure better inter-sectoral alignment regarding water supply requirements
  - Develop and improve national strategies to ensure delivery of water supply
  - Develop operational approaches to enable improved conjunctive use of water resources
  - Develop and implement approaches to ensure local groundwater use particularly in rural settings
  - Engage stakeholders at a national level

- **Strengthen local government's ability to ensure water services are delivered:** Local government as the hub for local socio-economic development faces a considerable array of institutional, technical and financial challenges. Building institutional capacity within municipalities is a critical part of ensuring their ability to deliver on their mandate. In many contexts, there is a significant lack of technical skills, especially with regards to groundwater development. Whilst this cannot be solved swiftly, there are various steps that can be taken to support these institutions. Closer institutional partnerships at the local level is important and will support better coordination in planning but will also encourage the exchange of knowledge and information. This will include discussions with local WUAs as well as professional drillers and groundwater experts. There would be value in developing a set of model bylaws for local government to use and could be developed nationally, led by Ministries. This would provide a standardised set of instruments, supported by a suite of tools to assist implementation and would enable the construction of a standardised training programme to develop capacity. Noting that developing improved approaches to compliance monitoring is important, this training would need to focus on developing skills in this area. There is a need to strengthen the land management practices within municipal areas, as these have significant impact upon groundwater resources. Engagement with geohydrological experts will be critical in developing these approaches and could be underpinned by the development of standard operating procedures that guide decision making. Lastly, within municipal areas there is much to do in terms of encouraging the right behaviours with regards to water use and the development of groundwater resources. Support from the Ministry of Water as well as from catchment agencies/ authorities can be provided to develop communications and awareness materials that local government can use through their various engagement platforms.

  - Build technical groundwater capacity at local government level
  - Develop closer institutional working relations between local level institutions to share capacity
  - Develop a set of model bylaws that can be used by any municipality and provide supporting tools to assist in implementing these bylaws
  - Develop standardized training for municipalities regarding groundwater development and in undertaking compliance monitoring and enforcement
  - Develop standardized groundwater communications and awareness creation materials for use by local government

- **Establish and develop public-private partnerships:** Developing groundwater resources requires a range of partnerships with the private sector. In the first instance, there is a need for a competent private sector that can provide contracting services of a high standard to undertake the various technical and professional studies that are required. This does require a sound working relationship between the public sector and these private sector contractors, and it is critical that the public sector encourages and supports the development of these contracting and consultancy services, which are essential to the ability to deliver water services targets. This is increasingly being supported by interest in the private sector to support in the provision of public works and service delivery. This does require that government institutions have a clear strategy for the engagement of the private sector supported by well-constructed procurement and contracting procedures. The hosting of 'market sounding workshops' to engage with the private sector in terms of these projects and interventions are useful mechanisms to test private sector interest, but also provide a useful conduit to gain constructive input to strengthen the project. These need to be supported by project planning and Terms of Reference that are technically sound, with adequate timeframes to enable delivery and sufficient budget to provide the quality services required. This does require sound in-house technical skills, but these can be underpinned by technical support from other institutions. Likewise, it is valuable to engage with other projects to ensure that lessons learned from these projects, especially with regards to contractual matters, are taken on board.

  - Develop a strategy to support the development of private sector groundwater contractors and consulting services
  - Identify clear public-private-partnership projects/ initiatives and develop strategy to realise these
  - Host private sector market sounding workshops to encourage private sector engagement and to test interest in such development interventions
  - Develop project Terms of Reference and supporting resources rigorously and bring in sufficient technical skills to ensure completeness
  - Learn lessons from similar projects particularly with regards to ensure contractual arrangements are rigorous

- **Establish a professional drillers association**: The promotion of technical excellence in the drilling and groundwater development industry is imperative to undertaking robust and resilient groundwater supply projects. The establishment of a professional drillers association or a professional geohydrological technical association would provide a useful technical interface between the public sector and private contracting sector and enable interaction on developmental projects and the needs of these. This exchange of knowledge would enable the public sector to approach these developmental projects in new and innovative ways. Of course, the Terms of Reference for such an association would need to be clear, but it would be incredibly valuable for this association to develop various tools and standard operating procedures that would guide practice in groundwater development projects. These would be developed in conjunction with the Ministry of Water as well as catchment agencies/ authorities and recognised groundwater experts and would provide the basis

