Unlocking the Potential of Groundwater for the Poor

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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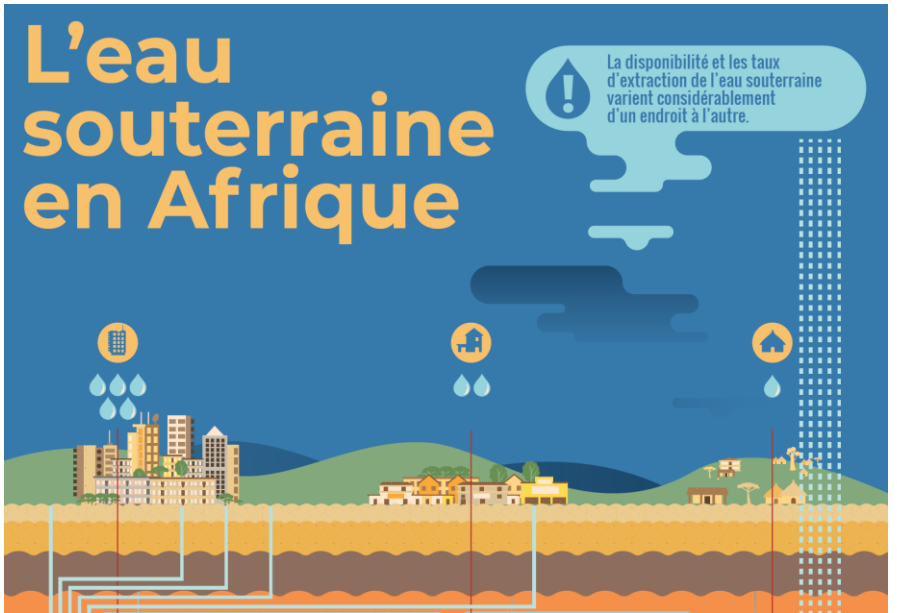
Africa Groundwater Atlas

