MODULE 4

MANAGEMENT OF TRANSBOUNDARY AQUIFERS

CONTENT

MODULE 4

Management of Transboundary Aquifers

Imprint

- A4A – Aqua for All
- AGW-Net – Africa Groundwater Network
- ANBO – African Network of Basin Organisations
- BGR – Bundesanstalt für Geowissenschaften und Rohstoffe
- BMZ – Federal Ministry for Economic Cooperation and Development
- GWP – Global Water Partnership
- IGRAC – International Groundwater Resources Assessment Centre
- imawesa – Improved Management of Agricultural Water in Eastern and Southern Africa
- IWMI – International Water Management Institute
- UNDP-CapNet – United Nations Development Programme Capacity Development Network in Sustainable Water Management

Editorial Staff: *Vanessa Vaessen, Ramon Brentführer – BGR*
Layout: *ff.mediengestaltung GmbH, Hannover, Germany*
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Implemented by:

MANAGEMENT OF TRANSBOUNDARY AQUIFERS

LEARNING OBJECTIVES

- To understand the concept of transboundary groundwater and its management issues
- To become familiar with the location and extent of transboundary aquifers in Africa
- To become familiar with the legal frameworks for the management of transboundary aquifers
- To understand some of the current management issues and approaches applied to transboundary aquifers in Africa

4.1 Introduction

Water management is typically perceived and practically carried out within hydrological basins (river basins, lake basins). When such basins transcend national borders, the issues at hand become a matter of international concern. This is because the actions and perturbations to the water resources in one country potentially affect the other countries sharing that transboundary resource. International water cooperation is rising to become a very important topic in water resources management, as water resources become increasingly stressed from various factors such as climate change and human development. Most of the major and many of the smaller river basins in the world are shared between two or more countries and in total 263 river basins are transboundary. Tools for co-management, international law, and general theory of the best options for transboundary water management (TWM) are being steadily developed, and experience across the globe is increasing (INBO and GWP, 2012).

4.2 What is a transboundary aquifer (TBA)?

Groundwater, as well as surface water, inevitably flows across international borders. However the attention to this and possible implications and approaches for TWM related to groundwater have only recently been developed. Focus has hitherto been on surface water, for obvious reasons of visibility of the resource. However since surface water and groundwater are usually linked hydrologically, the groundwater component cannot be ignored if proper accounting for transboundary water interactions is to be achieved and possible associated conflicts are to be avoided.

Transboundary aquifers (TBAs) are those major groundwater systems that span across more than one country. The definition of a TBA is: 'an aquifer or aquifer system, parts of which are situated in different States' (Article 2c, Stephan 2009) (Fig. 4.1). Since groundwater is more or less ubiquitous, most borders will be underlain with shared groundwater. However the term TBA seems to be reserved for those larger contiguous and productive aquifers or aquifer systems that merit joint management due to their potential or current importance for water supply or other reasons, e.g. for important connected ecosystems. Currently more than 450 TBAs have been identified globally (IGRAC, 2012). As illustrated in Figure 4.1, transboundary groundwater systems may not have obvious upstream-downstream relations, as opposed to rivers, and they may even change flow direction as a result of changing abstraction patterns.

Even within the same overall system, heterogeneity in properties and layering can give rise to opposing flow between local shallow aquifers and deeper, regional aquifers. Such complexities specific to groundwater make the characterisation and co-management of TBAs more complex.

TBAs need to be characterized in terms of extent (horizontal and vertical), recharge (areas, mechanisms, rates), storage capacity, as well as flow patterns, relationship with surface water systems, vulnerability, current exploitation levels, potential for further development, and existing threats.

Historically such assessments would terminate at the border of each country, but for TWM these assessments need to be done jointly, in a harmonised way, and with balanced focus on all the shared parts of the aquifer systems. An important distinction is between renewable vs. non-renewable aquifers, i.e. aquifers that receive insignificant recharge during present climate and land use, as these will basically not be naturally replenished if exploited.