  - Develop standard operating procedures and best practice guides for exploratory studies, drilling, well construction, infrastructure operations and maintenance etc
  - Develop communications materials and knowledge products as well as a programme of training and knowledge exchange workshops

for various communication and awareness tools that could be used to develop capacity. Hosted training sessions and feedback sessions on research and innovation would be important in striving for ongoing improvement. The association would need to provide some level of oversight on the implementation of these procedures and practices and would also need to improve these with time.

- **Develop capacity across institutions**: The provision of water supply from groundwater resources is effectively a local matter and gains more 'regional' importance when developed conjunctively with surface water resources. Many studies have emphasised the concern that developing groundwater resources requires adequate technical, geohydrological skills at these localised levels, and that these skills are not available in most instances. There is a need for ongoing capacity building to support localised institutions where water supply services are desperately required, but this needs to introduce a range of interventions that provide support, whilst training interventions take longer to realise institutional benefit. At a national level, there is a need to outline a strategy for addressing priority water supply issues and developing a clear approach to addressing these. This could include the development of technical "SWAT" teams that move from project to project or the use of regulatory instruments such as "general authorisations" that enable water use to be developed under specific circumstances, thus providing institutions with the 'capacity' to enable water use with limited intervention. Noting that rural water supply continues to be a major challenge in many contexts, there is specifically a need to develop capacity building interventions at community level to enable these communities to operate and maintain local groundwater supply systems. Local WUAs, where in place, can provide useful support and guidance to these communities. Exchange with the professional associations will also prove useful. Lastly, local government also has a key role to play in engaging the broader public, within its own municipal area, in terms of groundwater use and water use efficiency. This awareness, used in conjunction with stricter compliance monitoring, is essential is driving behavioural change.

  - Identify priority water supply areas (technically and spatially) and develop a strategy to address these
  - Development capacity building interventions in rural communities to improve the operation and maintenance of groundwater supply infrastructure
  - Engage WUAs to support in building capacity and technical understanding of groundwater supply issues
  - Local government to drive behavioral water use change in municipalities

5.4. Framework on Strengthening the National Framework for Groundwater Research and Development

Increased climate risk and ongoing socio-economic development will continue to place water resources under pressure and the effective management and development of groundwater resources is understood to be an important aspect of developing resilience. The approaches applied to the governance of these resources, through the institutions that undertake mandated roles and responsibilities, will have impact on the longer-term resilience of our groundwater resources. It is often noted that if integrated water resource management policy and legislation are effectively applied, then in many instances countries would become more resilient to the impacts of climate uncertainties. However, there is equally a need to

develop new and innovative solutions to deal with the varying and complex challenges that are emergent. Therefore, research and development (R&D) activities are, and will increasingly become, important to institutions in assisting them to manage and develop groundwater resources.

R&D is typically understood to be the 'wheelhouse' of Universities and research institutes, and while this is their area of expertise there is a more complex array of institutions that need to engage in setting the research agenda, in advising on programmes and projects, as well as actively participating in action-research (see Figure 14).