Making African groundwater information more visible and accessible

Sean Furey

skat_ Swiss Resource Centre and Consultancies for Development

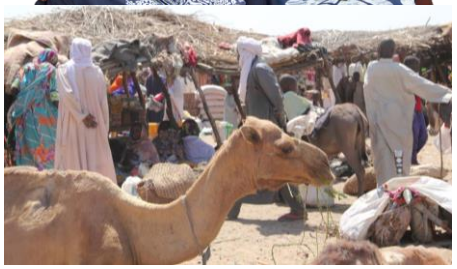


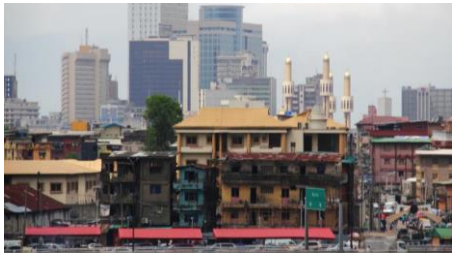
The true size of Africa

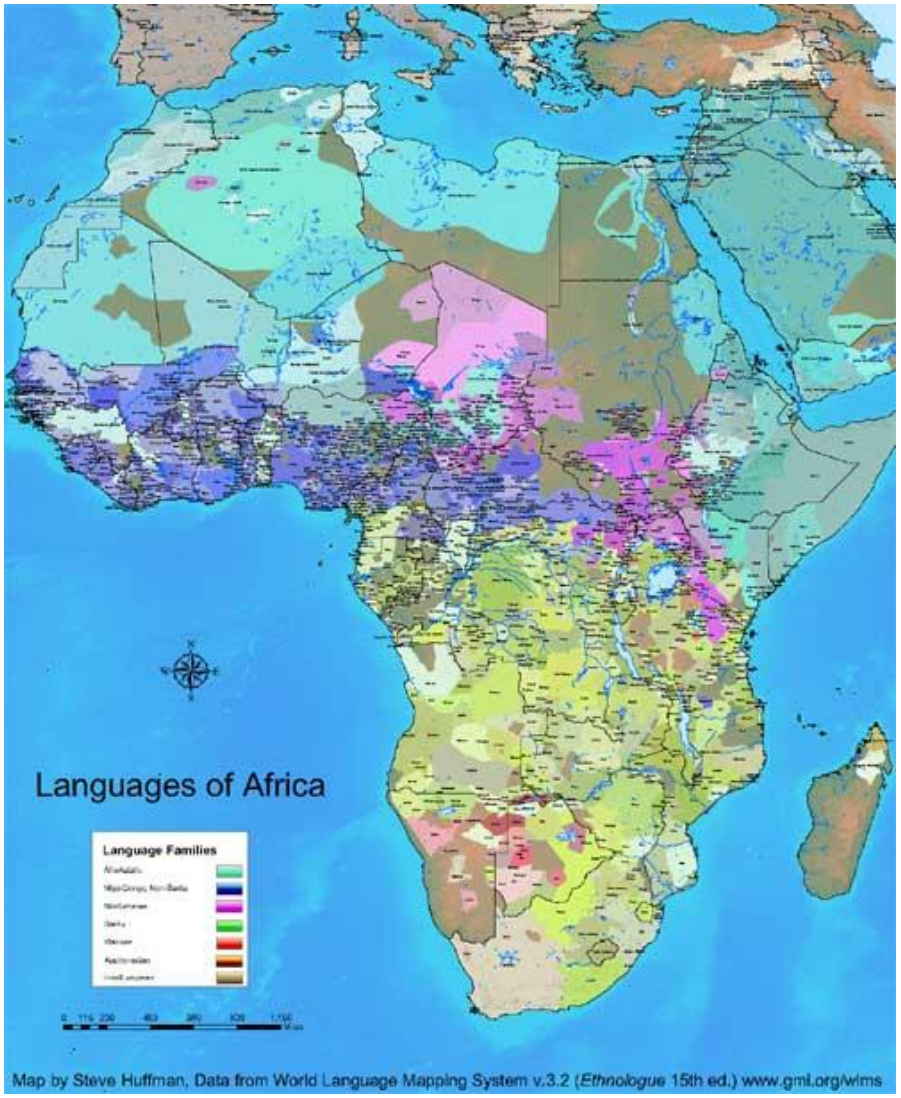
Most global map projections give a false impression: Africa is much bigger than we often think…