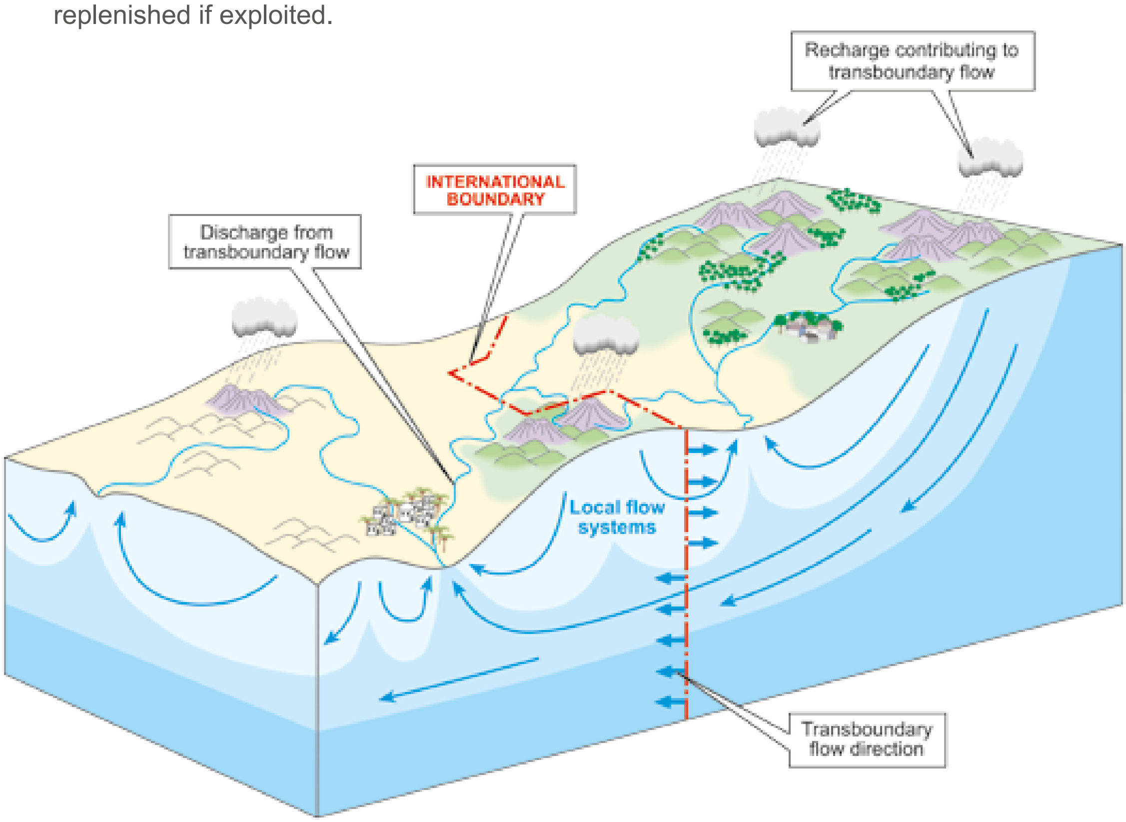


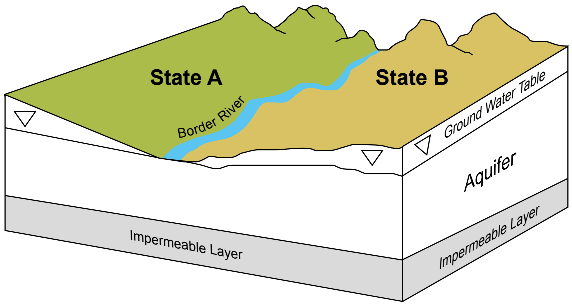
Figure 4.1 Transboundary groundwater

Different classification methods for TBAs have been developed in an attempt to systematically group the TBAs and as a tool to provide coherent management according to different characteristics of the TBAs. One such example is given in Figure 4.2. UNESCO's Internationally Shared Aquifer Resources Management (ISARM) initiative, the Worldwide Hydrogeological Mapping and Assessment Programme (WHYMAP), the International Groundwater Resources Assessment Centre (IGRAC), the UN World Water Assessment Programme (WWAP), the Food and Agriculture Organisation of the United Nations (FAO) and many other partner organizations over the last decade, and the recent TWAP Assessment of Transboundary Aquifers have been compiling and complementing the available information at the global scale related to TBAs.

4.3 Transboundary aquifers in Africa

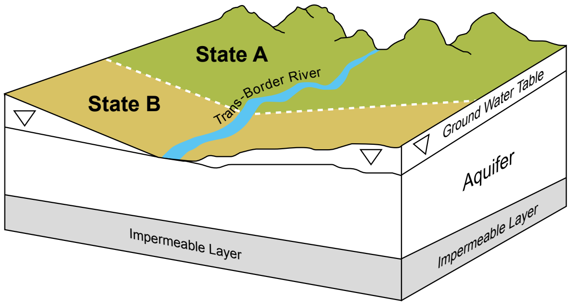
Africa is known for its large proportion of water systems that are shared between nations. Approximately 64 % of the continent's landmass occurs in transboundary international river basins. River basins such as the Nile, Congo, Niger, Volta, Orange-Senqu, and Zambezi are the major ones. A large number of TBAs have also been identified for Africa, presently about 80, but more and smaller ones are likely to be added as more information and knowledge becomes available. Figure 4.3 shows a map of the presently identified TBAs in Africa overlain on the international river basins, and Table 4.1 gives key data for the TBAs. It is clear from this that groundwater and surface water resources do not necessary coincide geographically.