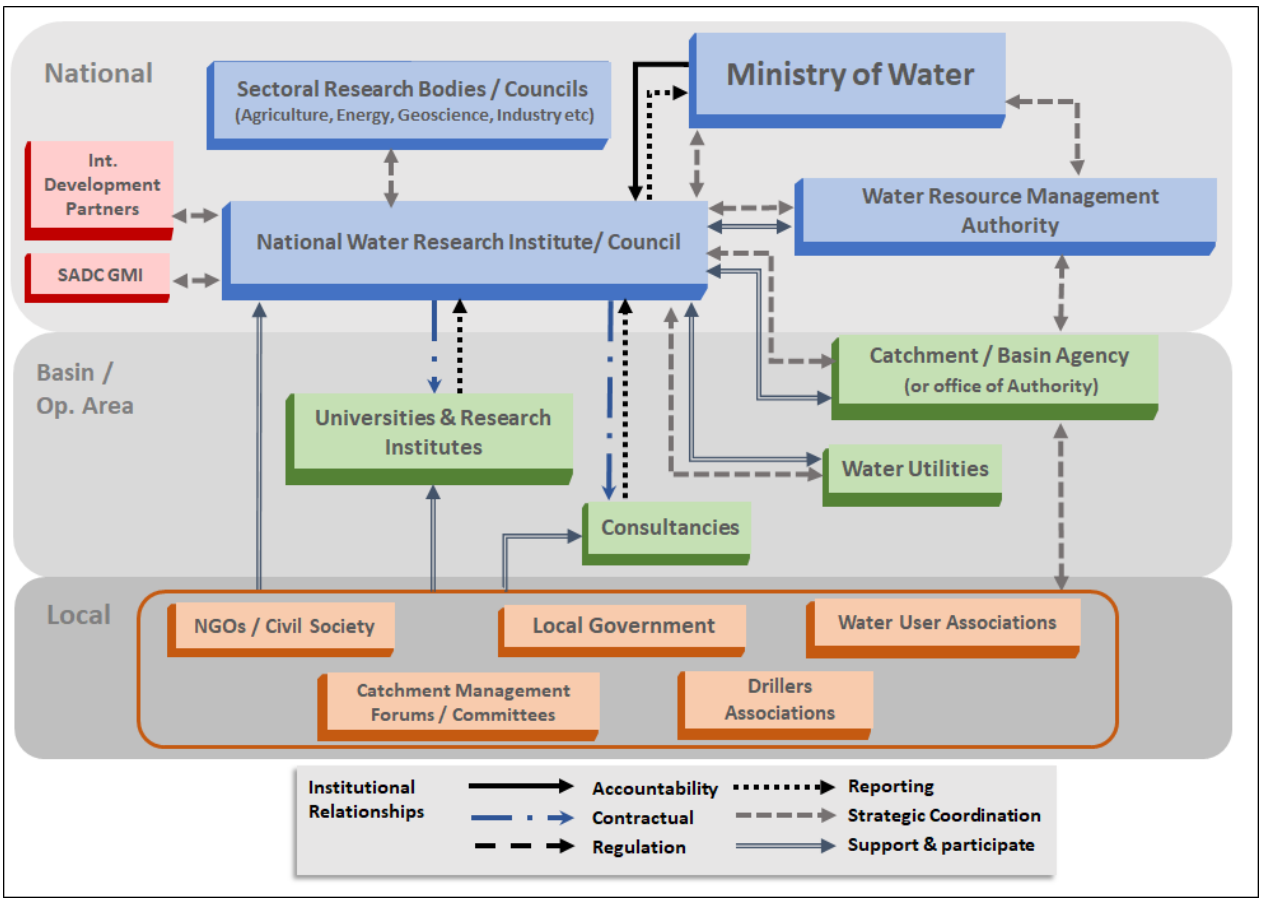


Figure 14: Institutional arrangements to effect groundwater research and development

Functions that these various institutions undertake in support of groundwater R&D are broadly outlined as follows:

- **Setting the research agenda:** Developing the research agenda is important and requires collective insights derived from broader engagement. Certainly, the role of the sector leader is important in guiding the needs for R&D across the wider water sector as well as more focused on the needs for groundwater management and development. Equally, insights from universities, research institutes, consultancies and from civil society are important and often focused more towards innovation. Engagement with international institutions (such as SADC-GMI) and development partners can also prove valuable in developing focus areas for research and can link these to

international and regional research programmes. This does provide the opportunity to learn from other projects and countries. Obtaining a balance between assisting in resolving current challenges and innovation for future advancements is important. The need to have more connected discussions across the water sector about R&D needs does result in outcomes that serve the sector more appropriately.

