Sustainable Groundwater Development and Management for Humans, Wildlife, and Economic Growth in the Kavango Zambezi Transfrontier Conservation Area (KAZA-GROW)

2021-2023

Transfrontier Groundwater Management Framework (Draft Report)

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Sustainable Groundwater Development and Management for Humans, Wildlife, and Economic Growth in the Kavango Zambezi Transfrontier Conservation Area
KAZA-GROW

DRAFT - TFCA Groundwater Management Framework

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Cover photo: Sioma Ngwezi National Park (credit: Peace Parks Foundation)

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ABBREVIATIONS AND ACRONYMS

AWP	Artificial Water Points
CBNRM	Community-Based Natural Resource Management
GDE	Groundwater-Dependent Ecosystem
GESI	Gender, Equality and Social Inclusion
HWC	Human-Wildlife Conflict
KAZA	Kavango Zambezi
KAZA-GROW	The project: Sustainable Groundwater Development and Management for Humans, Wildlife, and Economic Growth in the Kavango Zambezi Transfrontier Conservation Area
KRWDA	Kwando River Wildlife Dispersal Area
MAR	Managed Aquifer Recharge
KRS	Kwando River System
PES	Payment for Ecosystem Services
RBO	River Basin Organization
SADC	Southern African Development Community
TBA	Transboundary Aquifer
TFCA	Transfrontier Conservation Area
TGMF	Transfrontier Groundwater Management Framework
TDA	Transboundary Diagnostic Analysis

1. INTRODUCTION

1.1 Background

The project "*Sustainable Groundwater Development and Management for Humans, Wildlife, and Economic Growth in the Kavango Zambezi Transfrontier Conservation Area*" (KAZA-GROW project), was conceptualized in partnership with the Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) Secretariat and Peace Parks, to prioritize the management and conservation of freshwater, particularly groundwater resources in the KAZA TFCA. Groundwater knowledge across the TFCA is limited, with disparity and little coordination between Partner States. There is a need to co-develop the knowledge base, capacity, and decision support tools, policy guidelines, as well as management frameworks around groundwater management at the most appropriate integrated scales from local to transboundary for the TFCA. The river basin organizations (RBOs) - the Permanent Okavango River Basin Water Commission (OKACOM) and the Zambezi Watercourse Commission (ZAMCOM) - have complementary mandates of parts of the KAZA TFCA in terms of water resources. The RBOs not only play a pivotal role in coordinating activities across the respective member states in their basins (OKACOM: Angola, Botswana, and Namibia, and ZAMCOM: Angola, Botswana, Namibia, Zambia, and Zimbabwe) but increasingly also in coordinating issues of trans-basin character and in the context of the KAZA TFCA.

Developing a Transfrontier Groundwater Management Framework (TGMF) is necessitated by the need for more concerted efforts in managing groundwater across multiple-use sectors, including conservation in the KAZA TFCA. Foremost is the role of groundwater in improving livelihoods and supporting wildlife and biodiversity conservation. There are five transboundary aquifers (TBAs) in the KAZA TFCA with limited knowledge of their functioning and extent. The TGMF is a conceptual structure that will guide the development of supporting groundwater management institutional mechanisms in the KAZA TFCA. It is, therefore, not a detailed implementation program.

1.2 Project deliverables and the Transfrontier Groundwater Management Framework

The TGMF forms part of a series of studies within the KAZA-GROW project, comprised of several deliverables across the two-year project lifespan. Project deliverables consisted of reports on (i) Transboundary diagnostic analysis (ii) Water scarcity and vulnerability mapping (iii) Groundwater quality analysis (iv) Hotspots for groundwater development and (v) Gender equality and social inclusion analysis. These deliverables together with country and stakeholder consultations supported and informed the framework development.

1.2.1 Transboundary diagnostic analysis

An extensive Transboundary Diagnostic Analysis (TDA) provided a background analysis on the status of groundwater occurrence and use in the KAZA TFCA as well as the policy, legal and institutional arrangements currently in place for management.

Some highlighted main findings include:

- Identification and mapping groundwater dependent ecosystems (GDEs) within the Kwando River System (KRS) and wider KAZA TFCA. These investigations would support the identification of potential (transboundary) Ramsar sites as well as critical approaches to their long-term management.
- Implementation of a coordinated groundwater sampling and monitoring framework across the Kwando River System.
- Further investigation on the options for designating the trans-basin Moxico Water Tower (Lisima Lya Mwono area) in Angola, or a larger part of the transboundary Kwando River Basin,

as a (transboundary) Ramsar site. This would support the protection of source water areas that provide critical fresh water for downstream areas of the KRS, as well as the Cuito (Okavango River Basin) and other upper catchments of the Zambezi Basin. Models for its conservation including investments need to be put in place.

- Further investigations and cautious development of the resource potential of groundwater for sustainable water supply and small-scale livelihoods in the KAZA TFCA should be undertaken. The provision of drought-resilient water, sanitation and hygiene (WASH)facilities for poor local communities that will also cater to integrated small-scale productive uses is of particular relevance and importance. The installation of Artificial Water Points and broader groundwater exploration must critically assess the risks of human-wildlife conflicts, consider nature-based solutions and support natural migration dynamics.
- Further development of the integrated Transfrontier Groundwater Management Framework (TGMF) will support the KAZA TFCA in its integrated management of groundwater resources, in collaboration with SADC, Ramsar, RBOs, national ministries of water, as well as conservation and local stakeholder groups and community-based organizations. Integrating the TGMF across these scales is essential to ensure maximum cohesion between the different levels of governance.
- In support of a successful TGMF, it is recommended to support and facilitate stakeholder and technical support platforms at the local to transboundary level to better incorporate groundwater for sustainable development and conservation in the KAZA TFCA, with an early focus on the KRS - for example, to maintain and strengthen pre-existing structures such as the Kwando Joint Action Group (KJAG) and to incorporate groundwater technical committees in the river basin organizations. Such structures will incentivize stakeholders to abide by the principles of international best practices for multi-country water cooperation, while in the long term potentially formalizing cooperation (into a treaty, agreement, or other).
- It is recommended that groundwater knowledge and recommendations are offered to the Freshwater Working Group of the KAZA Secretariat through a dedicated Groundwater Expert or sub-Group.

