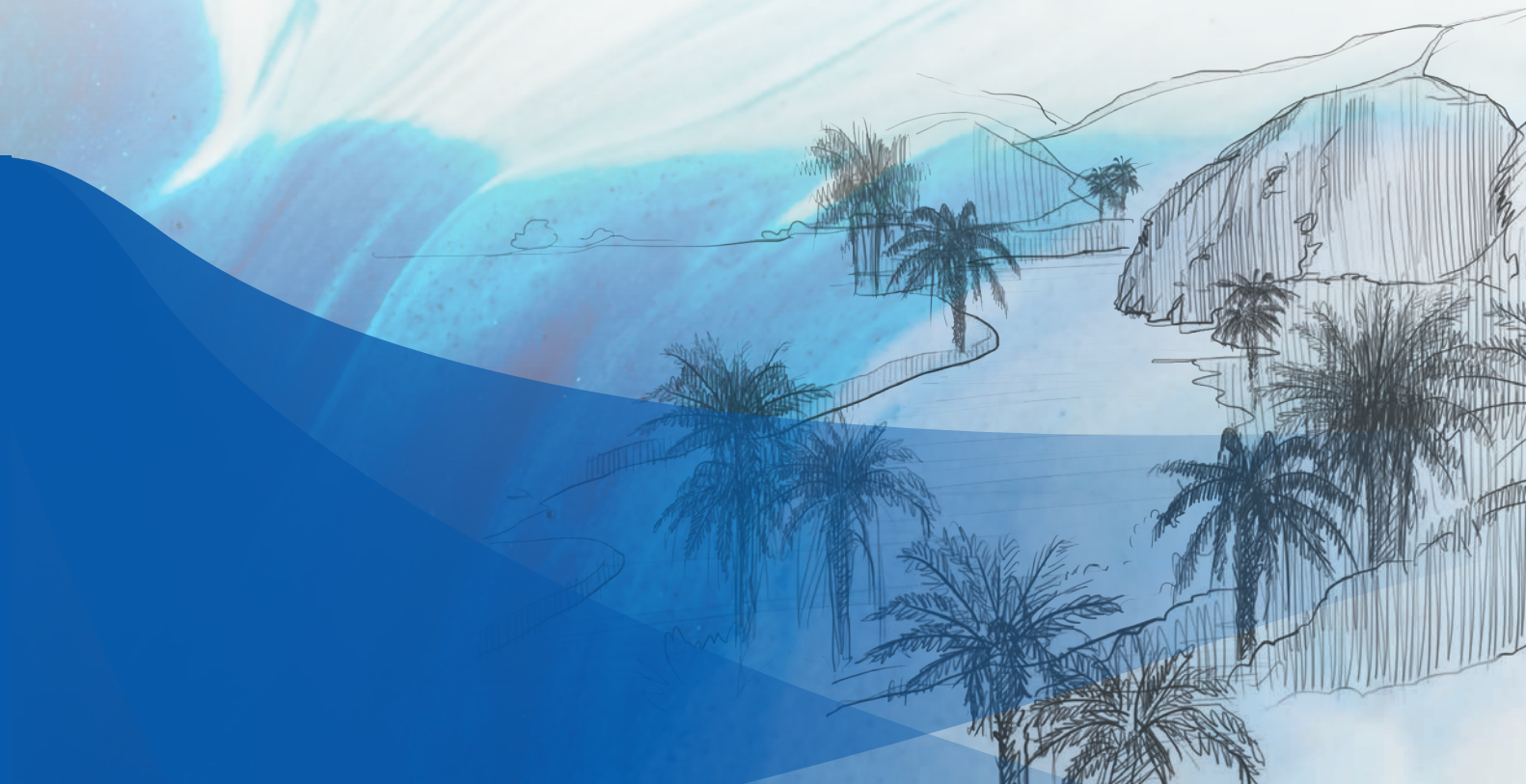




SAHARA  
AND SAHEL  
OBSERVATORY

# Coordinated management of shared groundwater in Africa

## Challenges and opportunities



Sahara and Sahel Observatory - OSS

**Coordinated management  
of shared groundwater in Africa**  
Challenges and opportunities

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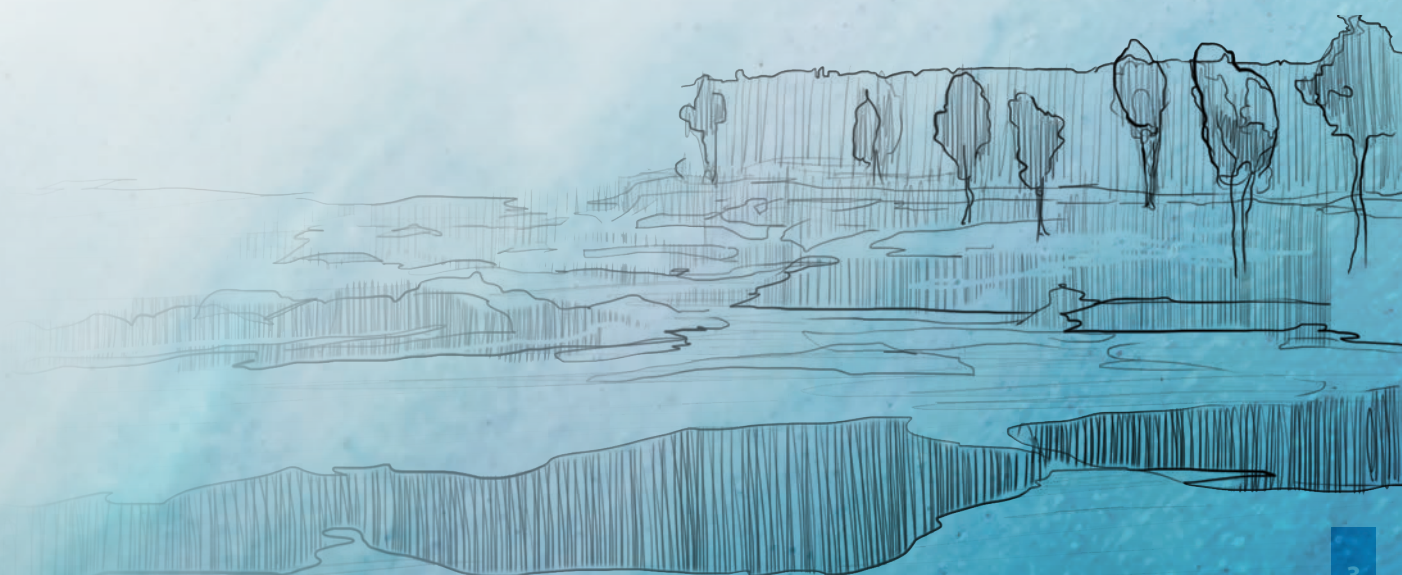
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## SUMMARY