- **Contracting and overseeing projects**: As with all projects, it is important to enable research projects to be effectively procured and contracted, and as such this does require well-constructed Terms of Reference and a robust supply chain management system. Ensuring there is adequate financing to undertake these projects is imperative and should be part of a longer-term financing strategy. Working with development partners to develop these funding streams is important, but equally there does need to be funding for R&D that comes from in-country resources. Project oversight and research guidance is an important part of the research process and the establishment of project reference groups or steering committees, with appropriate expertise, will provide valuable directional support.
- **Delivery on R&D projects:** Undertaking groundwater R&D projects does require that the project team has enough technical background in groundwater management and development, as well as associated fields of expertise. Beyond the technical details of the particular project, effective project management supported by regular and coherent reporting is essential and enables the team to garner support from the reference group or steering committee. Enabling sufficient engagement with additional experts, as well as with broader sets of stakeholders is sometimes important to consider, making the research findings more robust.
- **Facilitating joined up discourse:** It is essential that the findings from R&D projects are reported to a broader array of institutions in the water sector. All too often there is a significant gap between those undertaking research and the various institutions that are engaged in the business of managing and developing groundwater resources. Developing reporting mechanisms is important, but also needs to be supported by facilitated discussions on the study findings and the implications thereof. This may be best done through the hosting of thematic workshops or mini-conferences. Finding the most effective way to engage the water sector to have such discourse is as important as the research and its implications.

Institutions across the water sector play various roles in driving and supporting R&D. These roles and responsibilities are broadly summarised in Table 9.

Table 9: Institutional roles and responsibilities in terms of groundwater R&D

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
Ministry of Water	The oversight that the Ministry has over the water sector, as well as the ongoing engagement with water sector institutions would inform on R&D needs. ▪ Advise national research institutions on the R&D needs for the sector. ▪ Liaise with other water sector institutions as to the R&D needs	National

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
	▪ Engage in the findings of research and facilitate discussion on sector and specifically groundwater management and development implications ▪ Assist R&D in supporting the acquisition of financial resources to undertake R&D ▪ Strategically guide and oversee sector national water research institute	
Sector Research Bodies	Various sectors have their own bodies that undertake R&D on their behalf. Examples could include a Council for Scientific and Industrial Research, a Council for Geoscience or a Agricultural Research Institute. It will be important to engage on R&D agendas and align these, particularly regarding groundwater that is impacted upon by these various sectors. ▪ Discuss R&D agendas and key strategic projects to ensure alignment with national water research institute ▪ Ensure groundwater management and development is integrated into their research projects wherever necessary ▪ Develop integrated research programmes that link sectors	National
Water Resources Management Authority	The nature of the strategic management and regulatory role of this institution provides it with a key advisory role in terms of R&D. ▪ Advise national research institutions on the R&D needs for the sector. ▪ Liaise with the Ministry and catchment-based institutions as to the R&D needs ▪ Participate as needed in some of the projects ▪ With the Ministry, engage in the findings of research and facilitate discussion on sector and specifically groundwater management and development implications, especially focusing on catchment, aquifer and local levels aspects	National
National Water Research Institute	As leader for national water sector R&D, develops a longer-term research strategy with programmes aligned to national and local groundwater management and development needs. ▪ Engage with the Ministry and key water sector institutions on new strategic R&D requirements ▪ Liaise with other sector research bodies to gain alignment in R&D strategies and projects ▪ Engage with developmental partners to align research strategies and connect R&D programmes wherever possible ▪ Engage with SADC GMI on groundwater R&D to align research strategies and connect R&D programmes wherever possible ▪ Develop longer-term R&D financing strategy ▪ Procure, contract and oversee R&D projects ▪ Prepare policy briefs to support and guide water sector institutions ▪ Facilitate with Ministry (and other water sector institutions) discussion regarding R&D findings and groundwater management and development implications	National