1.2.2 Water scarcity and vulnerability map

Areas of unique importance were mapped to show regions prone to scarcity and groundwater vulnerability to impacts from climatic variations. The report went beyond mapping available resources to actual access by communities, using a set of ten parameters (rainfall, population density, poverty level, protected areas, wetlands, and distance to rivers, roads, wildlife corridors, boreholes, and fire outbreaks).

The main findings were:

- More than half (65.1%) of the study area was classified as having high to very high-water scarcity vulnerability. This very high-water scarcity area is likely to increase with climate change.
- Supporting communities with appropriate ground and surface water infrastructure to access good quality potable water for both humans and wildlife is vital for strengthening climate resilience.
- Increasing accessibility to water infrastructure by developing road networks should be an important focus.
- Location of water infrastructure, homesteads, and crop fields should be located far from wildlife corridors to reduce human-wildlife conflict.

1.2.3 Gender, equality and social inclusion analysis

As part of the water scarcity and vulnerability mapping, an analysis of gender equality and social inclusion (GESI) was undertaken in the Sesheke, Shangombo, and Sioma districts in Zambia and Rivungo districts in Angola. The objective is to identify and understand barriers to equitable access, knowledge, beliefs and perceptions, practice and participation, legal rights and status, power, and decision-making in groundwater management and distribution. This understanding is critical for children, women, Persons with Disabilities (PWDs), youth, and indigenous people to equitably take part in sustainable groundwater management. The analysis identified differential water needs and priorities of women and key GESI recommendations and considerations for integration into the Transfrontier Groundwater Management Framework.

The main findings showed that:

- Women, youth, and PWDs have significant understanding of access to water issues but there is need to enhance their capacities to contribute meaningfully to groundwater management activities and processes (e.g., active participation in water committee meetings, planning and designing water infrastructure projects).
- Children face significant barriers to accessing water for recreational purposes because of safety issues due to human-wildlife conflict and community beliefs that children would waste water at boreholes.
- There are robust traditional practices of water conservation and allocation such as limiting the number of buckets to 3x20 liters for each family per day and reuse of water in watering gardens and mulching crops to prevent water loss.
- Water Committees in the majority of research (90%) sites have equal representation of men and women but women, youth and PWDs have little say in the final decision made during the Water Committee meetings because of their limited capacity to contribute to the issues and cultural barriers governing gender and youth inclusion in such meetings.
- The legal rights and status of women, youth, and PWDs in water resources management decision-making processes are limited dues to patriarchal attitudes and limited awareness of the rights of women, youth, and PWDs.
- In some study sites, groundwater is highly saline and has high iron content, presenting serious water quality risks for children, women, youth, and PWDs.
- Human and Wildlife Conflict (HWC) is widespread across the study sites. It affects access to water for women, youth and PWDs by limiting movements to rivers and water points while posing a danger to human life and crops for the communities.

1.2.4 Groundwater quality analysis

The objective of this study was to analyze the spatial and temporal viability of water quality in the Kwando River Basin (KRB) and Kwando River Wildlife Dispersal Area (KRWDA). This involved selecting sites in collaboration with local water management and coordination officers. The samples were collected during both dry and wet seasons to assess if the water quality changes with seasons. A total of 280 samples were collected for both seasons and half of the samples were analyzed for chemical parameters and the other half for stable isotopes.

The main findings include:

- Chemical parameters of concern above the WHO standards, include salinity, iron, arsenic, selenium, barium, boron, sodium, potassium, fluoride, and sulfate.
- Rivers in the study area are sustained by groundwater discharge mainly during the dry period.
- Best catchment management practices are crucial to protecting the water resources in the study area due to considerable surface water and groundwater interaction.
- Despite the pollution challenge, there exists great potential for reducing further pollution and

restoring the polluted groundwater and surface water, and carefully selecting sites for future groundwater development for wildlife, and both rural and urban areas.

1.2.5 Hotspots for groundwater development

Identifying prospective groundwater potential sites is one of the first steps in successful implementation of groundwater development projects. Mapping the hotspots for groundwater development in the KRB and KRWDR was carried out using Geographic Information System-based Multi-Criteria Decision Analysis (GIS-MCDA). The resulting groundwater potential map was then classified into very good, good, moderate, poor, and very poor groundwater potential classes and is intended to serve as a baseline upon which further subsurface investigations can be based.

The main findings were:

- Nearly 49% of the study area is classified as having moderate potential for groundwater, and about 21.7% is classified as having good potential for groundwater.
- There is good potential for groundwater to alleviate the water challenges in the Kwando River Basin and Kwando River Wildlife Dispersal Area.

As a planning tool, the map provides a means of communicating results with stakeholders and policymakers on the overall groundwater situation and spatial potential. The map does not provide quantitative information on how much groundwater is in the aquifer; this would require further investigation.

1.3 Transfrontier Groundwater Management Framework

The proposed framework aims to enhance policy attention and guide sustainable groundwater development and management in the KAZA TFCA and broader in SADC. It builds on a high-level, consensus-driven process and assessment of risks, opportunities, best opportunities and institutional arrangements for developing and managing groundwater in a sustainable and harmonized manner for water security and resilience, as well as ecosystem integrity in the KAZA TFCA.