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Water is essential to life on Earth. Representing around 99% of all liquid freshwater on Earth, groundwater contributes half of the volume of water withdrawn for domestic use, and is indispensable for agricultural production and industrial activities.

Many aquifers bypass international borders, and their study and management require the establishment of mechanisms for cooperation between the States, and adequate funding instruments to develop sustainable models of governance that meet current needs while preserving these resources for the future.

There are currently 468 transboundary aquifer systems listed worldwide. With increasing dependence on groundwater, withdrawals from shared aquifers will also increase. With some 106 transboundary aquifers identified in Africa, there is a need to implement regional cooperation strategies. Many African countries are already facing problems of overexploitation and contamination of surface and groundwater resources at national level. Appropriate management and governance programs therefore need to be drawn up. These management plans must take into account the impacts of climate change, population growth and urbanization.

In Africa, several projects have been developed through multilateral cooperation. These include projects to study and manage the Stampriet aquifer, the North Western Sahara Aquifer System (NWSAS), the Iullemeden Taoudeni/Tanezrouft Aquifer System (ITTAS) and the Ramotswa aquifer. The lessons learned from these projects underline the importance of establishing an effective dialogue between the governments and the various users, sharing knowledge and putting in place solid legal and institutional frameworks.

The Sahara and Sahel Observatory (OSS) plays a key role in facilitating knowledge and promoting inter-state dialogue, both of which are essential to establishing shared management. Transboundary groundwater conflicts are currently limited, but could intensify in the future. Since the cost of inaction can be high, it is essential to develop technical and diplomatic cooperation practices. However, in Africa, very few transboundary aquifers have been the subject of detailed studies, and formal cooperation remains limited. Strengthening these efforts is vital for the development and stability of the region, ensuring equitable access to water resources and protecting the environment for present and future generations.

# 1. INTRODUCTION



Water resources are extremely important in supporting life on Earth, especially for ecosystems, agriculture, industry and domestic needs. However, this vital resource faces numerous environmental, social and economic challenges, which are amplified by the impacts of climate change on its availability and quality (Kundzewicz et al., 2008).

Although less visible than surface water, groundwater helps maintain river flows, ensures the sustainability of ecosystems, and offers protection against the effects of climate variability and change (IGRAC, WMO and UNESCO, 2021).

Like international rivers, there are no interstate boundaries to aquifers. The latest studies carried out by UNESCO have identified 468 transboundary aquifers worldwide, 106 of which are found in Africa (IGRAC, WMO and UNESCO, 2021). Cooperation between the States is necessary, as activities carried out in one country can have significant repercussions on the other side of the border, influencing the quantity and quality of groundwater and potentially altering the direction of its flow (ONU, 2022).

Managing transboundary aquifers often requires strong institutional will and sufficient resources. Collecting and sharing data is fundamental to establishing a reliable conceptual model of the aquifer, an essential element in drawing up effective management plans (UN, 2022).

Faced with increasing water stress, ineffective management of transboundary water resources can cause social tensions and trigger conflicts. Thus, the adoption of a supranational and integrated approach to the management of transboundary water resources is essential to balance the needs of the populations and the environment to face climate change and population growth (UN-Water, 2023) and prevent political tensions between the nations.

## 2. WATER RESOURCES IN AFRICA

The Earth has substantial water resources, in many forms and different qualities, in various stocks and flows of the hydrological cycle. 70% of the planet is covered with water with an estimated stock of around 1.4 billion km<sup>3</sup> of water (nearly 97%) is salt water in the oceans and a limited volume of fresh water estimated at approximately 35 million km<sup>3</sup> (2.53%) (Gleick & Palaniappan, 2010). Table 1 shows the distribution of the main components of global water.

	Volume (10 <sup>3</sup> km <sup>3</sup> )	Total water percentage (%)	Fresh water percentage (%)
Total water	1.386.000	100	-
Total fresh water	35.000	2.5253	100
World Oceans	1.340.000	96.6811	-
Groundwater (salt)	13.000	0.9380	-
Groundwater (fresh)	10.500	0.7576	30
Glaciers	24.365	1.7579	69.6
Saline lakes	85.4	0.0062	-
Freshwater lakes	91.0	0.0066	0.3
Soil moisture	16.50	0.0012	0.05
Peatlands	11.50	0.0008	0.03
Rivers (medium flow)	2.12	0.0002	0.006
In biological matter	1.12	0.0001	0.003
In the atmosphere (on average)	12.9	0.0009	0.04

Table 1. Distribution of the planet's water resources (Source : Gleick & Palaniappan, 2010)

Despite being home to approximately 17% of the world's population (UN, 2022), Africa has only 9% of the planet's renewable freshwater resources. It is the second driest continent in the world after Australia. Arid and semi-arid zones cover about two-thirds of the continent. Compared to the rest of the world, Africa has great variability in its rainfall patterns. On average, Africa receives around 700 to 1200 mm of rainfall per year, with significant variations depending on the geographical area. This situation highlights the challenges facing the continent in terms of access to drinking water.