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
International Development Partners	A range of international development partners are engaged in supporting nations and /or transboundary basins and aquifers to develop strategies for improved resilience, amongst other more technical R&D projects. Alignment or participation in such projects can have national benefits. ▪ Outline strategic priorities and advise national water research institute (and Ministry) on R&D strategies and linkages to those at a national level ▪ Provide support for identified R&D projects either through financial support or by participating to provide technical and experiential skills ▪ Facilitate linkages between R&D institutes in differing countries	National
SADC GMI	As a hub for regional SADC groundwater R&D, the SADC GMI is well positioned to advise countries on upcoming strategic R&D programmes and projects, make linkages to new and ongoing studies and to provide insights as to future R&D needs. ▪ Outline strategic R&D priorities and advise national water research institute (and Ministry) on R&D strategies and linkages to those programmes at a national level ▪ Undertake and manage regional groundwater management and development R&D studies, that impact member states ▪ Provide technical support for identified national R&D projects where appropriate ▪ Facilitate linkages between R&D institutes in differing countries regarding groundwater R&D ▪ Develop knowledge products that can support national level groundwater R&D strategies, programmes and projects	National
Universities and Research Institutes	As the hubs for higher learning, these institutions become the 'engine-room' for R&D projects. These projects may be funded through the national water research institute or through other mechanisms. The challenge for these institutions is to ensure that R&D programmes and projects are broadly aligned to national or local needs, wherever possible. ▪ Undertake various groundwater R&D projects, often linked to the capacitation and development of students ▪ Engage with water sector institutions and civil society wherever possible and especially undertake projects with the participation of catchment-based and local institutions ▪ Report R&D findings and submit policy briefs through the national water research institute to support water sector uptake	Various from national to local
Catchment/ basin-based Agencies	These institutions are the linkage between national policy and more locally based groundwater management and development, and stakeholders. Whilst, these institutions will be linked to the broader R&D agenda, they will also have specific catchment/ basin-level needs that can be taken up in R&D projects, and should communicate these with the national water research institute and/or with local universities and research institutes. ▪ Advise national water research institute and local universities on the R&D needs for the sector, within its catchment / basin ▪ Liaise with the Ministry and other water sector institutions as to the R&D needs	Catchment, basin or water management area

Institution	Broad roles and responsibilities	Geographic area of jurisdiction
	▪ Participate in project reference groups and steering committees ▪ Participate as needed in some of the projects, especially when undertaken in the catchment/ basin ▪ With the Ministry, engage in the findings of research and facilitate discussion at the catchment/ basin-level on sector and specifically groundwater management and development implications, especially focusing on the specific catchment, aquifer and local level aspects ▪ Communicate and share knowledge (internally and externally) gained from R&D studies and the implications thereof	
Water Utilities	Utilities primary function is to support water supply, often under contractual arrangements with local government. These institutions are often supportive of studies to develop innovative approaches to groundwater management and development, and frequently have capacity to engage in such R&D studies. ▪ Align groundwater development strategic priorities with the R&D strategies and programmes ▪ Participate in project reference groups and steering committees ▪ Provide technical support and guidance on R&D projects ▪ Potentially fund certain R&D projects to support developmental initiatives in area of operation	National or regional areas of operation
Consultancies	Consultancies often undertake R&D projects, but equally have the expertise to engage and advise R&D projects. ▪ Participate in project reference groups and steering committees ▪ Provide technical support and guidance on R&D projects ▪ Undertake various groundwater R&D projects, as contracted ▪ Engage with water sector institutions and civil society wherever possible and especially undertake projects with the participation of catchment-based and local institutions ▪ Report R&D findings and submit policy briefs through the national water research institute to support water sector uptake	Various from national to local
Local institutions **(Water User Associations, Drillers Associations, Catchment Management Forums/ Committees, NGOs/ Civil Society)**	Local level institutions have various mandates but are key in terms of engaging with R&D studies that have a more localised focus. Noting that groundwater is understood as a local resource, engagement with these institutions is essential. However, the findings of such studies can have impacts at more national scales. ▪ Participate in project reference groups and steering committees ▪ Provide technical support and guidance on R&D projects ▪ Participate as needed in some of the projects, especially when undertaken in their specific areas of jurisdiction ▪ Share R&D findings with stakeholders	Local to national

In looking to develop institutional arrangements to support groundwater R&D there are some steps that are useful to consider in guiding the process. These steps are reflected in Figure 15 and are described in some detail below.