1.3.1 Objectives of the framework

This framework will serve to guide management and development efforts within the KAZA TFCA at various implementation scales towards sustainably exploiting and protecting groundwater resources to enhance ecosystem integrity and biodiversity and improve socio-economic conditions. This framework should inform management decisions across a diversity of stakeholders, including transboundary water management, biodiversity conservation, and community-based natural resources management (CBNRM). Equally important, groundwater management should be considered within large project developments and the impact this may have on aquifer integrity. In addition, mounting pressure on water resources due to climate change requires a timely response to sustainably managing available resources, particularly groundwater. Based on this background the following are the main objectives of the framework;

i. To highlight specific management aspects critical to TFCAs concerning groundwater management.
ii. To bring enhanced policy focus to groundwater management in TFCAs
iii. To propose a policy and institutional framework that will coordinate efforts towards the sustainable development and management of groundwater in the KAZA TFCA in fulfilling the various ecological, conservation, and socio-economic roles.

1.3.2 Purpose and scope of the framework

A unique feature of this framework is its contribution to groundwater management in transfrontier conservation areas, where multiple interdependencies exist, with limited formal consolidated and targeted management frameworks. Its purpose is to provide a structure for conceptualizing a coordinated approach towards sustainable development and management of groundwater within a TFCA context. While the framework is based on studies in the Kwando River Wildlife Dispersal Area (KRWDA) within the KAZA TFCA, there is potential for broader application in other TFCA contexts.

1.3.3 Approach

The first step in developing the TGMF was to conduct a review and gap analysis of available frameworks both for conservation and water resources to identify areas that pertain particularly to groundwater management within a TFCA context. This gap analysis was followed by a synthesis of the components for a TGMF, which are later expounded into a framework. Stakeholder consultations supported this process to establish key areas of concern that need to be addressed in the framework as well as any missing supporting management structures that should be in place (Figure 1).

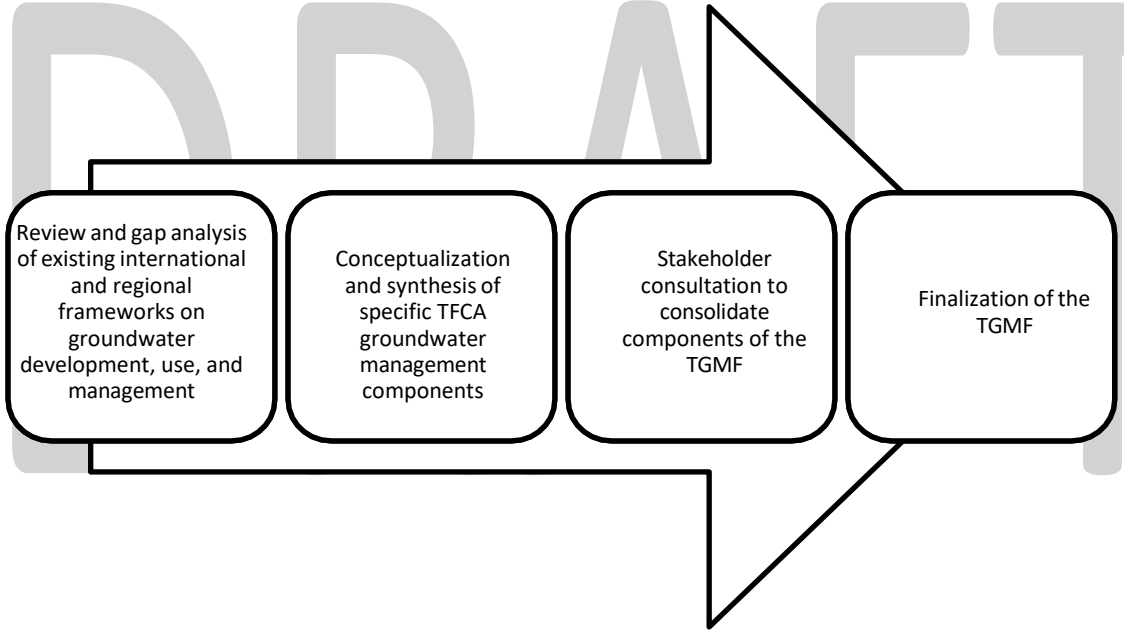


Figure 1. Steps towards developing the TGMF

1.3.4 Guiding principles

The Southern Africa Development Community (SADC) upholds the principles of regional integration, sustainability, equality, and social inclusion through its several legal and policy frameworks (e.g. the SADC Revised Protocol on Shared Watercourses, the Protocol on Wildlife Conservation and Law Enforcement). These principles are echoed in the KAZA TFCA Treaty and the ZAMCOM Agreement, providing a baseline for common understanding in the management of natural resources. Within a TFCA context, tenets of transboundary basin management, wildlife and biodiversity conservation, and integrated water resources management all apply to managing groundwater. At the core, is ensuring that groundwater management and development efforts account for the quantity and quality of the resource in sustaining ecosystem services for socio-economic development. Further, within a changing climatic landscape, building the resilience of communities and wildlife against the harsh realities of water scarcity is critical. Against this backdrop, four guiding principles emerge and inform this

framework (i) Sustainability (ii) Integration (iii) Resilience, and (iv) Equality and Inclusion.

Sustainability

Sustainability in the context of sustainable development as espoused by SADC points to ensuring that natural resources are used in a manner that will not compromise future use for those that depend on them including people, plants, and wildlife. As such, the use of and development of groundwater resources should be constrained by this principle. Local communities whose livelihoods are directly dependent on natural resources are especially vulnerable to unsustainable exploitation of natural resources including groundwater. Similarly, sustainable use of groundwater in TFCAs supports wildlife and biodiversity (e.g. groundwater-dependent ecosystems), and, subsequently economic activities that depend on them such as tourism.

