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Geography

Total area TBA (km^2): 51 000

No. countries sharing: 3

Countries sharing: Eritrea, Ethiopia, Sudan

Population: 1 600 000

Climate Zone: Semi-arid

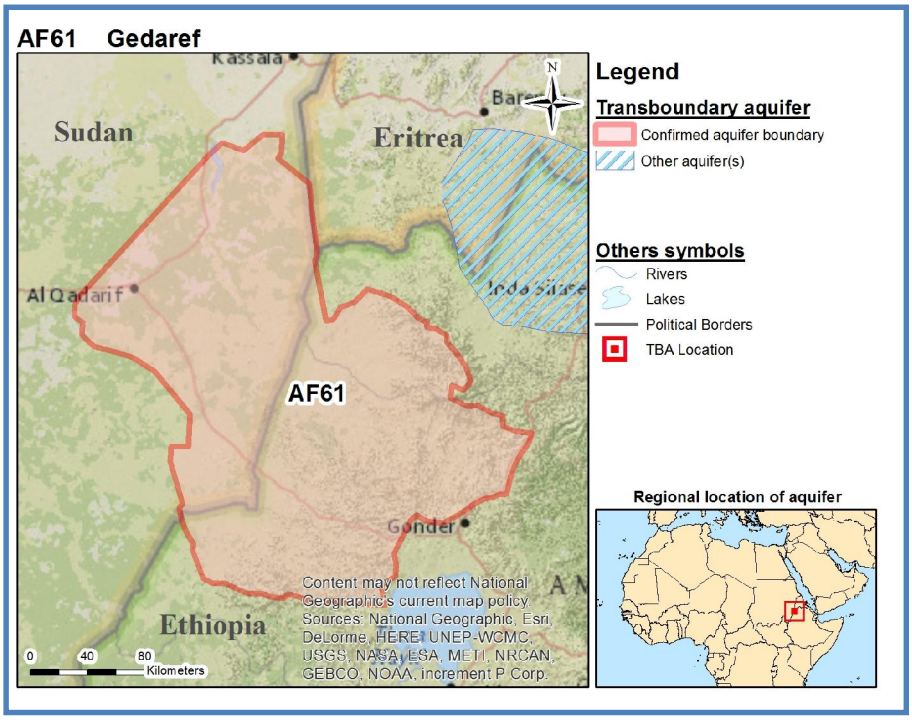
Rainfall (mm/yr): 790

Hydrogeology

Aquifer type: Multiple 3-layered hydraulically connected

Degree of confinement: Mostly confined, but some parts are unconfined

Main Lithology: Sedimentary rocks - Sandstone



No cross-section available

Map and cross-section are only provided for illustrative purposes. Dimensions are only approximate

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TWAP Groundwater Indicators from Global Inventory

	Recharge (mm/y) (1)	Renewable groundwater per capita (m^3/y/capita)	Natural background groundwater quality (%) (2)	Human dependency on groundwater (%)	Groundwater depletion (mm/y)	Groundwater pollution (%) (3)	Population density (Persons/km2)	Groundwater development stress (%) (4)	Transboundary legal framework (Scores) (5)	Transboundary institutional framework (Scores) (6)
Eritrea							20			
Ethiopia	2	35					43	290	D	
Sudan							19			
TBA level							**32**			

(1) Recharge: This is the long term average recharge (in m^3/yr) divided by the surface area (m^2) of the complete country segment of the aquifer (i.e. not only the recharge area).
(2) Natural background groundwater quality: Estimate of percentage of surface area of aquifer where the natural groundwater quality satisfies local drinking water standards.
(3) Groundwater pollution: A. No pollution has been identified; B. Some pollution has been identified; Positive number: Significant pollution has been identified (% of surface area of aquifer).
(4) Groundwater development stress: Annual groundwater abstraction divided by recharge.
(5) Legal framework: A. Agreement with full scope for TBA management signed by all parties; B. Agreement with limited scope for TBA management signed by all parties; C. Agreement under preparation or available as an unsigned draft; D. No agreement exists, nor under preparation; E. Legal Framework differs between Aquifer States (see data at National level).
(6) Institutional Framework: A. Dedicated transboundary institution fully operational; B. Dedicated transboundary institution in place, but not fully operational; C. National/Domestic institution fully operational; D. National/Domestic institution in place, but not fully operational; E. No institution exists for TBA management; F. Institutional Framework differs between Aquifer States (see data at National level).
X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

TWAP Groundwater Indicators from WaterGAP model

	Recharge, incl. recharge from irrigation (mm/yr)	Renewable groundwater per capita			Human dependency on groundwater (%)	Human dependency on groundwater for domestic water supply (%)	Human dependency on groundwater for irrigation (%)	Human dependency on groundwater for industrial water use(%)
		Current state (m^3/y/capita)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)				
Eritrea	26	1700	-19	-38	80	80	0	0
Ethiopia	69	1400	-19	-34	75	79	0	75
Sudan	32	1500	-28	-51	4	7	2	1
TBA level	**52**	**1400**	**-22**	**-40**	**41**	**55**	**1**	**20**

	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
Eritrea	1	15	53	100	1	3	10
Ethiopia	1	48	43	76	1	4	13
Sudan	1	22	59	130	<1	0	1

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	Groundwater depletion (mm/y)	Population density			Groundwater development stress		
		Current state (Persons/km2)	Projection 2030 (% change to current state)	Projection 2050 (% change to current state)	Current state (%)	Projection 2030 (% point change to current state)	Projection 2050 (% point change to current state)
TBA level	**1**	**36**	**48**	**90**	**1**	**3**	**10**

Key parameters table from Global Inventory

	Distance from ground surface to groundwater table (m)	Depth to top of aquifer formation (m)	Full vertical thickness of the aquifer (system)* (m)	Degree of confinement	Predominant aquifer lithology	Predominant type of porosity (or voids)	Secondary Porosity	Transmissivity (m^2/d)
Eritrea								
Ethiopia	63		350	Mostly confined, but some parts unconfined	crystalline basalts	Low primary porosity	Secondary porosity (fractures)	5
Sudan								
TBA level								

* Including aquitards/aquicludes

X A value was provided in the questionnaire, but it was considered un-realistic and therefore removed from the table.

