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Geography

Total area TBA (km^2): 31 000

No. countries sharing: 3

Countries sharing: Ethiopia, Kenya, Somalia

Population: 370 000

Climate Zone: Arid

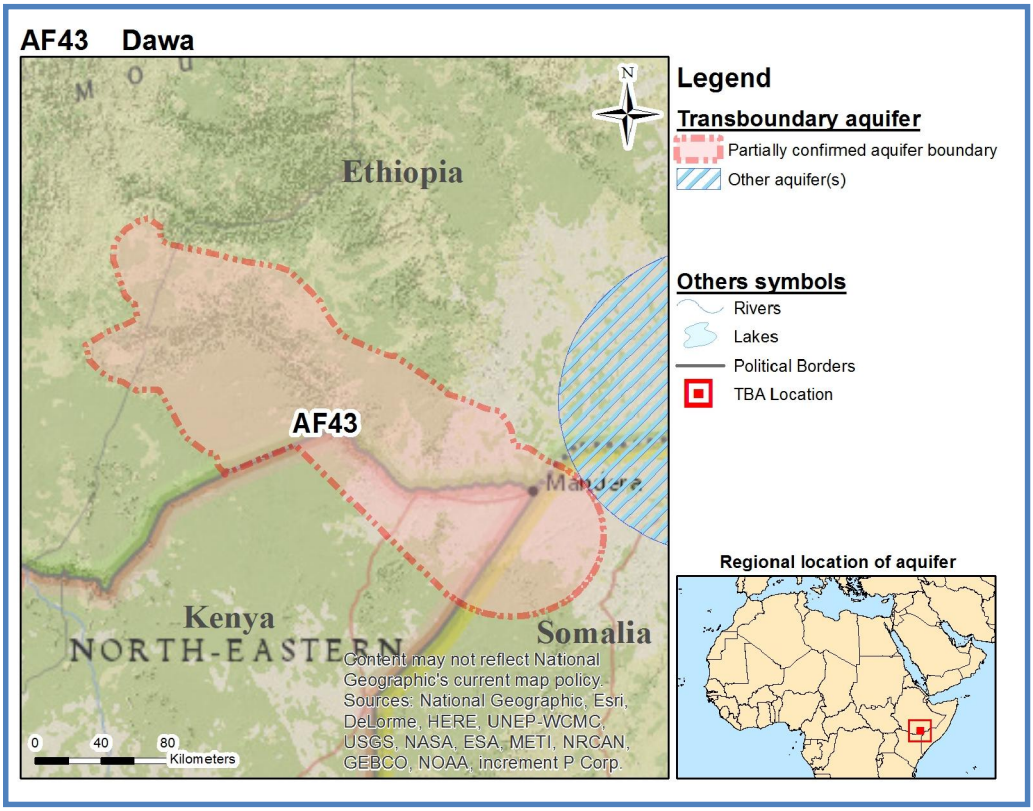
Rainfall (mm/yr): 370

Hydrogeology

Aquifer type: Multi-layered system

Degree of confinement: Semi-confined, mixed

Main Lithology: Sedimentary rocks – limestones



Cross-section

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)
Ethiopia	2	240	50	50	0		8	<5	D	C
Kenya	2	110	80				17		D	C
Somalia							27			
TBA level							**12**			

(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)				
Ethiopia	21	2600	-9	-12	12	78	0	0
Kenya	7	370	-25	-36	3	41	0	0
Somalia	16	810	-17	-30	0	70	0	0
TBA level	**18**	**1500**	**-12**	**-19**	**5**	**66**	**0**	**0**

	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)
Ethiopia	0	8	46	85	1	2	4
Kenya	0	20	53	120	2	6	12
Somalia	0	20	32	70	<1	0	0

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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	**0**	**12**	**45**	**91**	**1**	**2**	**4**

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)
Ethiopia	100	<5	200	Aquifer mostly semi-confined, but some parts unconfined	Sedimentary rocks - Limestone	Low primary porosity inter-granular porosity	Secondary porosity: Fractures	50
Kenya	6	8	110	Aquifer Mostly unconfined, but some parts confined	Sediment - Gravel	High Primary porosity fine/ medium sedimentary deposits	Secondary porosity: Fractures	
Somalia								
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 multi-3-layered system in Ethiopia and a 2-layered system in Kenya that is hydraulically connected. In Ethiopia it is mostly semi-confined with some unconfined parts but in Kenya it is mostly unconfined with some confined parts. The average water level within Kenya is 6 m and this increases to 100m within Ethiopia. The average depth to the top of the aquifer varies from <5 m within Ethiopia to 8 m within Kenya and the average aquifer thickness of the aquifer system varies from 110 m within Kenya to 200 m within Ethiopia.

Hydrogeological aspects

The major lithology is predominantly sedimentary rocks – limestones (Ethiopia) that have a low primary porosity and secondary porosity: fractures. They have a relatively high horizontal connectivity. Within Kenya the predominant lithology is sedimentary gravel. The gravels have a high primary porosity. The average transmissivity value within Ethiopia is 50 m^2 /d. The mean annual recharge was 48 Mm^3/yr over an area of about 2500 km^2. During prolonged drought periods within Ethiopia the annual recharge amount decreases by around 20 Mm^3/yr.

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Linkages with other water systems

Within Kenya the predominant source of recharge is through runoff into the aquifer, whereas the discharge mechanism is mainly through groundwater flow into another aquifer.

Environmental aspects

Within Ethiopia 50% of the aquifer does not satisfy local drinking standards, over a significant part of the aquifer due to natural salinity. In Kenya this is reduced to 20 % of the aquifer, mainly over superficial layers that are not suitable due to high salinity. Some pollution within the superficial layers has been observed but data are not available to determine the extent of the aquifer area that has been affected.

Socio-economic aspects

During 2010 the annual groundwater abstraction on the Ethiopian side was 0.90 Mm^3/yr. The total fresh water abstraction from the same area, including the groundwater was 1.70 Mm^3/yr.

Legal and Institutional aspects

There is no Transboundary Agreement in place, and the National Institutes have a full capacity and mandate.

Emerging Issues

Essential aspects of water quality and quantity and the likely issues in need of cooperation must be reviewed between the Aquifer States. Recharge seems to be very low and long-terms trends must be more closely followed.

Contributors to Global Inventory

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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.

2 of the 3 countries have provided the information. . Some quantitative information was also available, and some of the indicators could be calculated on the national levels.

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

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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.

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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