Integration

The siloed approach to natural resource management has shown its shortcomings and breeds duplication of effort and resource wastage. By integrating at the various institutional levels, more coordinated efforts can bring about the desired impact. Where two or more countries share resources such as in the KAZA, integration of policies, laws and operational structures is needed to ensure a harmonized approach. While the fundamentals may be similar, nuance in the conceptualization and implementation of policies and laws may result in variations that may impact the sustainable use of resources. Groundwater use requires urgent and greater policy attention due to increased use across the SADC region.

Resilience

The KAZA TFCA region is prone to droughts and floods, which are currently worsened by changing climatic conditions. Developing groundwater is seen as a key factor in building community resilience against climate shocks such as droughts. Groundwater – which is not impacted by evaporation in the same way as surface water, enables continued support for activities such as agriculture and water supply for people and wildlife.

Equality and Inclusion

The KAZA landscape is home to rural communities, largely dependent on natural resources for their livelihoods and highly vulnerable to external shocks, including climate change. Groundwater abstraction that limits their ability to access the resource should be regulated. Ensuring their inclusion within groundwater management and development efforts is critical to their very existence and future prosperity.

2. WHY MANAGE AND DEVELOP GROUNDWATER IN A TFCA?

A TFCA tables a unique set of variables for groundwater management that requires understanding the specific nature of the landscape. Effectively managing and developing groundwater for (i) human-wildlife conflict (ii) sustaining groundwater-dependent ecosystems (iii) supporting livelihoods (tourism, large and small-scale agriculture) and (iv) domestic water supply and sanitation can mitigate against water scarcity. This section explores these elements and why a framework such as this one is needed.

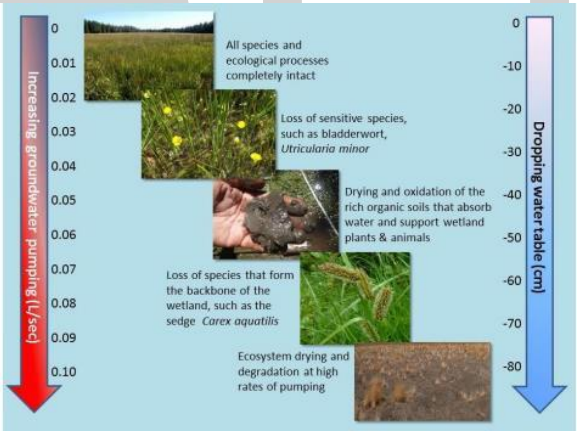
2.1 Human-Wildlife Conflict

Within a wildlife-based economy such as in the KAZA TFCA, interactions between humans and wildlife are inevitable. However, when such interactions result in conflict, this becomes a challenge that needs to be managed. Human-Wildlife Conflicts (HWC) arise when the presence of wildlife poses a perceived or direct threat to humans (Gross et al., 2021). When water resources are scarce, it forces humans and wildlife to compete for available resources. Further, as a result of climatic variations, prolonged drought periods, and poor landuse planning, HWC over water can only intensify. The recent Intergovernmental Panel on Climate Change (IPCC) report indicates that long dry spells will be a common occurrence in the southern African region in which the KAZA TFCA lies. Surface water resources are especially affected and this is where groundwater can play a role in alleviating challenges of HWC through developing groundwater resources for humans away from wildlife corridors.

2.2 Groundwater Dependent Ecosystems

Maintaining environmental flows in surface water resources is generally accepted and understood. While the supporting policy framework may not be as well-developed, countries in the KAZA TFCA do acknowledge the importance of environmental flows. Groundwater environmental flows and levels are equally important to consider and maintain as they enable a balance to be achieved "between groundwater left in the aquifer to support groundwater-dependent ecosystems (GDEs), and groundwater withdrawal for human uses" (Aldous and Bach, n.d); Box 1). Methodologies for determining this balance are currently evolving and there is need for such methods to be easily implementable for routine monitoring (Aldous and Bach, 2014). Isotope analysis from the groundwater quality report provided evidence of strong surface water-groundwater interaction in the KRS.

Box 1: Excessive groundwater pumping leads to groundwater-dependent ecosystem degradation



(Source: Aldous and Bach, n.d).

Eamus et al. (2016) classify groundwater-dependent ecosystems as those that (i) are found within groundwater (ii) that require a groundwater manifesting on the surface (e.g. springs; wetlands); and (iii) depend upon sub-surface availability of groundwater such as woodlands and riparian forests. Such ecosystems suffer degradation when groundwater is pumped excessively. Within the KAZA TFCA and the Kwando River Basin specifically, groundwater-dependent ecosystems such as the Linyanti Wetlands, Kumbilo- Dirico Wetland Complex, and the Kwando River itself are important ecosystems for supporting livelihoods (agriculture and fisheries), wildlife, and tourism.

2.3 Agriculture, Tourism, and Alternative livelihoods

Agriculture (both commercial and small-scale) and tourism are key economic activities in the KAZA TFCA. Both sectors benefit from the provisioning services of groundwater directly or indirectly. Rural communities living in and around wildlife conservation areas and who practice smallholder agriculture often encounter challenges with respect to water availability and wildlife destroying crops (Kent, 2020). Developing groundwater may further provide sources of water for such communities. However, it is also essential to consider alternative sources of income that are less water-dependent, given climate change and erratic water availability in some parts of the region. Improving livelihoods is one of the key value propositions of TFCAs and this includes those of local communities living within the TFCA and who depend on the same terrestrial and aquatic ecosystem as the wildlife.