Figure 15: Steps to consider in strengthening the institutions for groundwater R&D

- **Strengthen R&D institutional arrangements:** In many instances, R&D for groundwater is secondary to the development of water supply, which understandably is a priority. However, our ability to adapt will ensure our resilience, with R&D being key to developing adaptive solutions. As such the Ministry of Water needs to look towards improved approaches towards R&D and strengthening the institutional frameworks is important. This may not involve establishing new institutions, but only clarifying and strengthening mandates. It is essential as sector lead, that the Ministry leads in ensuring that water sector institutions engage in these R&D initiatives. Invariably these research projects are useful in terms of building staff capacity as well providing insights for innovative approaches to groundwater management. Developing approaches and mechanisms to enable various water sector institutions to engage in these R&D projects is important in breaking down the gaps that often exist between R&D institutions and those water sector institutions responsible for resource management. This is often the case at the more localised levels and enabling community engagement in these projects is needed. Staff capacity and funding streams are often limited, and therefore finding ways to ensure this engagement is needed. Likewise, the findings and research conclusions can have various implications for groundwater management and development and establishing platforms to discuss these is important. These can take the form of thematic workshops (to cover several projects) or could be mini-conferences or webinars.

  - Revisit institutional arrangements for R&D and develop strategy to improve these
  - Develop mechanisms for improved engagement between water sector institutions and R&D institutions/ projects
  - Establish platforms for R&D discussion and impacts for groundwater management and development

- **Improve the groundwater R&D strategy:** Frequently, R&D projects are developed in isolation or with only limited inputs from the various water sector institutions. Invariably these R&D projects may not serve the real needs of groundwater managers at more localised levels. Therefore, developing a more coherent national level R&D strategy for groundwater provides the opportunity to not only link the R&D agenda to the needs of managers and developers, but also provides the opportunity to develop

a more balanced strategy that covers technical and managerial aspects, short-term and long-term interventions as well as various spatial aspects. Engaging with international development partners and regional institutions such as SADC-GMI, will assist in linking this national strategy to international and regional R&D programmes. This five-year R&D strategy can be developed as part of the national groundwater management strategy. In order to realise impact, it will be important to develop an implementation plan with a focus on priority hotspots. This will support the realisation of impact, as well as provide key first steps for follow-on research. Noting the importance of having impact, it will be important for catchment/ basin level and local level institutions to engage on their specific R&D requirements and to ensure that these are included in the catchment/ basin groundwater management strategies. This will assist in guiding the development of national R&D strategies, as well as guiding more localised R&D institutions (universities and research institutes) in engaging with these needs. Lastly, it is important to develop systemic ways to enable R&D reporting and tracking of progress. This is not only important to evaluate progress on delivery of the strategy, but also enabling the more regular exchange of lessons being generated on projects. This may be more effective at the local levels where catchment forums become an invaluable platform for these exchanges.

- Develop national groundwater R&D strategy
- Develop suite of priority national "hotspot" groundwater R&D projects
- Develop catchment/ basin and local level R&D requirements as part of catchment/ basin management strategies
- Develop mechanisms for R&D reporting and tracking of progress

- **Improve funding streams for R&D:** Ensuring adequate funding is an essential part of the overall R&D strategy. Often, financial constraints hamper the ability to undertake necessary research, more than other aspects such as technical expertise. This requires that countries revisit the financing frameworks for R&D, and endeavour to improve these. Some countries use a levy to raise these funds, others ensure that water sector institutions have a budget-line for these kinds of projects, whilst others invariably rely on support from international development partners and research foundations. A financing framework may include combinations of all of these, for example. The financing framework would need to be realised in a phased and progressive manner, supported by a funding strategy. As part of the strategy development, it is important to engage with international development partners and research foundations to develop a strategic approach to unlocking such funding, as this does require time to come to fruition. Equally, it is important to engage with identified private sector actors to ascertain their appetite to support groundwater R&D projects, and if they have specific requirements for such support.