Some 64% of the African continent's surface area is located in transboundary watersheds (CEA, 2021). Transboundary watersheds include rivers and lakes of vital importance to populations and ecosystems. The central region of the continent is the best endowed with surface water resources, amounting to 48% of the resources (for only 18% of the continent's surface area). The countries of the Gulf of Guinea hold 24% of the continent's water potential. In contrast, the North African sub-region, which covers 19% of the continent's total surface area, is the most disadvantaged, having less than 1% of renewable resources (Figure 1).

The continent is also home to nearly 106 identified aquifers (IGRAC, UNECE and UNESCO, 2021) with 0.66 million km<sup>3</sup> of groundwater, representing more than 100 times the annual renewable fresh water resources stored in dams and rivers and 20 times the fresh water stored in African lakes (Seguin & Gutierrez, 2008).



Figure 1. Fluvio-lacustrine basins (Data source: FAO-Aquastat, 2002)



Figure 2. Shared aquifers





## 2.1. NORTH AFRICA

North Africa, identified as a “climate change hotspot” (Waha et al., 2017), is characterized by a great geographic and climate diversity, dominated by the vast Sahara, the largest hot desert in the world. The region benefits from a hybrid climate at the crossroads of tropical and temperate zones, presenting significant seasonal variations.

Surface water resources, namely the Nile and other rivers such as Oued Tensift, Oued Cheliff and the Medjerda River, are vital to the region. The Nile is the longest river in the world, stretching over approximately 6,850 km, with an average flow of approximately 2,664 m<sup>3</sup>/s at its mouth (UNEP, 2000). Nevertheless, water security of North Africa relies on the groundwater of the aquifers mostly shared by several countries. These groundwater resources play a crucial role for food security and are at the heart of the region’s sustainable development challenges. Table 2 presents the main aquifers in the region.

N°	Name of the aquifer	Countries	Area (KM <sup>2</sup> )	Reserves (Billions of m <sup>3</sup> )
1	Nubian Sandstone Aquifer System	Egypt, Libya, Sudan, Chad	2 000 000	457 570
2	North Western Sahara Aquifer System (NWSAS)	Algeria, Libya, Tunisia	1 000 000	60 000
3	Mourzouk Aquifer	Algeria, Libya, Niger	450 000	4 800
4	Tindouf Aquifer System (TAS)	Algeria, Morocco, Mauritania	221 019	800
5	Djeffara Aquifer System	Libya, Tunisia	43 000	170

Table 2. Main shared aquifers of North Africa  
(Source : OSS, 2003 & 2017 ; UNESCO et al., 2005 in OSS, 2020 ; UNEP , 2010)

## 2.2. WEST AFRICA

West Africa has very diverse landscapes and climates, ranging from dense, humid forests near the equator to the arid expanses of the Sahel (Sylla et al., 2016). The climate is mainly influenced by the monsoons, which bring crucial rains for agriculture that generally fall between June and September in the northern regions, and distributed over two seasons in the wetter areas of the south (Dieng et al., 2018).

Rainfall significantly influences water resources. The region relies on major river systems such as the basins of the Niger rivers (4,200 km, 5,280 m<sup>3</sup>/s), Senegal (1,800 km, 500 m<sup>3</sup>/s), the Volta, the Gambia and Lake Chad (17,000 km ). However, these water resources are under increasing pressure due to climate variability and the impacts of climate change, exacerbating the risks of drought and water scarcity (Di Baldassarre et al., 2013). Groundwater is emerging as a vital alternative water source for many parts of West Africa (MacDonald et al., 2012).

N°	Name of the aquifer	Countries	Area (KM <sup>2</sup> )	Reserves (Billions of m <sup>3</sup> )
1	Iullemeden-Taoudéni/Tanezrouft Aquifer (ITTAS)	Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger, Nigeria	2 500 000	15 000
2	Aquifer of the Lake Chad Basin	Algeria, Cameroon, Central African Republic, Libya, Niger, Nigeria, Chad	1 900 000	5 800
3	Senegalese-Mauritanian Aquifer System	The Gambia, Guinea-Bissau, Mauritania, Senegal	300 000	1 500
4	Volta Basin	Benin, Burkina Faso, Ghana, Niger, Togo	130 000	

Table 3. Main shared aquifers of West Africa  
(Sources : OSS, 2012 & 2023 ; UNESCO et al., 2005 in OSS, 2020)

## 2.3. CENTRAL AFRICA

Located in the heart of the African continent, Central Africa is distinguished by a diversity of landscapes, including dense forests, savannahs, plateaus, and important hydrographic basins. This region enjoys an equatorial and tropical climate, characterized by high temperatures and abundant rainfall distributed over nine months per year.

The region has abundant surface water resources thanks to its numerous rivers and lakes. The 4,670 km long Congo River, with its flow rate of 40,000 m<sup>3</sup>/s (Laraque et al., 2001), is the second longest river in Africa and the second most important in the world after the Amazon. Lakes such as Lake Chad (17,800 km<sup>2</sup>), Lake Kivu (2,700 km<sup>2</sup>) and Lake Tanganyika (32,900 km<sup>2</sup>) are also important water sources for the region. In addition to surface water resources, Central Africa also has significant groundwater resources (MacDonald et al., 2012). Underground aquifers are a reliable source of water for rural and urban communities, especially during periods of drought and water stress (Table 4).