The TBAs encompass a wide variety of characteristics, in size as well as geological setting, recharge and population density. Presently identified TBAs represent approximately 42% of continental land area and 30% of the population. There is a huge difference between the aquifers in terms of population living within individual TBAs, reaching approximately 63 million in the case of the Nubian Sandstone Aquifer System (AFNE12) to less than hundred inhabitants (Medium Zambezi Aquifer, AFS17; and L'Air Cristalline Aquifer, AFWC21) (Altchenko and Villholth, 2013). The same heterogeneity exists in terms of areal extent, ranging from smaller than 1500 km2 (Jbel El Hamra Aquifer, AFNE22 and Figuig Aquifer, AFNE18) to larger than 2.6 mill. km2 (Nubian Sandstone Aquifer System, AFNE12). The latter is comparable to the size of the Lake Chad River Basin (2.4 mill. km2). TBAs are shared between two and up to eight states, the latter being the case for the Lake Chad Aquifer Basin (AFWC14).



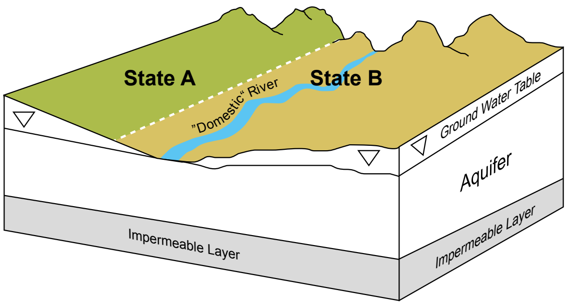
Type A:

An unconfined aquifer that is linked hydraulically with a river, both of which flow along an international border (i.e., the river forms the border between two states)



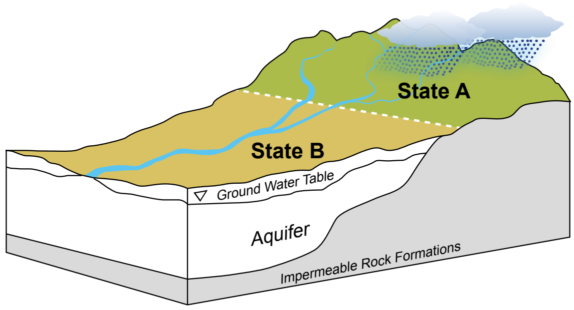
Type B:

An unconfined aquifer intersected by an international border and linked hydraulically with a river that is also intersected by the same international border



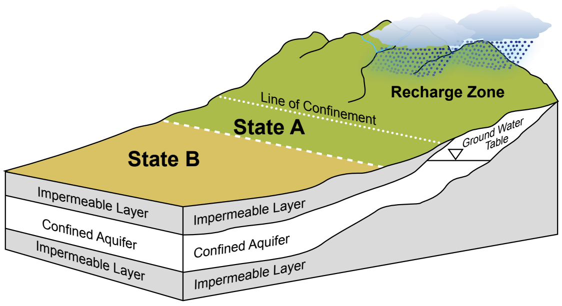
Type C:

An unconfined aquifer that flows across an international border and that is hydraulically linked to a river that flows completely within the territory of one state)



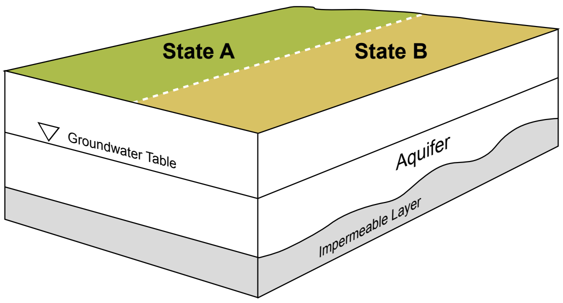
Type D:

An unconfined aquifer that is completely within the territory of one state but that is linked hydraulically to a river flowing across an international border (in such cases, the aquifer is always located in the "downstream" state)



Type E:

A confined aquifer, unconnected hydraulically with any surface body of water, with a zone of recharge (possibly in an unconfined portion of the aquifer) that traverses an international boundary or that is located completely in another state



Type F:

A transboundary aquifer unrelated to any surface body of water and devoid of any recharge

Figure 4.2. Different types of TBA systems, based on flow characteristics and interactions with surface water. Source: Eckstein and Eckstein (2003)