Source: Kai Krause: http://kai.sub.blue/en/africa.html

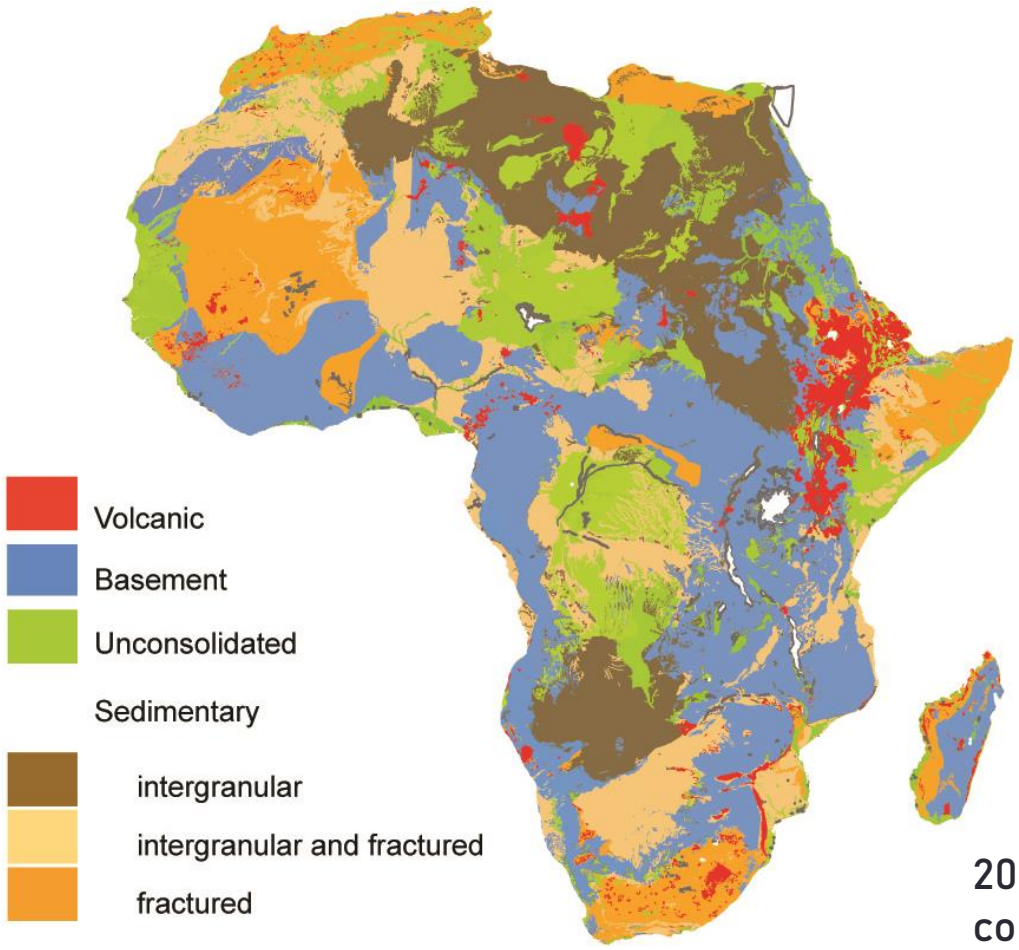
Diverse People

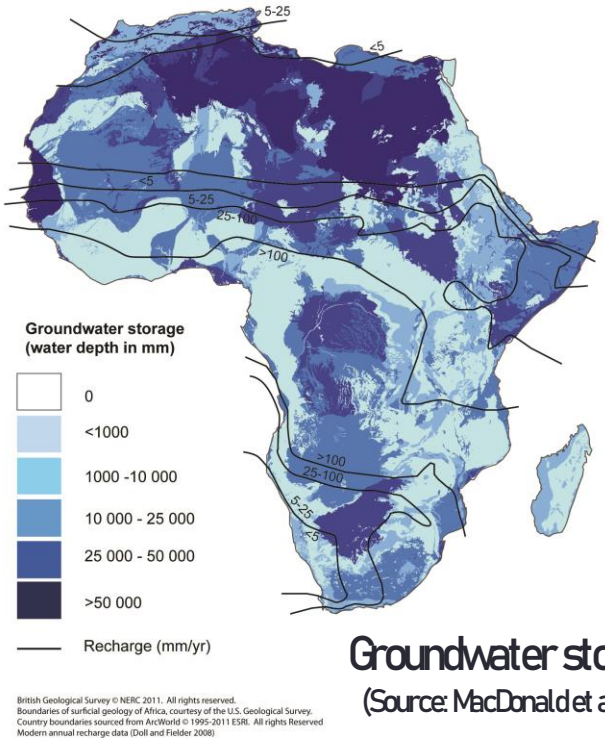






Diverse Geology & Groundwater





Groundwater storage
(Source: MacDonald et al, 2012)

2012: first quantitative continent-wide maps of aquifer storage and potential published

- 0.66 million km^3 of storage (not all available for abstraction)

What is the Africa Groundwater Atlas?

- Brings together existing groundwater information from many sources in a consistent way
- A consistent overview of groundwater resources, status & management for 51 African countries
- A starting point for understanding groundwater at a country-scale
- A gateway to more detailed information
- In collaboration with IAH & hydrogeologists across Africa