N°	Name of the aquifer	Countries	Area (KM <sup>3</sup> )
1	Karoo-Carbonate Aquifer	Central African Republic, Democratic Republic of Congo, South Sudan	941 100
2	Bénoué Valley Aquifer	Cameroon, Nigeria	219 001
3	Central Cuvette of the Congo	Congo, DRC	3 700 000
4	Tanganyika Aquifers	DRC, Burundi, Uganda, Rwanda, Tanzania	-

Table 4. Main shared aquifers of Central Africa  
(Source : OSS, 2003 & 2017 ; UNESCO et al., 2005 in OSS, 2020 ; UNEP, 2010)

## 2.4. EAST AFRICA

East Africa is characterized by a great diversity of landscapes, ranging from the coasts of the Indian Ocean to high plateaus and vast savannahs. The climate varies between coastal areas, where it is generally hot and humid, and the highlands, where it is cooler and drier. The region is also subject to seasonal weather phenomena, such as monsoons and droughts.

The region benefits from an abundant diversity of surface water resources including major rivers such as the Nile, Zambezi River (2,700 km, 5,000 m<sup>3</sup>/s); and the great lakes, namely Lake Tanganyika (32,000 km<sup>2</sup>) and Lake Malawi (30,900 km<sup>2</sup>). These water resources are crucial for irrigation and drinking water supply. However, these surface water resources are threatened by overexploitation, pollution and the impacts of climate change. In this context, groundwater resources represent an important water source for the socio-economic development of the region.

N°	Name of the aquifer	Countries	Area (KM <sup>3</sup> )
1	Al Sudd Basin Aquifer (Bahr al Jabal)	Ethiopia, Kenya, South Sudan	370 648
2	Baggara Basin	CAR, South Sudan, Sudan	213 600
3	Afar Rift Valley Aquifer/Afar Triangle	Djibouti, Eritrea, Ethiopia	51 000
4	Rift Aquifer	Democratic Republic of Congo, Uganda, South Sudan	44 632
5	Dawa Aquifer	Ethiopia, Kenya, Somalia	31 000
6	Ogaden-Juba Aquifer	Ethiopia, Somalia	31 000
7	Sabelle Aquifer	Ethiopia, Somalia	30 985
8	Kilimanjaro Aquifer	Kenya, Tanzania	14 579
9	Merti Aquifer	Kenya, Somalia	12 000

Table 5. Main aquifers of East Africa  
(Sources : OSS, 2012 & 2023 ; UNESCO et al., 2005 in OSS, 2020)

## 2.5. SOUTHERN AFRICA

Southern Africa is home to a great diversity of landscapes, ranging from high plateaus to deep valleys, and includes the renowned Rift Valley lakes. The region's climate ranges from the temperate climate of South Africa to the arid Namibia and Botswana, including the tropical climate of Mozambique and Zimbabwe. Like other sub-regions of Africa, it is impacted by climate change, which has significant effects on the environment and water resources.

Water resources are abundant, with numerous rivers, such as the Zambezi, Limpopo (1,750 km, 170 m<sup>3</sup>/s) and Orange (2,200 km, 365 m<sup>3</sup>/s), which cross the region and Lake Kariba, the largest artificial lake in the world with a 5580 km<sup>2</sup> area (Mensah et al., 2019). These are the main sources of fresh water for local communities. However, managing these resources is a significant challenge, due to population growth, urbanization, agriculture and industrialization. Droughts and floods are also major risks for the region. The groundwater resources of the aquifers then constitute an alternative and valuable source of water for this region (SADC, 2012).

N°	Name of the aquifer	Countries	Area (KM <sup>2</sup> )
1	Kalahari/Karoo Aquifer	Namibia, Botswana, South Africa	
2	Ramotswa Aquifer in the Limpopo Basin	Botswana, South Africa	135 500
3	Stampriet Aquifer	Namibia, South Africa	86 647

Table 6. Main aquifers of Southern Africa  
(Source : OSS, 2003 & 2017 ; UNESCO et al., 2005 in OSS, 2020 ; UNEP, 2010)



Shared aquifers in Africa are understudied, with only 11 of them having been extensively examined (Nijsten et al., 2018). This gap hampers regional cooperation and sustainable water management, as data on the potential and characteristics of these aquifers are often not available. It is therefore urgent to conduct extensive studies and make data available for all affected countries.

### 3. CHALLENGES OF TRANSBOUNDARY COOPERATION IN THE MANAGEMENT OF TRANSBOUNDARY AQUIFERS IN AFRICA

Groundwater represents a vital resource in Africa, where surface water resources are often unevenly distributed. According to the UN (2022), these groundwater resources are relatively abundant and present in almost all African countries. Transboundary aquifers are particularly important, covering 40% of the continental land area and supporting approximately 33% of the population, or approximately 381 million people (Nijsten et al., 2018).

These transboundary aquifers are highly important, particularly for arid regions of Africa. They play a crucial role in water security, sustainable development and environmental conservation. These aquifers provide a vital resource for agriculture, livestock, drinking water supply and other needs, particularly in regions where surface water sources are limited.

However, according to the UN-Water report (2021), the management of shared groundwater in Africa faces several major challenges depending on the area, including overexploitation, pollution and the risk of conflicts between users. This situation is aggravated by the very limited number of effective cooperation mechanisms for coordinated management of these essential resources. Similarly, pollution of transboundary aquifers, caused by agricultural, mining, industrial and domestic activities, also compromises water quality in Africa. Contaminants such as nitrates and industrial pollutants endanger the health of ecosystems and populations. Shared management and cooperative agreements between the countries are therefore necessary to establish environmental standards and practices that protect these vital resources from pollution.





**Sustainable management of these aquifers is essential to preserve ecosystems, biodiversity and the long-term health of natural habitats**

Tensions linked to water resources, exacerbated by climate change and population growth, could lead to conflicts if adequate management is not put in place. Transboundary cooperation, supported by agreements between the affected countries, is essential to ensure equitable and sustainable use of shared aquifers, while preventing water-related conflicts. Initiatives such as those of the Lake Chad Basin Commission and the Niger Basin Authority illustrate the importance of an integrated regional approach to groundwater management in Africa.