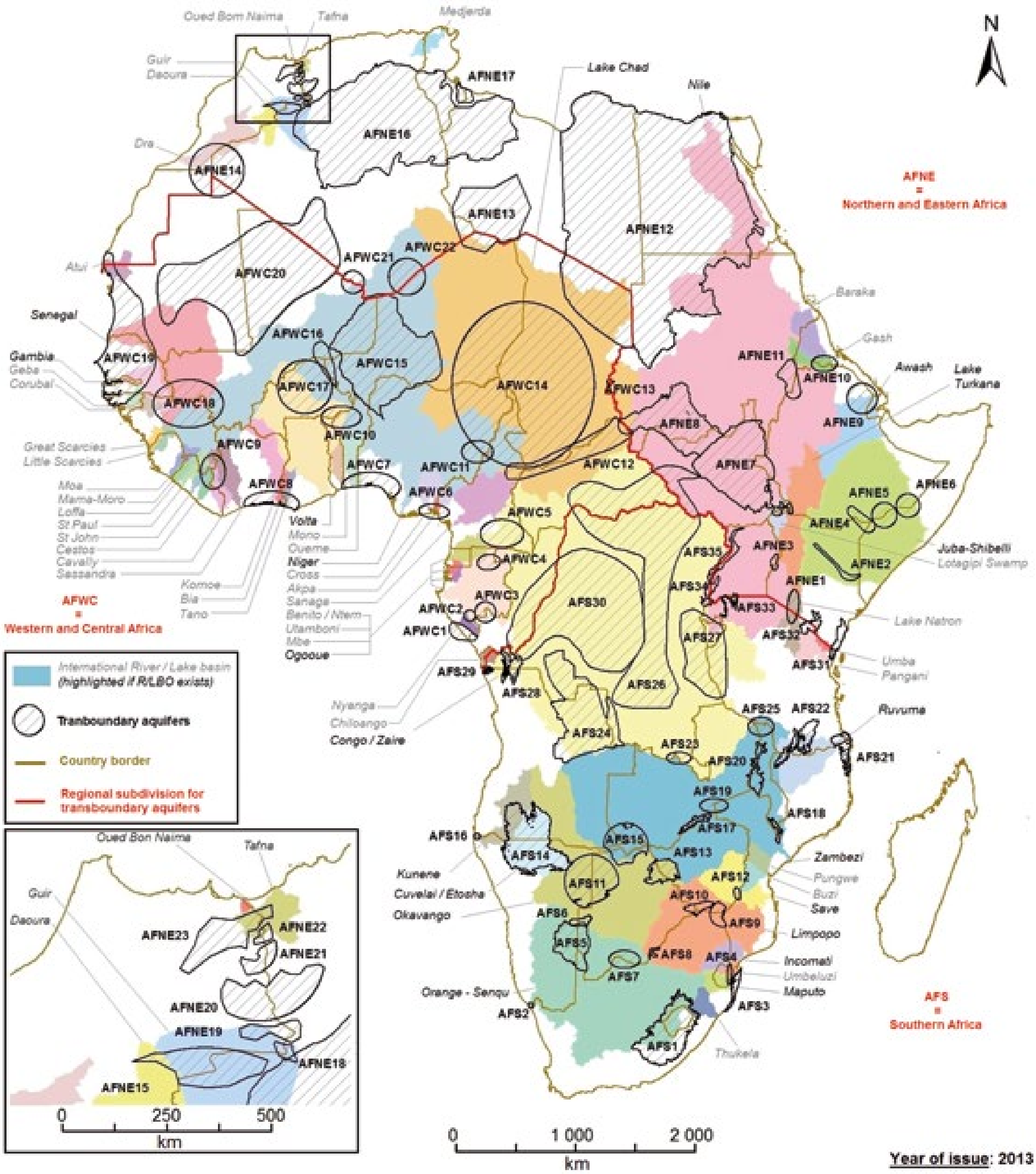


Figure 4.3. Map of transboundary aquifers in Africa. Source: Altchenko and Villholth (2013)

Table 4.1. Key data for transboundary aquifers in Africa (refer to Fig 4.3 for location of TBAs)