Aquifer description

Aquifer geometry

It is a multiple layered hydraulically connected system that is mostly confined, but some parts are unconfined. Within the Ethiopian portion, where it is a 3-layered system, the average depth to the water table is 63 m and the average thickness of the aquifer system is 350 m.

Hydrogeological aspects

The predominant lithology consists of crystalline basalts that are characterized by a low primary porosity and relatively high secondary porosity (fractures) that have a high horizontal and vertical connectivity. The transmissivity values are low with an average value of 5 m^2/d. The total groundwater volume is 40 km^3 (Ethiopia). The mean annual recharge is 385 Mm^3/yr over an area of about 4 100 km^2. With the cyclical droughts that are characteristic in the area the mean recharge reduces to 95 Mm^3/yr (Ethiopia).

Linkages with other water systems

The predominant source of recharge is through precipitation over the aquifer area, and the predominant discharge mechanism is through river base flow.

Environmental aspects

Within Ethiopia about 12 % of the aquifer does not satisfy national drinking standards mainly due to high contents of natural nitrates. Some pollution within the superficial layers has been observed but the data is not available to determine the percentage of the aquifer area that has been affected.

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Socio-economic aspects

During 2010 the annual groundwater abstraction on the Ethiopian side was 3.2 Mm^3/yr of which 70% of this amount was used water for agricultural purposes.

Legal and Institutional aspects

No Transboundary Agreement is in place. No information on the National Institutes within the countries was recorded.

Emerging Issues

The cause of the high natural nitrates within parts of the aquifer should be further investigated.

Contributors to Global Inventory

Name	Organisation	Country	E-mail	Role
Greg Christellis	CHR Water Consultants	Namibia	gregchristelis@gmail.com	Regional coordinator
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Tadesse	Ministry of Water and Energy	Ethiopia	twtesfaye@gmail.com	Contributing national expert

Considerations and recommendations

Most data in the tables and text above have been provided by national and regional experts (listed above) or have been derived from the global WaterGAP model. See colophon for more information, including references to data from other sources.

Only 1 of the 3 TBA countries has provided information. Information was adequate to describe the aquifer in general terms. Some quantitative information was also available, and 50% of the indicators could be calculated at the national level.

Data gaps and also differences between data from national experts (Global Inventory) and data derived from WaterGAP highlight the need for further research on transboundary aquifers.

Colophon

This Transboundary Aquifers information sheet has been produced as part of the Groundwater Component of the GEF Transboundary Water Assessment Programme (GEF TWAP). **GEF TWAP** is the first truly global comparative assessment of transboundary groundwater, lakes, rivers, large marine ecosystems and the open ocean. More information on TWAP can be found on: www.geftwap.org . **The Groundwater component** of TWAP carried out a global comparison of 199 transboundary aquifers and the groundwater systems of 41 Small Island Developing States. The data used to compile this transboundary aquifer information sheet has been made available by national and regional experts from countries involved in the TWAP Groundwater project. For aquifers larger than 20 000 km2 and which are not overlapping, additional data are available from modelling done by the Goethe University Frankfurt (Germany) as part of TWAP Groundwater. All data were compiled by UNESCO-IHP and the International Groundwater Resources Assessment Centre (IGRAC – UNESCO Category II Institute). Values given in the fact-sheet represent an approximate guide only and should not replace data obtained from recent local assessments. The editors of this information sheet are not responsible for the quality of the data.

For more information on TWAP Groundwater and for more data, please have a look at the TWAP Groundwater Information Management System which is accessible via www.twap.isarm.org or www.un-igrac.org.

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Request:
If you have additional data or information about this transboundary aquifer that can improve the quality of this information sheet and the underlying database, please contact us via email at info@un-igrac.org. If appropriate, the information will be uploaded to the database of transboundary aquifers and will also be used in new versions of this information sheet.

References:
- Population: Population has been calculated based on the aquifer map and grid information on population. Source population data: Center for International Earth Science Information Network - CIESIN - Columbia University, United Nations Food and Agriculture Programme - FAO, and Centro Internacional de Agricultura Tropical - CIAT. 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid, Future Estimates. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H42B8VZZ. Accessed Jan 2015.
- Rainfall: Average rainfall per TBA has been calculated based on the aquifer map and grid data for precipitation. Source precipitation data: Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965-1978. Grid data download from www.worldclim.org (2015): Data for current conditions (~1950-2000), ESRI grids, 30 arc seconds, Precipitation.
- Climate: Climate indicates the major climate zone which occurs in the aquifer area. If more than 1 climate zone is present the zone with the largest surface area was selected. Source climate data: ArcGIS Online (2015), Simplified World Climate zones. Owner: Mapping Our World GIS Education. Original map: National Geographic World Atlas for Young Explorers (1998).
- All other data: TWAP Groundwater (2015).

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