Sustainable management of these aquifers is essential to preserve ecosystems, biodiversity and the long-term health of natural habitats. Collaboration between the countries sharing these aquifers promotes transboundary dialogue, data sharing and joint research efforts, thereby contributing to peaceful relations and sustainable use of shared water resources (Nijsten et al., 2018). These cooperative efforts show the importance of coordinated management of transboundary aquifers for regional development and stability, highlighting the need for effective policies and governances to ensure equitable access to water resources and promote socio-economic development while protecting the environment for current and future generations (Nijsten, 2018).

Transboundary cooperation must therefore make it possible to broaden knowledge, strengthen the range of water-related risk mitigation measures, improve readiness and recovery operations in the event of drought and floods and to provide more profitable solutions (CEA, 2021).

## 4. PRINCIPLES OF COORDINATED MANAGEMENT OF GROUNDWATER RESOURCES

Coordinated management of groundwater resources refers to a set of sustainable management principles and practices.

These principles aim to ensure equitable and efficient use of groundwater, while protecting this important natural reservoir for future generations. Here are the key principles of coordinated management of groundwater resources:

### Stakeholder involvement and integrated management

Stakeholder involvement and integrated management are essential in transboundary groundwater management. It aims at involving relevant parties in decision-making processes, promoting transparency, identifying common interests and addressing challenges such as conflicting priorities. Integrated management coordinates actions across sectors and administrative levels to ensure sustainable use of groundwater, optimize resource allocation and improve ecosystem health. These approaches promote collaboration, inclusion and sustainability in the transboundary management of shared groundwater resources, resulting in mutually beneficial outcomes for all stakeholders (Knüppe and Pahl-Wostl, 2011).

### Sustainability, precaution and prevention of overexploitation

Managing transboundary groundwater requires a sustainable, prudent and cautious approach. To ensure equitable and efficient use of shared resources, it is essential to establish long-term objectives, adopt integrated and inclusive practices and actively involve local communities in the decision-making process. Additionally, regular monitoring and data sharing between riparian countries is essential to ensure sustainable practices. It is also crucial to assess potential risks and put in place preventative measures, such as the development of early warning systems and the adoption of adaptation strategies to face all forms of change. In order to avoid overexploitation, it is necessary to establish sustainable limits on extraction and put in place strong legal frameworks to effectively regulate the use of shared resources. (Gleeson et al., 2012).

## Knowledge and data

In the context of transboundary ground water management, the key to cooperation and sustainable decision-making lies in access to adequate knowledge and data. It is vital that stakeholders have a thorough understanding of how aquifer systems work and share information on flow patterns, water quality and recharge rates. Additionally, establishing continuous monitoring programs is essential to assess the health of the aquifer by monitoring water levels, extraction rates and water quality. Finally, it is crucial to promote transparent data sharing mechanisms to build trust and encourage collaboration in the management of transboundary aquifers (Sanz et al., 2016).

## Adaptive management

Adaptive management of transboundary groundwater involves a dynamic and iterative approach to decision-making. It relies on continuous monitoring, research and feedback mechanisms to adjust management strategies based on changing conditions and new information. This adaptive framework allows water managers to deal with uncertainties, prioritize ecological values and minimize risks associated with transboundary groundwater use activities. By integrating risk assessment and scientific research, adaptive management enables sustainable management of shared groundwater resources while taking into account the needs of the depending ecosystems (Rohde et al., 2017).

## Equity and accessibility

Equity and accessibility are crucial factors in transboundary groundwater management. Ensuring fair and equitable access to shared groundwater resources is essential for sustainable cooperation between the countries. Transboundary cooperation in groundwater management involves establishing mechanisms that promote equity, the inclusion and mutual benefit for all parties involved. By addressing issues of equity and accessibility, countries can foster cooperation and prevent conflict over shared groundwater sources (Earle & Neal, 2017).

## Good governance

Water governance is crucial for developing and implementing effective policies, involving shared responsibility between different levels of government, civil society, businesses and other key stakeholders. It is essential that water governance systems respond to specific challenges and focus on problem solving rather than formal institutional structures. Policies must be focused on tangible results and are based on three aspects of water governance (OECD, 2015): i) Trust and commitment: contributing to building public trust and ensuring the inclusion of stakeholders through democratic legitimacy and equity for society as a whole; ii) Effectiveness: determining clear objectives and setting goals for sustainable water policy at all levels of government and ensuring their implementation and the achievement of expected targets; iii) Efficiency: optimizing the benefits of sustainable water management and well-being at the lowest cost to society (OCDE, 2015).

## Legality and regulation

Transboundary groundwater management relies on strong legal and regulatory frameworks, which ensure effective cooperation and sustainable use of shared resources. These frameworks take into account several essential aspects: i) Legal and regulatory framework: establishing a clear legal framework defining the rights and responsibilities of the participating countries (Foster & Chilton, 2020); ii) Environmental and water quality standards: Compliance with environmental and water quality standards ensures the protection of shared water resources as well as the environment (Foster & Chilton, 2020); iii) Institutional responsibilities: the need for a clear division of the roles at the national and local level for successful implementation of groundwater management policies, including the regulations monitoring and enforcement (Foster & Chilton, 2020).

## 5. COOPERATION MECHANISMS AND INSTRUMENTS

Around 468 aquifer systems are shared by more than two States including 106 in Africa, corresponding to 60% of fresh water reserves (IGRAC, UNECE and UNESCO, 2021), and around two billion people depend on groundwater resources (UN-Water, 2024). Only 9 shared aquifer systems in the world, including 6 in Africa, are governed by an agreement/consultation framework (Nijsten et al., 2018) :

1. Genevois Aquifer (Switzerland, France) Agreement signed in 2007;
2. Guarani Aquifer (Argentina, Brazil, Paraguay, Uruguay) Agreement signed in 2010;
3. Iullemeden-Taoudeni/Tanezrouft Aquifer System - ITTAS (Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger and Nigeria) - MoU signed in 2014 by Benin, Mali, Niger and Nigeria;
4. Nubian Sandstone Aquifer System - NSAS (Egypt, Libya, Sudan, Chad) Agreement signed in 1997;
5. North Western Sahara Aquifer System (2008, Algeria, Libya, Tunisia);
6. Al-Disi aquifer (Saudi Arabia, Jordan) 2015 ;
7. Stampriet Aquifer (Botswana, Namibia, South Africa) 2017;
8. Ramotswa aquifer (Botswana, Mozambique, South Africa, Zambia) 2019;
9. Senegalese-Mauritanian aquifer system - SMAS (Gambia, Guinea, Mauritania, Senegal - 2021).