Inventory of transboundary aquifers in Africa

ID	Name	Countries sharing the aquifer	Population (inhabitants)	Area (km^2)	Aquifer type	Rainfall (mm/year)	Annual recharge (WHYMAP)
AFS1	Karoo sedimentary aquifer	Lesotho/South Africa	5,568,000	166,000	Consolidated sedimentary rocks	350 – 1,200	VL to M
AFS2	Coastal sedimentary basin 5	Namibia/South Africa	7,900	1,700	Quaternary and consolidated sedimentary rocks	45 – 55	VL to M
AFS3	Coastal sedimentary basin 6	Mozambique/South Africa	548,000	11,700	Quaternary and consolidated sedimentary rocks	700 – 1,200	M to H
AFS4	Rhyolite-Breccia aquifer	Mozambique/South Africa/Swaziland	206,000	5,500	Volcanic/Quaternary	600 – 850	VL to M
AFS5	Southwest Kalahari/Karoo basin	Botswana/Namibia/South Africa	15,500	85,000	Kalahari groups aquifer and Karoo supergroup aquifers	200 – 350	VL to M
AFS6	Ncojane aquifer	Botswana/Namibia	2,300	10,300	Consolidated sedimentary rocks	300 – 350	VL to M
AFS7	Khakhea/Bray dolomite	South Africa/Botswana	57,000	30,000	Dolomite	300 – 450	VL to M
AFS8	Ramotswa dolomite basin	Botswana/South Africa	135,500	3,200	Malmani subgroup of the Transvaal supergroup	500 – 550	VL to M
AFS9	Limpopo basin	Mozambique/South Africa/Zimbabwe	313,800	20,000	Volcanic and basement rocks	400 – 700	VL to L
AFS10	Tuli Karoo sub-basin	Botswana/South Africa/Zimbabwe	70,600	14,330	Volcanic and basement rocks	300 – 450	VL to L
AFS11	Northern Kalahari/Karoo basin	Angola/Botswana/Namibia/Zambia	35,900	144,400	Consolidated sedimentary rocks	380 – 550	VL to H
AFS12	Save alluvial aquifer	Mozambique/Zimbabwe	32,600	4,500	Alluvial	400 – 600	VL to M
AFS13	Eastern Kalahari/Karoo basin	Botswana/Zimbabwe	54,300	39,600	Upper Karoo Sandstone	400 – 600	VL to M
AFS14	Cuvelai and Etosha basin	Angola/Namibia	1,032,400	202,000	Consolidated sedimentary rocks	300 – 900	L to M
AFS15	Nata Karoo sub-basin	Botswana/Namibia/Zimbabwe	195,000	91,000	Ecca sequence	500 – 750	VL to M
AFS16	Coastal sedimentary basin 4	Angola/Namibia	20	2,200	Quaternary and consolidated sedimentary rocks	100 – 150	VL to M
AFS17	Medium Zambezi aquifer	Mozambique/Zambia/Zimbabwe	50,800	10,700	Quaternary and consolidated sedimentary rocks	720 – 780	VL to M
AFS18	Shire Valley aquifer	Malawi/Mozambique	527,000	6,200	Tertiary/Quaternary	780 – 900	M to VH
AFS19	Arangua Alluvial	Mozambique/Zambia	12,500	21,200	Alluvial	700 – 1,100	VL to M
AFS20	Sand and gravel aquifer	Malawi/Zambia	2 233,000	25,300	Unconsolidated intergranular aquifer and weathered basement complex	800 – 1,200	VL to VH
AFS21	Coastal sedimentary basin 3	Mozambique/Tanzania	794,000	23,000	Quaternary and consolidated sedimentary rocks	930 – 1,200	H
AFS22	Karoo-Sandstone aquifer	Mozambique/Tanzania	214,500	40,000	Consolidated sedimentary rocks	900 – 1,700	M to VH
AFS23	Kalahari/Katangian basin	DRC/Zambia	1,006,000	15,600	Katangian and Kalahari sequence	1,200 – 1,300	H to VH
AFS24	Congo Intra-cratonic	Angola/DRC	1,920,000	317,200	Consolidated sedimentary rocks	1,200 – 1,650	H
AFS25	Weathered basement	Malawi/Tanzania/Zambia	852,000	25,842	NI	900 – 2,000	M to VH
AFS26	Karoo Carbonate	CAR/Congo/South Sudan	9,400,000	941,100	Limestone/Sandstone	1,000 – 1,800	H to VH
AFS27	Tanganyika aquifer	Burundi/DRC/Tanzania/Rwanda	11,940,000	222,300	Fractured basalt and granite	800 – 1,800	VL to VH
AFS28	Dolomitic aquifer	Angola/DRC	750,600	21,300	Karst weathered dolomite	1,100 – 1,450	H to VH
AFS29	Coastal sedimentary basin 2	Angola/DRC	34,000	2,250	Quaternary and consolidated sedimentary rocks	800 – 1,000	VL to H
AFS30	Cuvette Centale	Congo/DRC	14,000,000	814,800	Alluvial Sandstones	1,400 – 2,100	H to VH
AFS31	Coastal sedimentary basin 1	Kenya/Tanzania	2,150,000	16,800	Quaternary and consolidated sedimentary rocks	850 – 1,250	M to H
AFS32	Kilimanjero aquifer	Kenya/Tanzania	1,396,000	14,600	Volcanic alluvium	600 – 1,600	VL to M
AFS33	Kagera aquifer	Rwanda/Tanzania/Uganda	493,500	5,800	Alluvial unconsolidated sand and gravels	930 – 1,800	VL to M
AFS34	Mgahinga	DRC/Rwanda/Uganda	1,451,000	4,400	Volcanic	1,250 – 1,650	VL to M
AFS35	Western Rift valley sediment	DRC/Uganda	1,151,000	29,500	Volcanic	800 – 1,250	VL to H
AFWC1	NN	Congo/Gabon	13,300	23,000	NI	1,400 – 1,750	M to VH
AFWC2	NN	Congo/Gabon	48,500	7,100	NI	1,650 – 1,950	H to VH
AFWC3	NN	Congo/Gabon	41,000	23,500	NI	1,750 – 1,950	H to VH