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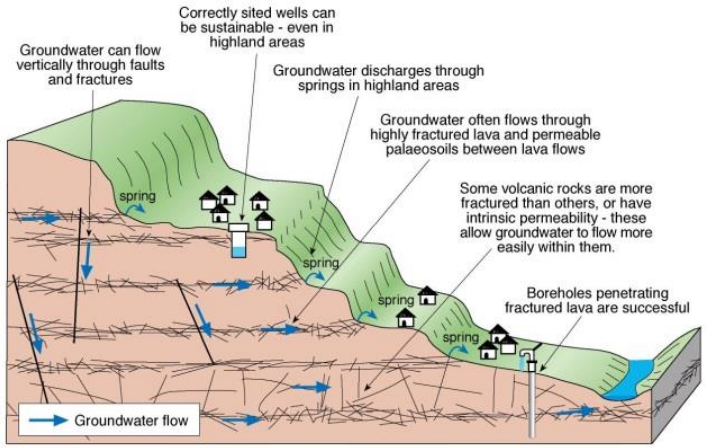
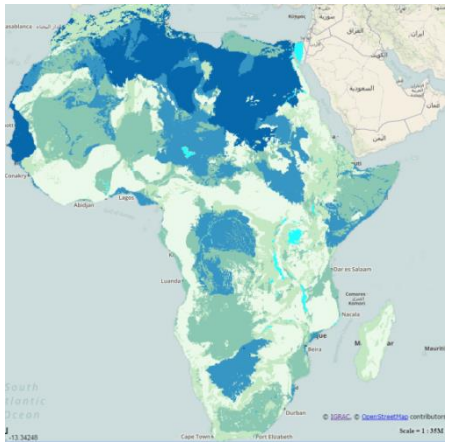
Why is the Atlas important?

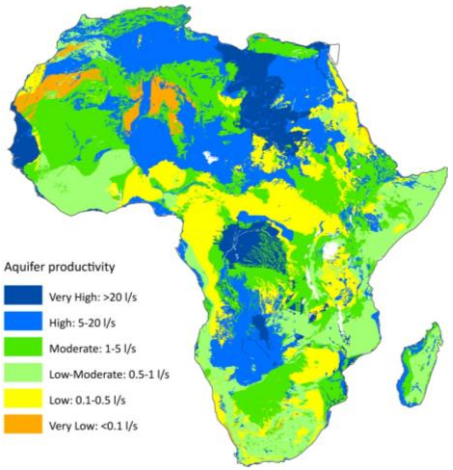
- For safe, sustainable groundwater development we need to understand groundwater
- To understand groundwater we need good information – which is hard to find!
- BUT there is lots of good information out there – it's just not always easily visible and accessible



Background to the Atlas

- Publication of continental-scale maps of aquifer productivity, groundwater storage and depth to groundwater





Download maps from BGS website as GIS files[1]
or
View IGRAC's Groundwater Resources in Africa webpage[2]

- Demand for country-scale information
- Increased spending from UK government on development cooperation research e.g. UPGro

[1] http://www.bgs.ac.uk/research/groundwater/international/africanGroundwater/maps.html

[2] https://ggis.un-igrac.org/ggis-viewer/viewer/groundwaterafrica/public/default

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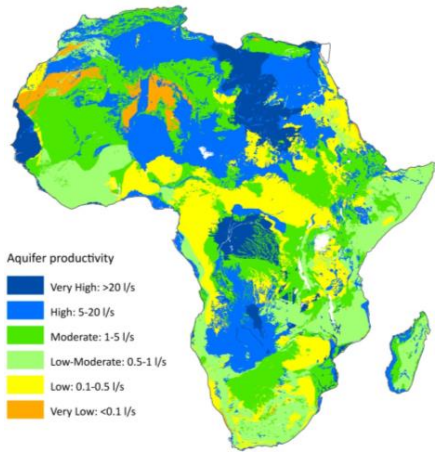
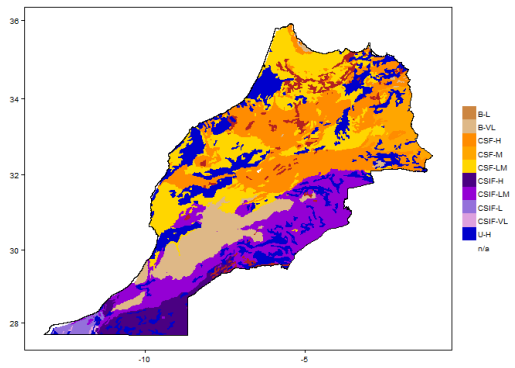
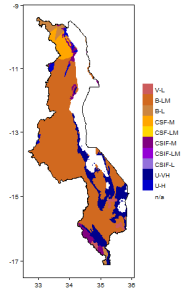
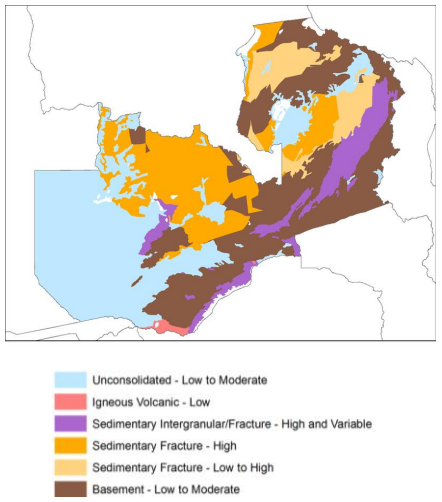
Developing the Africa Groundwater Atlas