The different cooperation instruments can be legal frameworks or institutional mechanisms between the countries. They make it possible to ensure different missions and are agreed upon in different forms :

- Conventions (Geneva Aquifer)
- Agreements/MoU (Guarani, Disi, Ramotswa Aquifers; ITTAS; STAS)
- Ministerial declaration: (NWSAS; SMAS)
- Constitution of a common authority (NSAS)
- "Letter of intent for the creation of a future bilateral cooperation mechanism for sustainable management" (Ocatepeque-Citalá Aquifer - Trifinio region: Salvador, Honduras).



In order to ensure coordinated, equitable and sustainable management of transboundary aquifer systems, it is essential to have not only technical skills and adequate financial resources, but also a strong and constant political will from the States involved. Furthermore, the active participation of other stakeholders, such as non-state actors and international Organizations, is also essential to ensure the effective implementation of agreed management measures (Machard et al. 2010).

The aim of transboundary cooperation is to facilitate exchanges between the Nations involved in order to share experiences on the management of common resources, the challenges encountered, the potential risks and the measures taken to deal with them. International professional, scientific and academic Organizations, such as the International Association of Hydrogeologists, can play an extremely beneficial role in facilitating communication between experts from relevant countries (Machard et al., 2010).

Advances in research and the development of cutting-edge water management technologies, combined with the organization of regional forums to share knowledge and resolve all conflicts, strengthen transboundary cooperation. It is essential to establish an effective monitoring-evaluation mechanism to monitor progress and adjust water management policies according to changing needs. By adopting these approaches, Africa can ensure its water security and contribute to regional prosperity and peace, while meeting the challenges of climate change and population growth.

## 6. ADVANTAGES AND OPPORTUNITIES OF COORDINATED MANAGEMENT

Coordinated management is essential to put an end to the unreasonable exploitation of natural resources and promote their sustainability. This approach is based on the establishment of constant dialogue, mutual respect, partnership and the promotion of local knowledge between the different stakeholders. By encouraging the creation of local entities for community resources management, it offers an interesting avenue for understanding the process of developing and implementing territorial charters and local resources management conventions (Bechir et al., 2009).

Coordinated management of water resources offers various advantages and opportunities. First of all, it promotes cooperation between riparian countries, making it possible to resolve potential conflicts linked to the use of transboundary water resources (Guyomard, 2011). This collaboration strengthens international relations and contributes to regional stability by promoting constructive dialogue and mutually beneficial agreements.

Lucky for Africa, it has governance structures both at the continental level, with AMCOW, and at the sub-regional level, with the eight Regional Economic Communities (RECs) of the African Union namely:

- The Arab Maghreb Union (UMA)
- The Common Market for Eastern and Southern Africa (COMESA)
- The Community of Sahel-Saharan States (CEN-SAD)
- The East African Community (EAC)
- The Economic Community of Central African States (ECCAS)
- The Economic Community of West African States (ECOWAS)
- The Intergovernmental Authority on Development (IGAD)
- The Southern African Development Community (SADC)



In addition, the continent has around twenty working river and lake basin Organizations. AMCOW's engagement in the Continental Strategic Initiative on Groundwater through the African Groundwater Commission established in 2007 is critical for groundwater in Africa. The main river and lake basins have been identified as water management units. This presents a challenge for the management of transboundary aquifers underlying multiple river/lake basins, or transboundary aquifers located in areas not covered by international river or lake basin Organizations, such as NWSAS or NSAS.

In addition, coordinated management encourages transparency and the exchange of information between the relevant parties (Guyomard, 2011; Yahya, 2018). By sharing data on the availability of water resources, the needs of different regions and the impacts of human activities, the involved stakeholders can better understand the issues and collaborate more effectively for sustainable use of water resources.

This approach also promotes a holistic and integrated vision of water resources management (Yahya, 2018). By considering technical, social, economic and environmental aspects, it makes it possible to design more sustainable and resilient policies and strategies, better adapted to local and regional needs.

## 7. CASES AND GOOD PRACTICES IN AFRICA

### Stampriet Transboundary Aquifer System (STAS)

The Stampriet Transboundary Aquifer System (STAS), located in the Orange-Senqu River Basin, illustrates the effectiveness of international collaboration in groundwater management (UNESCO-IHP, 2016). Shared between Botswana, South Africa and Namibia, the STAS is led by a Multi-Country Cooperation Mechanism (MCCM) within the Orange-Senqu River Commission (ORASECOM), highlighting the importance of coordinated management of water resources.

This cooperation framework is strengthened by the Governance of Groundwater Resources in Transboundary Aquifers (GGRETA) project, led by UNESCO-IHP. It includes specialized country-based focal points, promoting coordinated and informed management of the aquifer. The STAS Strategic Action Plan, established in 2021, focuses on monitoring and effective sharing of hydrological data, key components for maintaining the sustainability of the aquifer and strengthening regional cooperation.

The success of STAS and its cooperation framework can trigger other transboundary initiatives, highlighting the need for collective action to face climate and sustainable development challenges.