Through supporting Community Based Natural Resource Management (CBNRM) across existing structures within the KAZA TFCA countries, maximum benefits can be harnessed. Environmental degradation due to activities such as charcoal production and illegal timber extraction pose a threat to habitats within the TFCA e.g., in the Simalaha Wildlife Dispersal Corridor (Munthali et al., 2018). As such, for communities to become stakeholders in environmental protection and conservation management, Payment for Ecosystem Services (PES) may hold the potential to guarantee livelihoods while sustaining ecological integrity. PES may come in the form of communities receiving proceeds from tourist activities or compensation for damage caused by wildlife (Kansky et al. 2021). However, the success of interventions such as PES depends significantly on the history of the local communities, their relationship with the landscape, and a sense of stewardship and not just the monetary benefits (Kansky et al. 2021). Similarly, PES can thus be applied in terms of protecting GDEs and groundwater recharge zones.

2.4 Domestic Water Supply and Sanitation

Availability of water for domestic water supply and sanitation are critical to the urban and rural communities in the KAZA TFCA. Developing groundwater for meeting domestic and sanitation demands is also in line with the SDG 6 target for clean water and sanitation for all by 2030. With this consideration in mind, groundwater can play a role in augmenting water supplies for domestic use and improving the living conditions of the millions in the region. Nonetheless, this development has to take into account sustainable abstraction rates and ensure that environmental requirements to sustain GDEs are maintained. Further, the development of water supply services reduces Human-Wildlife Conflict for example, the Kapau Community along the Sioma Ngwezi National Park who has benefited from the development of groundwater to secure water access away from wildlife (Kent, 2020).

2.5 Water Scarcity and Multiple use(rs)

Over and above the threat of water scarcity, water pollution is a real problem in surface and groundwater. Activities such as intensive agriculture may result in high nutrient loads in water sources. Groundwater is also susceptible to pollution through practices such as poorly designed onsite sanitation facilities and intensive stock farming that result in high nitrate levels. The KAZA TFCA is also experiencing increasing threats from industrial development, commercial fish farms, and mining activities. While groundwater is less vulnerable to pollution than surface water, once polluted, remediation is costly and difficult. As such, strengthening management frameworks, where pollution to aquifers and groundwater can be controlled is vital. Managing groundwater withdrawals are critical to sustainable aquifer yields. When abstraction rates surpass the level of recharge this may be detrimental to the future production of those aquifers. Establishing sustainable abstraction rates curbs excessive drawdown and protects aquifer productivity.

3. FUNDAMENTALS OF TRANSFRONTIER GROUNDWATER MANAGEMENT

3.1 Transboundary Aquifer Protection

Shared resources including transboundary aquifers require collaborative efforts to manage. The Nata Karoo aquifer – is one of several TBAs identified within the KAZA landscape. While there is limited knowledge on its full extent and groundwater capacity, protecting it from pollution and overexploitation is a priority. Clear land use planning at the local level is one such strategy for aquifer protection that helps prevent pollution. Groundwater and land use are thus closely connected as particular land uses may result in the pollution of aquifers in cases of proximity to the surface (Riemann et al., 2012). Establishing clear parameters for aquifer protection across the five countries sustains the resource in the long term.

3.1.1 Groundwater recharge and discharge

Aquifer recharge and discharge impact how groundwater can be used sustainably. For example, depleting groundwater storage may result in degraded GDEs, high pumping costs, and energy consumption, increasing the cost of drilling for deeper wells, thereby excluding the poor from accessing the resource. Managed aquifer recharge – the deliberate recharge of aquifers - is one strategy used to artificially increase the amount of available groundwater. It is especially beneficial in arid and semi-arid conditions for storing variable surface water runoff and provides an adaptation measure against climate change impacts (Ebrahim et al., 2020). Further, pockets of high salinity identified in the KAZA TFCA may benefit from managed aquifer recharge through dilution.

3.1.2 Groundwater quality management

Generating knowledge on the aquifer and the type of pollution are essential management actions. Without the data to respond to pollution challenges, it is difficult to determine the extent of pollution and the required resources for rehabilitation. The general custom that groundwater is a free-access resource often complicates implementation of policy strategies (FAO, 2016). Further, groundwater quality can be both of natural origin and human-induced and, as such requires different management approaches. The KAZA already experiences high salinity and iron and arsenic are identified as contaminants of concern in parts of the TFCA[1].

3.2 Joint Groundwater Monitoring, Assessment, and Data management

Monitoring groundwater is one of the key areas of focus in terms of understanding the resource and ensuring sustainable use. A lack of data has been one of the main challenges in managing groundwater utilization, demanding more concerted efforts towards data generation and applying the data to inform decisions about the resource. Sound policy decisions require sound data. In this regard, generating data (e.g. groundwater level and borehole registration data), for example, by park management officials in collaboration with basin organization technical committees may serve to provide the required baseline information. The lack of adequate information on boreholes and dams negatively impacts strategic planning for water resources and weakens efforts to regulate groundwater development. Joint monitoring efforts supported by appropriate data sharing agreements can support developing a common understanding on shared resources and foster sustainable use.

3.3 Supporting Institutional Arrangements

Cascading global, regional, and national policies into groundwater management in TFCAs requires a

[1] Cf. KAZA-GROW Groundwater Quality Report

clear and coherent policy and institutional framework to enable sustainable use. Given the multiplicity of actors and mandates, such coordination will occur at various scales. A thorough understanding of the landscape facilitates this coordination and allows for synergies to be leveraged. Section 4 offers more insights into how this coordination can potentially be achieved.

4. GLOBAL, REGIONAL AND TRANSBOUNDARY LEGISLATION AND INSTITUTIONS

The KAZA TFCA is a rich natural resource landscape. As a result, several global, regional, and transboundary frameworks apply – for water, biodiversity, and wildlife. Enhanced coordination is a key priority where oversight of the same resource may fall within the mandate and scope of multiple frameworks. Although there are numerous represented interests in the KAZA TFCA, common challenges such as climate change require consolidated and collaborative efforts. To tap into the potential for groundwater to alleviate climate impacts for people and wildlife, clear mechanisms for cooperation and collaboration are critical.