- 1:5M USGS Geology Map of Africa > BGS Geology & Hydrogeology Map of Africa > country hydrogeology maps
- Country profiles for 51 countries
- Co-written with hydrogeologists from across Africa
- Online and free
- Offline version available

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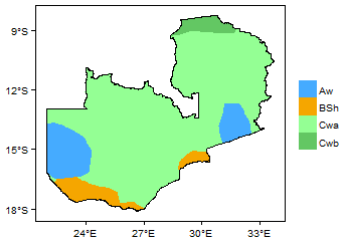
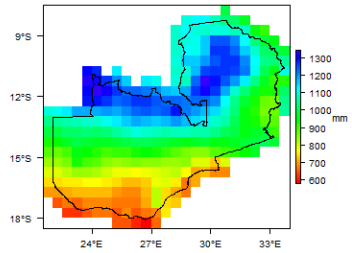
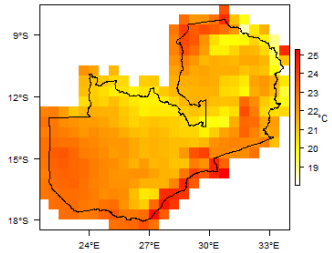
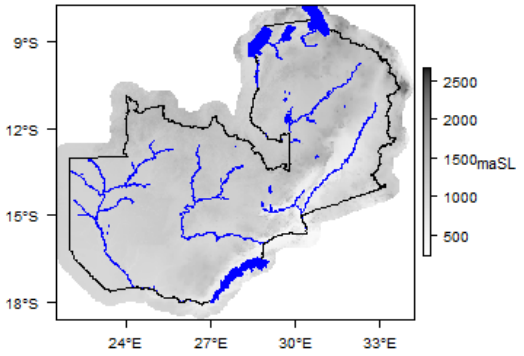
What's inside the Atlas: Climate, Soil, Land Cover

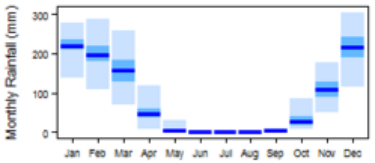
- Derived from 3rd party data
- Easy to compare from one country to another