### Senegalo-Mauritanian Aquifer System (SMAS)

The Senegalo-Mauritanian Aquifer System (SMAS), vital for The Gambia, Guinea-Bissau, Mauritania and Senegal, is at the heart of an unprecedented cooperation effort. Recognized for its crucial importance in supporting communities and ecosystems, SMAS is the subject of a transnational collaboration initiative, encouraged by the UNECE Water Convention and led since April 2020 by a regional taskforce. The latter marks the fulfilment of the collective will of the four nations, supported by influential regional institutions such as the OMVG, the OMVS and the OSS, with the facilitation of UNECE, Geneva Water Hub and IGRAC and marks a giant step towards integrated and sustainable management of this shared aquifer.

Thanks to the active participation of the Water Resources Departments of each country, this taskforce laid the foundations for sharing essential data and information, thus catalyzing a better understanding and coordinated management of the SMAS. In September 2021, a landmark declaration signed by the water ministers of the four countries officially committed the States to the creation of a legal and institutional framework dedicated to the sustainability of the aquifer.

## Nubian Sandstone Aquifer System (NSAS)

Discovered in the 1950s in Libya during oil exploration, the Nubian Sandstone Aquifer System (NSAS) is a water resource shared by Egypt, Libya, Sudan and Chad. This vast underground reserve is mainly used for irrigation, particularly in large agricultural projects in Libya and for traditional farms in Egyptian oases.

In order to monitor and manage the NSAS, the Center for Environment and Development for the Arab Region and Europe (CEDARE) developed the Nubian Aquifer Regional Information System (NARIS), a tool that provides detailed data on physical characteristics, the history of water levels and geological information of water points.

In order to achieve coordinated management, the four nations sharing this aquifer established in 1991 the «Joint Authority for the Study and Development of the Nubian Sandstone Aquifer System» in Tripoli. In 2013, a Strategic Action Plan was put in place to improve the management of the aquifer, with financial support from the Global Environment Facility (GEF) and technical support from the International Atomic Energy Agency (IAEA).

## North Western Sahara Aquifer System (NWSAS)

The North Western Sahara Aquifer System (NWSAS) is a critical reservoir of low-renewable groundwater shared between Algeria, Libya and Tunisia. This aquifer is managed thanks to the commitment of various national institutions, making the NWSAS a remarkable example of regional cooperation and transboundary data management.

Since 2008, the NWSAS Consultation Mechanism (CM) has led this collaboration through several bodies including the Ministerial Council, the Permanent Technical Committee, the Coordination Unit and various working groups. The Sahara and Sahel Observatory (OSS) temporarily hosted the Coordination Unit until June 2023, strengthening the commitment to integrated water resources management.

The “SAGESSE” platform, a key tool in this collaboration, fosters the exchange of crucial information for environmental monitoring, resource assessment, research and development, enabling the creation of thematic maps and sharing of analyzes essential for sustainable management of the aquifer.

The NWSAS initiative illustrates how transparency and cooperation can lead to effective groundwater management in a context of limited resources.

The NWSAS targets more than simple water management; it is a pillar of regional stability, sustainable development and transboundary cooperation. In a global context where water is often a source of tension, the NWSAS has become a sign of hope for peaceful and sustainable cooperation in the management of water resources.



## Iullemeden Taoudeni/Tanezrouft Aquifer System (2018-2025)

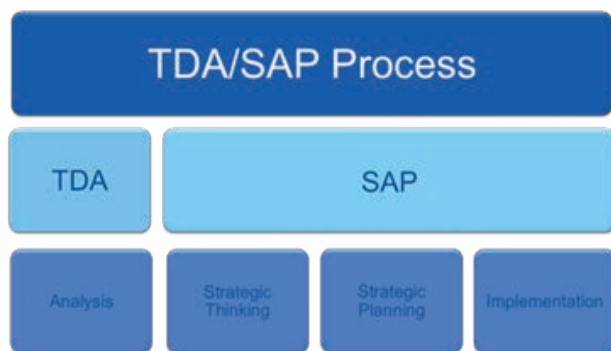
The Iullemeden-Taoudeni/Tanezrouft Aquifer System (ITTAS) covers seven African nations and is in hydraulic interaction with the Niger River watershed. The Transboundary Diagnostic Analysis (TDA) and the Strategic Action Program (SAP) are the first steps towards joint management based on transboundary cooperation, in accordance with existing legal standards (UNESCO, 2024).

Launched in 2012, the NB-ITTAS project aims to improve the management and governance of the ITTAS and the Niger River basin resources. It also promotes integrated water resources management (IWRM) to support local communities and increase the resilience of ecosystems to climate change. These efforts have made significant progress in understanding the interactions between surface and groundwater, leading to a more holistic and sustainable management approach.

Among the successes of the project, funded by the Global Environment Facility (GEF), are the development of a hydrogeological model, the implementation of Transboundary Diagnostic Analysis and technical training in hydrodynamic modeling, data management, geographic information systems (GIS) and remote sensing. A dedicated ITTAS website has been established to increase visibility and facilitate access to information, thereby encouraging knowledge sharing and collaboration between relevant countries.

### The GEF TDA/SAP process

The TDA/SAP approach is presented as follows:



More than 60 international water systems have benefited from the TDA/SAP process. Unfortunately, out of the 468 transboundary aquifer systems (including 106 located in Africa), there are only four (4) aquifer systems (including ITTAS) which have benefited from said process due to the invisible nature of groundwater. <https://iwlearn.net/documents/tda>; IW:LEARN | Documents - SAPs (iwlearn.net)

This initiative, supported by agencies such as NBA, OSS, UNIDO and UNESCO, illustrates the potential of international and regional cooperation in the transboundary management of water resources. It shows that collaboration and common commitment of the nations can lead to sustainable and beneficial solutions for all, transforming water into a vector of cooperation and shared prosperity.