- Develop sustainable financing framework for R&D
- Develop funding strategy to progressively support groundwater R&D
- Engage with international development partners
- Explore private sector engagement and stewardship support

6. CONCLUSIONS

The need for effective and sustainable groundwater management is imperative for many countries as a response to climate change and variable surface water availability. Within the SADC region these factors combined with significant pressures to develop social economies, means that the effective management and development of groundwater resources, and their conjunctive use with surface water, becomes increasingly important.

The effective delivery of regional and national governance frameworks for groundwater is a key dimension of this resilience. From a groundwater management perspective there is still significant effort required both at transboundary and national scales to improve our approach to ensuring sustainable groundwater management and development, though our institutions. Whilst there are few institutions dedicated to groundwater management, most institutions possibly provide greater attention to the management and development of surface water resources. Nevertheless, there is much to do in terms of strengthening institutions give effect to the governance framework and how this translates into effective operational groundwater management, into sustainable groundwater development and water supply, as well as into robust groundwater R&D.

Looking across these differing dimensions of the groundwater business there are a number of lessons that can be distilled and thus provide guidance when establishing and developing the institutional framework for groundwater. These include:

- **Functional differentiation**: *Ensure clarity of functional mandate*. Effective management of water resources is supported by differentiating those functions (form-follows-function) that provide policy intent from the more operational functions that support groundwater use and development. This is then overseen by a regulatory function that may be institutionally close to the setting of policy (e.g. the Ministry) but could equally reside within a separate institution (e.g. national water resources management authority). There is a growing trend towards the establishment of more independent regulators, but more important is that there is a clear differentiation from those that are responsible for the setting of policy frameworks and those that develop groundwater resources.
- **Progress institutional development**: *Enable institutions to progressively develop functional competency*. Do not amend the policy and legislative frameworks regarding institutional establishment and development, when groundwater management and development targets are not being met. Rather unpack the functional aspects and determine what the challenges are and develop the appropriate responses to assist institutions to ensure delivery. It must be understood that institutional processes take time to settle and develop their competencies progressively over time. Often delivery challenges are caused by lack of clarity in mandate or even overlapping mandates, hence resolving institutional roles and responsibilities is important.
- **Develop institutions to support research**: *Improve the level of research into groundwater resources to enable adaptive management, as part of developing resilience*. Whilst certain universities do undertake research with regards to groundwater management, these are few across the region with sufficient in-

depth technical abilities. In addition, few countries have a focused national water research institute that has a core research mandate such as the Water Research Commission (in South Africa). Whilst the establishment of the Water Research Commission in South Africa has to be seen as best practice in terms of supporting and coordinating integrated water research, it may be sufficient for the Ministry of Water to work closely with the existing research institutions and to support a more collective approach across these various institutions.

- **Improve intergovernmental relations**: *Develop stronger partnerships with sector ministries*. Whilst there is an apex Ministry responsible for water and groundwater management, there are a range of other Ministries and Departments that have very significant impact upon groundwater resources. This includes sectors such as agriculture, minerals and mining, human settlements, trade and industry and energy. Whilst there are often challenges in ensuring effective coordination and collaboration horizontally between sectors, there are also significant challenges when trying to ensure effective cooperation vertically across the different spheres/tiers of government. Noting the importance of local government in terms of driving local socio-economic development, and the importance of groundwater resources at that level, the interface with municipalities is particularly important in terms of groundwater supply. It is important to ensure improved levels of planning between these different sectors, despite the complexity.
- **Build institutional capacity at local levels**: *Prioritise on improving groundwater management and development at more localised levels*. The establishment of water user associations, catchment management forums and catchment management committees, as well as possibly strengthening other stakeholder platforms is possibly more important from a groundwater perspective. These institutions will effectively coordinate local projects, support more integrated planning and will strengthen localised compliance monitoring and enforcement. Provide support through technical experts to these localised institutions to realise more effective and efficient response in the management and development of groundwater. This may require focused technical project work but could include training interventions. This would prove immensely important in empowering local communities to better operate and maintain local groundwater infrastructure.
- **Redefining areas of operation:** *Consider aquifer boundaries when looking at institutional areas of operations*. Noting the importance of groundwater across the region it is particularly important that the areas of operation, of differing institutions, takes into consideration geohydrological boundaries wherever possible and necessary. This has been undertaken in several instances and enables more effective groundwater management at the local scale. It is understood that there are various institutional challenges when trying to manage groundwater across an array of natural, administrative and political boundaries. These are often solved at the local level by establishing focused working groups.
- **Develop appropriate funding mechanisms**: *Develop a holistic investment framework for the water sector, supported by a strategy to realise implementation*. A key factor in enabling the implementation of institutional frameworks has been the ability to ensure there are adequate and sustainable financial