AFWC4	NN	Congo/Gabon	1,700	19,600	NI	1,600 – 1,750	H to VH
AFWC5	NN	Cameroon/CAR/Gabon	178,000	66,400	NI	1,550 – 1,650	H to VH
AFWC6	Rio Delrey	Cameroon/Nigeria	3,300,000	24,000	Upper Miocene to Quaternary	2,500 – 3,130	VH
AFWC7	Keta basin	Benin/Nigeria/Togo	16,896,000	55,400	Quaternary (sand, silt, clay)	950 – 2,450	H to VH
AFWC8	Tano basin	Côte d'Ivoire/Ghana	4,740,000	43,000	Quaternary Terminal Continental and Maestrichtien Aquifer	1,300 – 1,930	H to VH
AFWC9	NN	Côte d'Ivoire/Guinea/Liberia	2,370,000	47,300	NI	1,400 – 2,050	H to VH
AFWC10	Kandi sedimentary basin	Benin/Burkina Faso/Ghana/Togo	1,143,000	47,800	Cambro-Ordovicien and alluvial	850 – 1,100	VL to VH
AFWC11	Garoua - Chari	Cameroon/Nigeria	1,870,000	38,400	Sandstone - Clay	950 – 1,400	H to VH
AFWC12	NN	Cameroon/CAR/Chad/Sudan	716,000	155,400	Sedimentary	700 – 1,600	H to VH
AFWC13	Disa	Chad/Sudan	74,300	1,500	Sandstone	500 – 550	VL to M
AFWC14	Lake Chad	CAR/Cameroon/Chad/Niger/Nigeria	22,419,100	1,300,500	Sedimentary: the Upper Quaternary, the Lower Pliocene and the TC	40 – 1,400	VL to H
AFWC15	Irhazer-Iullemeden	Algeria/Mali/Niger/Nigeria	12,888,600	545,400	Sedimentary deposit including IC and TC	80 – 900	VL to VH
AFWC16	NN	Burkina Faso/Mali/Niger	333,000	3,500	NI	250 – 600	VL to M
AFWC17	Liptako-Gourma aquifer	Burkina Faso/Niger	7,758,300	159,500	Fractured metamorphic	400 – 900	VL to H
AFWC18	NN	Guinea/Mali/Senegal	4,250,000	185,500	Birrimien	850 – 1,650	VL to VH
AFWC19	Senegalo-Mauritanian basin	Gambia/Guinea-Bissau Mauritania/Senegal	11,930,000	331,450	Maestrichtien	20 – 1,850	VL to VH
AFWC20	Taoudeeni basin	Algeria/Mali/Mauritania	82,400	936,000	Multilayers	10 – 350	VL to L
AFWC21	L'air Cristalline aquifer	Algeria/Mali	84	28,400	NI	60 – 100	VL to M
AFWC22	Tin Seririne	Algeria/Nigeria	520	73,700	NI	20 – 50	VL to L
AFNE1	Rift aquifer	Kenya/Tanzania/Uganda	279,000	21,150	Volcanic	450 – 1,100	VL to M
AFNE2	Merti aquifer	Kenya/Somalia	129,000	13,500	Semi-consolidated sedimentary	350 – 750	L to M
AFNE3	Mount Elgon	Kenya/Uganda	806,550	5,400	Volcanic	1,000 – 1,300	VL to M
AFNE4	Dawa	Ethiopia/Kenya/Somalia	223,150	24,000	Volcanic rocks, alluvials and Precambrian basement	300 – 650	VL to L
AFNE5	Juba aquifer	Ethiopia/Kenya/Somalia	197,600	34,600	Aquifers in Precambrian and intrusive rocks	270 – 450	VL to L
AFNE6	Shabelle aquifer	Ethiopia/Somalia	334,000	31,000	Sedimentary and minor volcanic aquifers	280 – 400	VL to L
AFNE7	Sudd basin	Ethiopia/Kenya South Sudan/Sudan	2,926,500	331,600	Precambrian and volcanic rocks with patches of alluvials/ sedimentary	450 – 1,100	M
AFNE8	Baggara basin	CAR/South Sudan/Sudan	2,433,500	239,300	Umm Ruwaba (overlain the Nubian Formation)	300 – 900	L to M
AFNE9	Awash Valley aquifer	Djibouti/Eritrea/Ethiopia	627,400	50,700	Volcanic	110 – 350	VL to L
AFNE10	Mareb aquifer	Eritrea/Ethiopia	1,827,900	22,800	Precambrian and intrusive rocks	450 – 550	VL to M
AFNE11	Gedaref	Eritrea/Ethiopia Sudan	732,000	38,700	Precambrian and volcanic rocks with patches of alluvials/sedimentary	400 – 950	VL to M
AFNE12	Nubian Sandstone aquifer system	Chad/Egypt/Libya/Sudan	67,320,000	2,608,000	Nubian and Post-Nubian	1 – 550 (mainly < 30)	Mainly VL (VL to VH)
AFNE13	Mourzouk-Djado basin	Algeria/Libya/Nigeria	108,000	286,200	Sedimentary	< 20	Mainly VL (VL to M)
AFNE14	Tindouf aquifer	Algeria/Mauritania/Morocco	107,000	160,000	Alternating series of calcareous rocks and sand	30 – 200	VL to M
AFNE15	Errachidia basin	Algeria/Morocco	156,300	18,500	Sandstone, calcareous, dolomite	80 – 200	VL to L
AFNE16	North Western Sahara Aquifer system	Algeria/Libya/Tunisia	4,000,000	1,190,000	Sand, Sandstone, sandy clay, calcareous, dolomite	10 – 300 (mainly < 50)	VL to L
AFNE17	Djaffar Djeffara	Libya/Tunisia	262,400	15,800	NI	130 – 250	L
AFNE18	Figuig	Algeria/Morocco	32,300	1,500	Phreatic Aquifer, Porous	100 – 170	VL to L
AFNE19	Chott Tigri-Lahouita	Algeria/Morocco	26,800	4,700	Porous, Karst, Dolomite Limestone and Sandstone	180 – 250	VL to L
AFNE20	Ain Beni mathar	Algeria/Morocco	23,100	20,000	Karstic, Dolomite Limestone and Dolomite	260 – 350	VL to M
AFNE21	Angad	Algeria/Morocco	25,600	3,500	Porous, Plio-Quaternary	350 – 450	VL to M
AFNE22	Jbel El Hamra	Algeria/Morocco	40,100	1,250	Karstic	440 – 500	VL to L
AFNE23	Triffa	Algeria/Morocco	920,000	13,100	PorousVillafranchian and Quaternary	370 – 450	M