## Ramotswa Aquifer and Limpopo Aquifer Basin

The Ramotswa Aquifer, shared between Botswana and South Africa, illustrates how cooperation and data exchange can improve groundwater management. Although data exchange has been irregular, projects supported by USAID and IWMI from 2015 to 2019 enabled the first joint assessment of this aquifer, resulting in the creation of the Ramotswa Information Management System (RIMS).

The 2020 Joint Strategic Action Plan (JSAP) and the efforts of the Limpopo Groundwater Committee (LGC) have reinforced the two countries' commitment to overcoming the challenges of transboundary water management, essential for areas like Gaborone.

The 2020 JSAP established a solid foundation for stronger policies and the necessary mobilization of human, technical and financial resources. To secure the future of groundwater management in areas like Ramotswa, increased transboundary cooperation and regular data sharing are crucial, requiring constant support and close collaboration between relevant countries and regional and international Organizations. Strengthening these efforts is vital to preserving these water resources for future generations, contributing to the prosperity and water security of the region.

## LESSONS LEARNED AND SUCCESS FACTORS TO INSPIRE NEW COOPERATION INITIATIVES

The coordinated management of shared aquifers in Africa has highlighted several crucial lessons and success factors essential for accomplished cooperation initiatives. These lessons originate from various cases and good practices observed across the continent, namely in the aquifer systems of Stampriet, Senegalo-Mauritanien (SMAS), North Western Sahara (NWSAS), lullemeden Taoudéni/Tanezrouft (ITTAS) and Ramotswa. The analysis of these examples reveals effective strategies to address the challenges related to the management of shared and sometimes interconnected water resources and suggests avenues for better cooperation efforts in the future.

Acquiring and sharing knowledge on hydrogeological characteristics, water uses and environmental impacts is fundamental for the effective management of shared aquifers. This includes studies and the TDA/SAP approach for a common understanding of the resources.

### **Importance of institutionalized cooperation and legal frameworks**

The establishment of cooperation mechanisms, such as the MCCM for the Stampriet aquifer system and the NWSAS Consultation Mechanism, and the establishment of legal frameworks are essential to formalize collaboration between countries sharing water resources and guarantee their sustainability.

### **Key role of data and information sharing**

Sharing data and information is fundamental for coordinated management of the aquifers. This requires the establishment of common and accessible information systems, facilitating the exchange of information and best practices, paving the way for good cooperation (Unesco, 2024).

### **Capacity Building**

Developing local skills and building institutional capacities through technical training and awareness-raising are essential to ensure sustainable and autonomous management of shared aquifers.

### **Importance of technical and financial commitment**

Sustained technical and financial commitment from the relevant countries is necessary to maintain monitoring, management and protection activities for shared aquifers.

### **Need for integrated approaches**

The adoption of integrated and coordinated management approaches to water resources makes it possible to take into account the entire water cycle and to align the joint management of groundwater with that of surface water, taking into account the complex interactions between these resources. Well-advised management of water resources can sustainably support the socio-economic development of the region.

### **Adaptation to climate challenges**

Taking into account the impacts of climate change on water resources requires the development of flexible and resilient adaptation strategies likely to face climate variations and their effects on aquifers.

The coordinated management of shared aquifers in Africa is based on solid interstate collaboration, supported by institutional, technical and financial commitments. Inclusive approach, knowledge sharing and adoption of appropriate legal frameworks are cornerstones to address transboundary challenges and ensure the sustainability of shared water resources for future generations.

## KEY MESSAGES

Management and cooperation around transboundary water resources are crucial to prevent intersectoral conflicts linked to these shared resources.

As the main funders of transboundary cooperation, riparian States must clearly define and communicate their expectations regarding the works and activities of the joint bodies, while permanently monitoring and supervising them.

A robust legal and institutional framework for the management of transboundary water resources is essential to promote fundraising and effective financing of these initiatives.

It is imperative to keep building capacities and exchanging experiences and information on financing opportunities, as well as challenges and lessons learned (UNECE, 2021).

Establishing a consultation framework between the countries, pooling data, sharing knowledge and building institutional and technical capacities are essential for sustainable governance of transboundary water resources.



## 8. CONCLUSION

The need for coordinated and collaborative management of transboundary aquifers in Africa is more pressing than ever in the face of growing challenges posed by climate change and increasing multi-faceted water demands. Operational cooperation frameworks around shared groundwater clearly demonstrate the potential of a unified approach to ensure water security and promote sustainable development on the continent.

In order to fully benefit from the potential of collaborative management of groundwater resources, several key strategies must be adopted:

- **Building Institutional Capacity:** It is crucial to build and strengthen groundwater management institutions to ensure their effectiveness and resilience.
- **Stakeholder Awareness and Engagement:** Active involvement of all stakeholders, from the local community to regional and international actors, is essential to share knowledge, data and to promote groundwater management best practices.
- **Development of Shared Management Mechanisms:** Effective mechanisms for peacefully resolving disputes help prevent water-related conflicts and promote sustainable cooperation.

The implementation of these Strategies consolidates transboundary cooperation and ensures sustainable management of groundwater resources vital to Africa's prosperous future.

The Sahara and Sahel Observatory (OSS) plays a central role in improving knowledge and establishing frameworks for transboundary cooperation on shared aquifers. Through these initiatives, the OSS works tirelessly to develop tools and methodologies to support countries in the Implementation of their Sustainable Development Policies.

## 9. REFERENCES



Water is essential for life on Earth as groundwater plays a crucial role in the supply of fresh water. Cooperation between nations is necessary to manage transboundary aquifers, particularly in Africa where overexploitation and contamination threaten these resources.

Partnership projects have been carried out, but more efforts are needed to establish strong governance frameworks and ensure equitable access to water while protecting the environment for current and future generations.

The study titled 'Coordinated Management of Shared Groundwater in Africa: Challenges and Opportunities' provides an in-depth analysis of the challenges for effective management of transboundary groundwater in Africa, highlighting the importance of regional cooperation and the establishment of strong governance mechanisms.



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