resources to support the institutional development, as well as underpin the functional mandate. This mandate does have impact upon what types of financing can be accessed and this must be clearly articulated in the frameworks and strategy. It is important to work with local level institutions to improve payment for water use and services, as well develop cost recovery approaches. Hold discussions with international development partners as well as the private sector regarding opportunities to fund projects and explore how these funding opportunities can support specific interventions. Obtaining alignment between various strategic partners can be challenging, but ultimately be rewarding when packaged towards achieving key outcomes and objectives.

- **Strengthen data and information management systems**: *Ensure access to data and information through supporting management systems*. The development of appropriate systems that enable water users to submit data (water use, waste discharge etc), as well as access data and information, enables more effective decision making across various institutions. Noting that there are concerns regarding over abstraction from many aquifers, as well as concerns about groundwater quality, institutions should be finding mechanism's or systems to enable efficient submission of data by water users.
- **Build groundwater capacity**: *Build a cohort of groundwater managers and technical experts*. There are generally shortages of staff focused upon groundwater management, with many institutions struggling to appoint skilled and trained people that have suitable groundwater qualifications. Many states have a well-developed network of tertiary institutions that provide training, but there are only a few institutions (across SADC) that provide training with regards to groundwater management and development. The limited availability of these training offerings is a key dimension of the limitations in capacity across the region and requires strengthening. This requires effective leadership from the water sector leader (the Ministry) as well as support from other water sector institutions. Noting that this is a regional challenge across SADC, the SADC-GMI is seen as being a regional leader in developing programmes to develop this capacity.
- **Build Public Private Partnerships (PPPs):** *Engage with the private sector to support in groundwater management and development*. Whilst, private sector business is developing an appetite for stewardship-based approaches to local groundwater management, the water sector can benefit from the expertise of the private sector through PPPs for such activities as delivering water services, providing technical assistance, undertaking planning, design and contract supervision, overseeing construction by large and small contractors, preparing guidelines, preparing communications materials, training and capacity building, supporting the development of financing frameworks, and others.
- **Establish professional Bodies**: *Establish professional associations for geohydrologists or borehole drillers to improve the quality of work undertaken*. It is becoming increasingly important to ensure that there is consistency and quality in approach to drilling and siting of boreholes, and associated groundwater assessment studies, especially when one notes that these studies are undertaken at local level. Such an association can establish a suite of standard operating procedures, supported by guidelines and training materials. Importantly, it is in the interest of such an association to oversee how professionals are undertaking projects and to drive good practice.

- **Ensure stakeholder engagement**: *Provide stakeholders with the platforms to engage on groundwater*. Integrated groundwater management is underpinned by the principles of stakeholder engagement. However, in many instances there are concerns that the efforts to engage stakeholders have not been enough. This has resulted in a poor awareness regarding the complexities of groundwater management. Developing appropriate institutional platforms (e.g. forums, working groups, committees etc) to enable effective engagement is important, supported by the availability of awareness creation materials using social media and the internet. These stakeholder engagement forums should meet on a regular basis and should be open to attendance by a wide range of interested and effected parties. There are undoubtedly challenges in ensuring that these platforms are sustainable, and this should be considered in the financing strategies to support groundwater management and development.

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