Notes: NN = No name referenced; NI = No information; TC = Terminal Continental; IC = Intercalary Continental;
VL = Very low (0 - 2 mm/year); L = Low (2 - 20 mm/year); M = Medium (20 - 100 mm/year); H = High (100 - 300 mm/year); VH = Very high (> 300 mm/year)

4.4 Approach and mechanisms for TBA management

Groundwater management is a complex endeavour as it requires coordination across many sectors and users (e.g. water supply, agriculture, energy, industry, and environment) and it needs to integrate with surface water management. Trying to do this at the international level poses another dimension of challenges in terms of coordination and integration. Groundwater traditionally has been considered a national matter, but the need for international cooperation on groundwater is increasingly recognised. This is particularly the case where:

- Groundwater resources evidently flow across borders, as in the case where groundwater is primarily recharged in one country but discharges in another (like Type E in Figure 4.2)
- Groundwater development in one country has (or could have) significant implications and adverse impact in the other country
- Significant ecosystems in one country depend on groundwater influx from another country
- Significant groundwater development or land-use changes with implications for groundwater resources (quantity or quality) in neighbouring countries is planned in one country
- Groundwater is a significant resource in drought management and generally for human development for one or more of the sharing countries

The principles of international law for cooperation on transboundary aquifers build on the general principles of cooperation on surface water. Some of these principles relate to:

- Cooperation on the basis of sovereign equality, territorial integrity, mutual benefit and good faith
- The concept of 'equitable and reasonable use'
- The concept of 'no-harm', i.e. that all resource development and management is done with no prior intention of harming the other part
- Prior notification, i.e. that states have an obligation to inform each other before implementing major investments and interventions that may affect the resource in a transboundary sense. Notification also refers to immediately informing other states of emergency conditions related to the watercourse that may affect them, such as flooding

Table 4.2 Particular characteristics of aquifers and implications for management of TBAs

	Special considerations/provisions needed in TBA management								
Groundwater distinct characteristic	Joint user/use registration, regulation, monitoring and enforcement	Prior notification of development plans to other party	Precautionary principle	Conflict resolution	Stakeholder engagement	Long-term monitoring of resource	Flexibility in conceptual model and clear data- sharing arrangements	Land use and waste regulations	Prioritized protection
Open source	xx				xx				
Invisible and heterogeneous		x	x	x	x	x	x		
Vulnerable to land use impacts					x			xx	x
Slow reacting/delay in response/slowly renewable		x	xx	x		xx			
Recharge/discharge is distributed and uneven								x	xx
Boundaries uncertain				x		x	xx		
Climate change impacts uncertain						xx	xx		
Blurred up and downstream relations			x	x	x	x	xx		

- Sharing of data, i.e. institutionalised mechanisms for regular sharing of new data and knowledge related to the TBAs
- The precautionary principle, i.e. that development is not done if insufficient knowledge exists to show that environmental and socio-economic impacts will be low. These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no significant harm will result
- Stakeholder involvement, i.e. that stakeholders are involved and have a say in decisions related to the development of the resource
- Dispute settlement

However, it is important to bear in mind that groundwater has some particular inherent characteristics that necessitate strong emphasis on certain of these principles, i.e. the precautionary principle, long-term monitoring of the resource, joint monitoring/registration of users, prior notification, and prioritized protection (Table 4.2). Because groundwater generally moves very slowly, the precautionary principle, the long-term monitoring and the prioritized protection, e.g. of significant recharge zones, are critical. For the prior notification, development may relate to significant land use change plans or widespread development of the groundwater resource, rather than large infrastructure dams that typically affect surface water sharing. Prior notification could also relate to the spill of chemicals or detection of groundwater contamination in the border region. In order to achieve full and efficient cooperation on TBAs, states need to formulate joint (or separate but coordinated) plans and programmes for groundwater development, use and protection, to implement common/harmonised groundwater management policies, the joint training of technical personnel and the joint undertaking of environmental studies.

In principle, groundwater as part of the unified hydrological system falls under the provisions of international water law[1]. However, the mechanisms for managing international waters traditionally have focused on surface water, and groundwater was either ignored or simply assumed to be covered. Due to recognition of the importance of groundwater as well as its inherent characteristics, there has been an increase in work dedicated to developing separate and integrated frameworks for international law on groundwater.