4.1 Global Conventions

Increased focus on and use of groundwater makes it imperative that it receives policy focus for strengthening policy and legal and institutional frameworks. At the global scale, key directives with an implication on groundwater, include the Ramsar Convention on Wetlands, the 1992 Water Convention, and the 1997 Watercourses Convention.

4.1.1 The Ramsar Convention on Wetlands

There are a number of prominent Ramsar Sites within the KAZA TFCA dependent on surface and groundwater flows (e.g. the Busanga Swamps, Okavango-Bwabwata Wetland, Okavango Delta System and the Victoria Falls National Park). These ecosystems provide habitat for diverse wildlife species and are a source of multiple ecosystem goods and services. Further, all partner countries in the KAZA TFCA are party to the Ramsar Convention and therefore familiar with its principles. Identification of potential (transboundary) Ramsar sites as well as critical approaches to their long-term management is essential in harmonizing transboundary water management and conservation efforts. The Ramsar broad definition[2] of wetlands includes rivers and lakes presenting overlaps with management frameworks for rivers, aquifers, and wetlands. The Ramsar Convention, therefore, works closely with other international conventions such as the Convention on Biological Diversity and 1992Water Convention, to explore and strengthen synergies. Similarly, the Ramsar Convention is involved with basin organizations such as the Zambezi Basin (e.g., on the Barotse Floodplain, Kafue Flats, and the Zambezi Delta) and Okavango on the Okavango Delta although there is no formal agreement between the basin organizations and the Ramsar Secretariat.

Ramsar Convention implementation mechanisms are fairly mature and advanced in the region. The Convention has developed supporting guidelines on groundwater management[3] and integrating wetlands into river basin management through conjunctive surface and groundwater use[4]. Designating appropriate Ramsar sites in the KAZA TFCA can ensure protection of critical ecosystems (e.g. for groundwater recharge).

[2] Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters (Ramsar Convention - https://www.ramsar.org/sites/default/files/documents/library/info2007-01-e.pdf)

[3] Ramsar Handbook 9, 3rd edition

[4] Resolution X.19

4.1.2 The 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention)

The 1992 Water Convention embraces the ecosystem approach to transboundary cooperation going beyond the development and uses towards ecosystem protection based on the interconnectedness of the natural system (UNECE 1993; Wehling 2020). In 2014, guidelines on the management of transboundary groundwater were developed under the Convention – *Model Provisions on Transboundary Groundwaters.* Nine provisions are presented as important for transboundary groundwater development and management (UNECE, 2014). These are:

- Reasonable and equitable use and no significant harm principles.
- Sustainable management, use and preservation of groundwater-dependent ecosystems.
- Cooperate on the common identification, delineation, and characterization of groundwater.
- Cooperate on the integrated management of transboundary groundwaters and surface waters
- Appropriate measures to control, prevent and reduce pollution.
- Data and information exchange.
- Establish and implement joint or coordinated plans for transboundary groundwater management
- Environmental Impact Assessment on planned activities.
- Establish a joint body to coordinate cooperation on the nine provisions of the Convention.

While none of the KAZA TFCA partner states are party to the 1992 Water Convention, Namibia has shown interest in ascending[5]. With the future in mind, it is worthwhile to integrate these provisions into existing frameworks where appropriate. The importance of the conjunctive management of surface and groundwater is even more imperative given the strong interdependencies observed in the KAZA TFCA (i.e. in the Kwando River System[6]).

4.1.3 The 1997 Convention on the Law of the Non-Navigational Uses of International Watercourses (Watercourses Convention)

The 1997 Watercourses Convention defines a watercourse as "a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus". The Convention considers groundwater in as far as it contributes to surface water flows. Groundwater is therefore not further addressed outside of this inclusive definition. The SADC Protocol on Shared Watercourses is based on this global instrument and reflects its provisions[7]. Consequently, the Agreement on the Establishment of the Zambezi Watercourse Commission also adopts a similar interpretation of the watercourse through its ratification of the SADC Protocol and the UN Watercourses Convention. The Agreement on the establishment of the Permanent Okavango River Basin Water Commission (OKACOM) does not make reference to groundwater within its provisions. However, OKACOM is currently in the process of reviewing the 1994 OKACOM Agreement to be in line with global best practice trends[8] and have undertaken extensive groundwater assessment studies in the basin.

4.2 Pertinent Regional Institutions

Currently, groundwater management at regional level is gaining attention through several interventions at regional (SADC) and basin level (ZAMCOM/OKACOM). There is scope for further integrating

[5] https://unece.org/media/news/368642
[6] Cf. Hotspots for KAZA-GROW Groundwater Water Quality Report
[7] https://www.unwatercoursesconvention.org/documents/UNWC-Fact-Sheet-13-Relationship-with-SADC-Revised-Protocol.pdf
[8] https://www.okacom.org/review-okacom-agreement-nears-finalisation

groundwater management within TFCA operations through the KAZA TFCA Secretariat and SADC TFCA Network. Table 1 summarizes global and regional legislation, structures, their resource focus and implementing agencies.

4.2.1 Zambezi Watercourse Commission and the Permanent Okavango River Basin Water Commission

The SADC Protocol on Shared Watercourses is based on the fundamentals of the 1997 Watercourses Convention and cascades into several RBO agreements in the region. There are currently no supporting guidelines or mechanisms for groundwater specifically. However, given the unique challenges of monitoring and managing groundwater, supporting guidance at this level is warranted. Developing supporting mechanisms for groundwater at the SADC level will filter into basin organizations (i.e. ZAMCOM and OKACOM), and national policies and strengthen the integrated management of groundwater and surface water conjunctively.

At SADC level - A supporting groundwater or conjunctive management instrument that accounts for specific groundwater characteristics, calling for better land use management, the application of the precautionary principle, strong local engagement, and adaptive long-term conjunctive management of surface and groundwater resources

4.2.2 KAZA Secretariat

The KAZA TFCA Treaty was signed in 2011 and establishes the KAZA TFCA Secretariat. Article 9 of the Treaty further articulates the specific role of SADC for the KAZA TFCA as a custodian of frameworks that support the sustainable utilization of natural resources. SADC thus ensures that the KAZA TFCA activities are aligned with SADC provisions for regional integration, harmonization, resource conservation, poverty alleviation, and community empowerment, as well as facilitating technical and financial assistance to support development programs. More concrete groundwater management actions can be integrated in the integrated planning process of the KAZA TFCA.

4.2.3 SADC TFCA Network

The SADC TFCA program was established to coordinate the development of TFCAs across the SADC region. Its key objectives are to (i) Promote political will in support of the development of TFCAs (ii) - Support the harmonization of policy and legal frameworks for TFCA management; and (iii) Promote cross-sectoral dialogue on TFCA developments at national and regional levels. Through this program, guidelines are developed for TFCA development. A TFCA Network of SADC member countries was formed to share information and knowledge and to provide guidelines for developing TFCAs. The network is a multi-stakeholder platform with various actors, including NGOs and community members. This network holds the potential for raising awareness of the role of groundwater management within TFCAs.

4.2.4 SADC Groundwater Management Institute

In response to the growing challenges in the southern Africa region due to water scarcity and climate change, the SADC Groundwater Management Institute was established with the key objectives of fostering sustainable groundwater management. The Institute is at the forefront of supporting countries with understanding, developing, and managing their groundwater resources through leading activities in groundwater policy harmonization, knowledge sharing, and infrastructure development.

Table 1: Global, regional and transboundary frameworks related to freshwater ecosystems in the KAZA TFCA

Global and regional frameworks	Implementing structures	Resource focus	Supporting mechanisms[9]	Scope
Ramsar Convention	National government focal points	Wetlands, rivers, and lakes including transboundary Ramsar sites	Groundwater guidelines	Ramsar designated sites - protected sites with legal status
UN Watercourses Convention/ UNECE Water Convention	River Basin Organizations (Member States)	Transboundary surface water and linked groundwater systems	Working groups of the 1992 Water Convention including the Model Provisions on Transboundary Groundwaters	Transboundary river basins
Protocol on Wildlife Conservation and Law Enforcement	SADC Secretariat (Member States)	Wildlife	SADC TFCA Programme SADC TFCA Network	TFCAs
SADC Revised Protocol on Shared Watercourses	River Basin Organizations	Transboundary surface and linked groundwater systems	RBOs	Transboundary river basins
2004 Agreement on the Establishment of the Zambezi Watercourse Commission	ZAMCOM (Member States)	Transboundary linked surface and groundwater systems	Technical Sub-Committee on Hydrology[10] under the Zambezi Watercourse Commission Technical Committee (ZAMTEC), Basin-wide Stakeholders Coordination Committee, National Stakeholders Coordination Committees.	Zambezi River Basin and associated groundwaters
1994 Permanent Okavango River Basin Water Commission	OKACOM (Member States)	Transboundary surface water system	Hydrology Technical Taskforce Groundwater assessment studies	Okavango River System
KAZA TFCA 2011 Treaty	KAZA TFCA Secretariat (Member States)	Wildlife, natural resources	Working groups, e.g. Freshwater Working Group under the Conservation Working Group	Transfrontier conservation area

[9] Mechanisms refer to platforms, guidelines and strategies etc.

[10] A groundwater committee is to be established under the ZAMTEC

4.3 Platforms for Integrated Implementation of the TGMF

Integrating the various institutional mandates in the KAZA TFCA requires platforms that enable integrated management, coordinated efforts and knowledge sharing. Several mechanisms are already established at the different operational scales in the KAZA. However, there is scope for further enhancement and integration across scales as proposed in the following sections and illustrated in Figure 2.

4.3.1 Memoranda of Understanding

A tripartite mechanism that brings together transboundary basin management (ZAMCOM/OKACOM) and conservation (Ramsar and KAZA TFCA Secretariat) towards the protection of important ecosystems for aquifer protection.

Currently, there is a Memorandum of Understanding between the KAZA TFCA Secretariat and OKACOM to strengthen synergies and build cooperation in areas of overlap between the two organizations. A similar mechanism of cooperation between the KAZA TFCA Secretariat and ZAMCOM is underway. However, a working arrangement with the Ramsar Convention will further strengthen the representation of the ecological considerations in the KAZA having direct implications for groundwater management. This proposed tripartite arrangement will allow for consolidated identification of transboundary Ramsar sites.

4.3.2 Working groups and technical committees

Several working groups currently operate under the KAZA TFCA Secretariat such as the newly formed Freshwater Working Group, which falls under the Conservation Working Group. Similar structures also exist in ZAMCOM, i.e. the ZAMCOM Technical Committee. This committee has a Technical sub-Committee on Hydrology and a proposed Groundwater Committee. Coordination at this level will better serve to consolidate transboundary efforts on groundwater management and development, for example through data sharing arrangements.

4.3.3 Multi-stakeholder platforms

Under ZAMCOM, multi-stakeholder platforms such as the Basin-wide Stakeholders Coordination Committee (BASC), and National Stakeholders Coordination Committees (NASC) serve the purpose of bringing together multiple interests toward the integrated management of shared waters. A clear link between the level and that of the working groups needs to be established. At this level, it is essential to strengthen pre-existing structures such as the Kwando Joint Action Group (KJAG) and to incorporate groundwater technical committees from the river basin organizations. Such structures will incentivize stakeholders to abide by the principles of international best practices for multi-country water cooperation, while potentially facilitating formal cooperation (e.g. through a treaty, agreement, or other) in the long term.