Four most important pieces of international water legislation, with each their strong and weak aspects, are included in Table 4.3. These conventions are meant as guidelines and encourage states to draft specific binding agreements (treaties) between nations related to their specific shared (ground)water resources and establish permanent transboundary organizational setups for their management.

Since aquifers and river/lake basins seldom coincide (Fig 4.3), the most appropriate body to oversee management of TBAs may not necessarily be the basin organisation specific to the river/lake (if existent). Cooperation among several basin organisations may be necessary. Similarly, separate aquifer basin organisations may be a relevant solution where there is no effective surface water-based transboundary basin organization.

[1] International water law is a system of norms and rules governing relations between and among sovereign States and plays an important role in the peaceful management of transboundary water resources.

Table 4.3. Four most important pieces of international water legislation for groundwater

	Focusing on groundwater or surface water?	Regional scope	In force	Reference
UN Convention on the Law of the Non-Navigational Uses of International Watercourses	Surface water, and groundwater hydraulically connected to surface water	Global	No[a]	United Nations (1997)
Convention on the Protection and Use of Transboundary Watercourses and International Lakes	Both	Europe[b]	Yes (1996)	UNECE (1992)
SADC Revised Protocol on Shared Watercourse	Surface water, and groundwater hydraulically connected to surface water	SADC region	Yes (2003)	SADC (2000)
UN Draft Articles on Transboundary Aquifers	Groundwater	Global	No	Stephan (2009)

[a] Only one more country needs to ratify it for it to enter into force, as of 27 Feb. 2014.

[b] Enters into force if all 33 states originally parties to the convention approve. So far 23 have approved.

4.5 Specific challenges and cases of TBA management in Africa

The need for transboundary groundwater management in Africa is at present most acute in semi-arid and arid regions where the surface water resources may be limited or seasonally or inter-annually very variable or located far away from significant populations. These are typically also the regions where significant transboundary groundwater reserves are non- or less renewable, increasing the challenges of sustainable TWM.

One of the most important decisions that joint management committees have to make in such conditions is the maximum allowed annual drawdown of the aquifer. This is the case in much of northern Africa and in southern Africa. Transboundary management could also be of concern in areas where surface waters are declining or affected by contamination, e.g. the Lake Chad Basin in western Africa.

Significant conflicts over shared aquifers are not apparent or are still not fully documented in terms of extent and underlying causes. The ‘needs assessment’ (BGR / IWMI 2013) identified alluvial groundwater abstraction for irrigation alongside international water courses (Fig 4.2 Type A and Type B) in some of the surveyed TBOs (LIMCOM, OMVS) as the activity with the most immediate “suspected” transboundary impact. These TBOs expressed concern at the impacts of alluvial groundwater abstraction on transboundary surface water flows, but indicated that no conflicts have yet been experienced.

Reflecting these needs, greater efforts have been pursued in the arid regions in terms of managing the shared groundwater resources. At present, formal agreements exist between countries sharing the Nubian Sandstone Aquifer System (NSAS, AFNE12), the Northwestern Sahara Aquifer System (AFNE16), while significant work is ongoing in the Lake Chad aquifer (AFWC14) and the Iullemeden/Taudeni Aquifer Systems (AFWC20+15). Such efforts are typically supported by international organizations (eg. UNESCO, FAO) and technical institutions with expertise in groundwater characterization (eg. IAEA, IGRAC, BGR, and BRGM).

The agreements relate mostly to the setting up of consultative mechanisms to coordinate, promote and facilitate the rational management of the aquifers and the collection, sharing and interpretation of data as part of so-called transboundary diagnostic analyses. The TBA in Africa that counts on the most advanced level of joint management is the Nubian Sandstone Aquifer System (NSAS, AFNE12), which constituted a Joint Authority in 1989 for the study and development of the aquifer and with quite broad responsibilities. The aquifer-sharing states (Egypt, Libya, Sudan, and Chad) and the Joint Authority also agreed on a strategic action plan in 2013 for the shared vision and future cooperative management of the NSAS.

4.6 References

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4.7 Exercise

This exercise provides an example guideline of the manner in which TBOs may approach the management of TBAs in the first instance.

Step 1.

For your country, list the transboundary aquifers or groundwater resources with potential or apparent transboundary issues in terms of development, use, and management.

Step 2.

Categorize and rank the resources in terms of problems or possible solutions to human and environmental needs.

Step 3.

Compare your list with the lists for your neighboring countries and identify the areas of joint priority for transboundary and cooperative management.

Step 4.

Identify technical and management interventions that could be best dealt with jointly to address the issues identified in Step 1-3.

Step 5.

Assess the interventions in terms of the benefits and trade-offs for the countries, in terms of addressing equity, sustainability and efficiency.

Step 6.

Indicate where the institutional responsibility lies to carry out the proposed management interventions. Highlight in particular the role / interventions that can be best carried out by the TBO.