4.3.4 National level mechanisms

At the country level, several mechanisms can be leveraged to improve groundwater management, such as Ramsar national focal persons, TFCA national coordinators, and groundwater personnel. Park management plans have the potential to integrate freshwater management, including groundwater, with conservation management (see Figure 2). Focus on the provisioning ability of groundwater can be integrated within park management plans to a greater extent than is currently observed. Issues that can be addressed at this level include local assessment of the resource potential, monitoring of groundwater abstraction, levels, and quality, and analysis of how groundwater can support conservation activities and mitigate against climate variability impacts. Furthermore, hydrogeological studies should be undertaken to identify and map the underlying aquifers, their connectedness with

surface water resources in recharge and discharge areas, and the groundwater-dependent ecosystems (GDEs) they support within the national parks.

4.3.5 Community level forums

While CBNRM has brought about variable levels of success across the KAZA TFCA Partner States, the approach is promoted in regional and national policies. With this realization, it is important to integrate groundwater considerations into CBNRM frameworks by highlighting management actions that protect groundwater from pollution and over abstraction (see Figure 2). Ultimately this serves to benefit both communities and wildlife for food and water security.

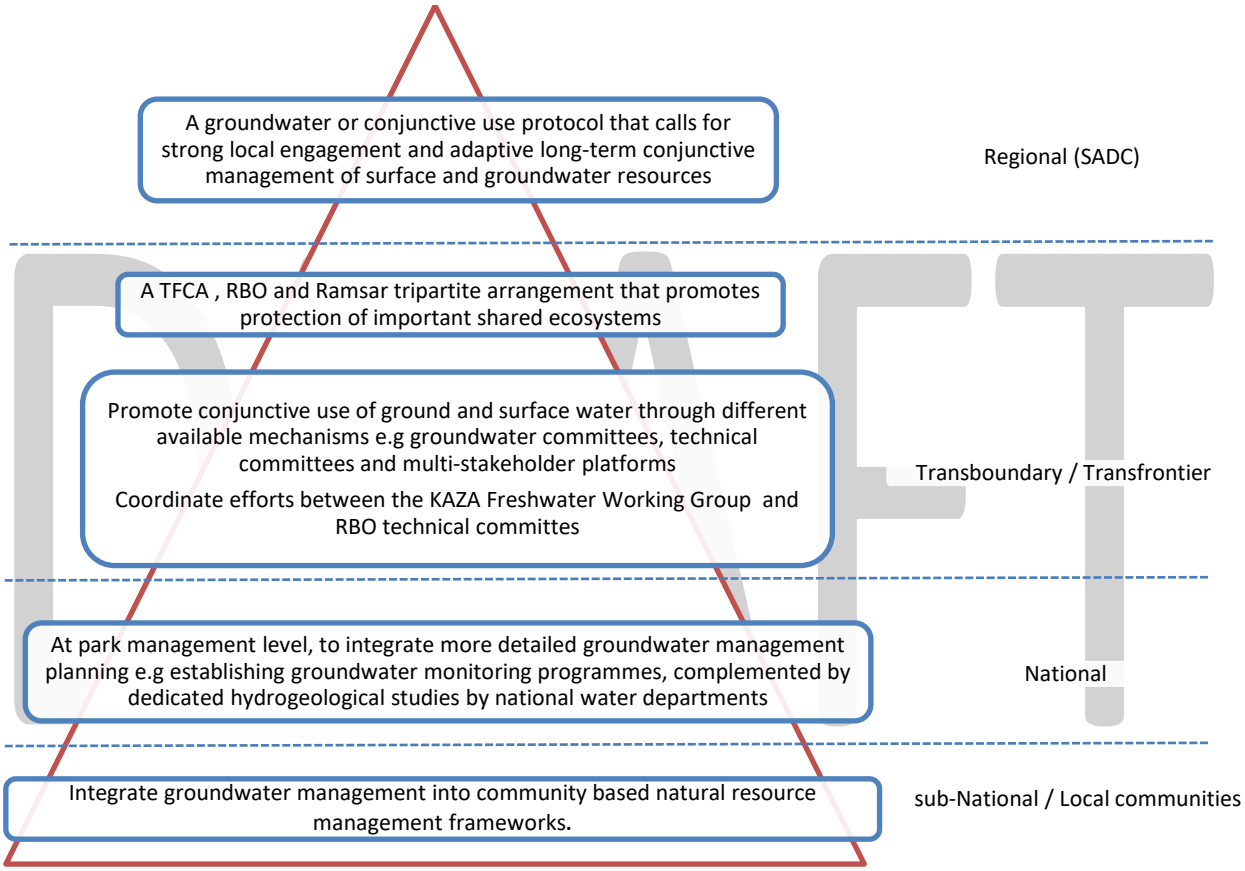


Figure 2: Proposed integration of groundwater management across scale

4.4 Operationalizing the Framework

The unique nature of the KAZA TFCA landscape is the presence of several institutional mandates operating at various scales. At the trans-national level – River Basin Organizations, specifically ZAMCOM and OKACOM and the KAZA Secretariat have oversight over water resources and wildlife conservation, respectively. Implementing this framework, therefore, requires coordinated efforts toward the common goal of sustainable use and management of groundwater. Without adequate coordination, there is risk of collision in mandates and, without clear guidance, may result in duplication of effort and lack of accountability. A co-custodianship of this framework would ensure the interests of the various actors are represented and that the framework is operationalized collaboratively.

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