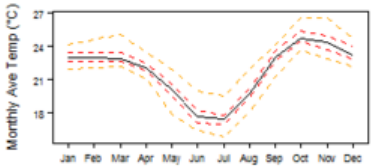


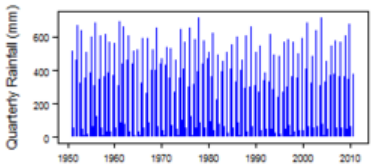


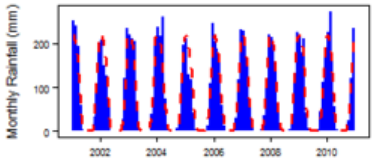






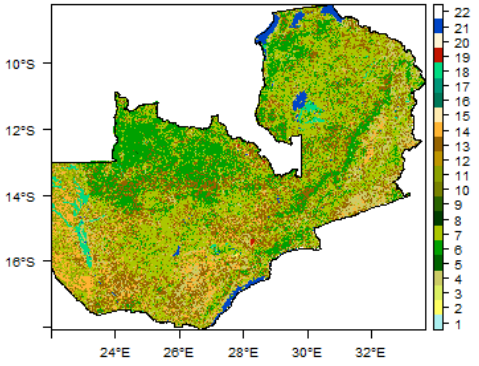


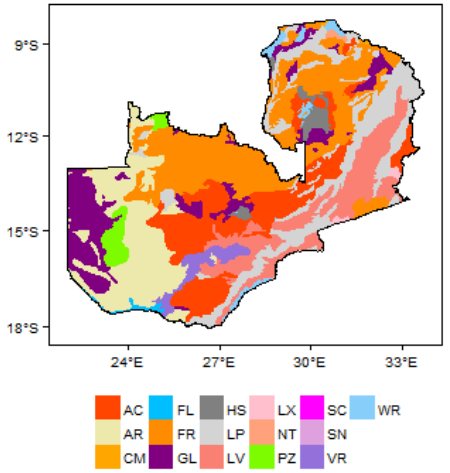




Answers to questions like:

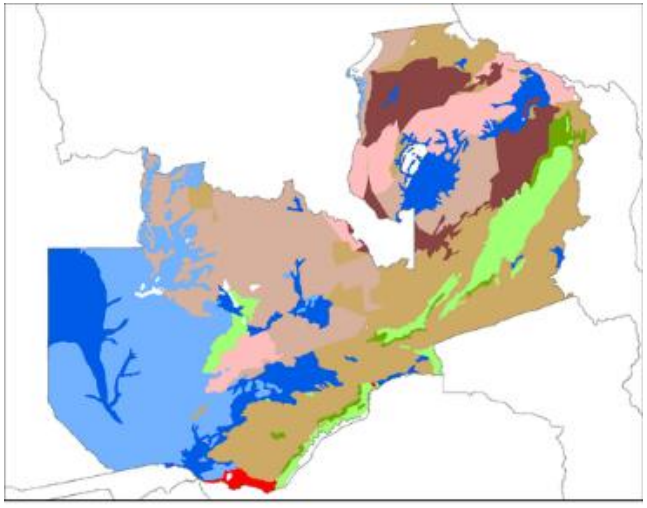
- When is the recharge season?
- Have there been droughts in recent year
- Are there areas with no surface water resources?





What's inside the Atlas: Geology

Summary of main geological formations

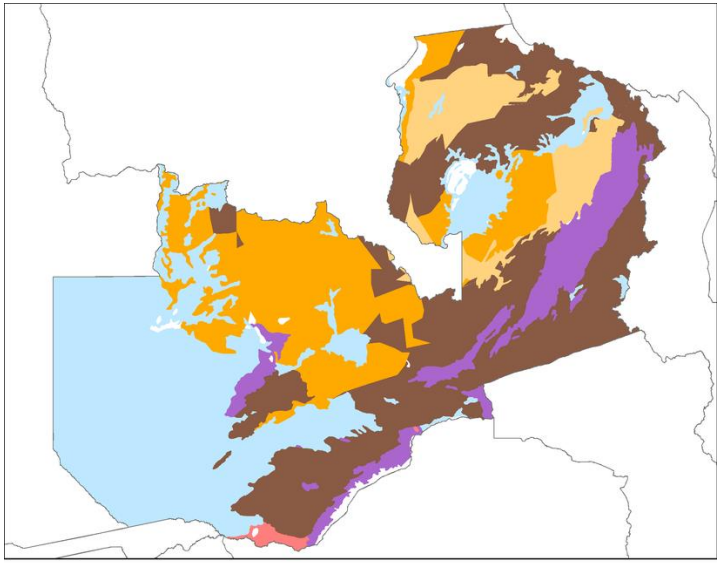


Geological Environments

Key Formations	Period	Lithology	Structure
Alluvium			
Alluvium and lacustrine deposits	Recent (Quaternary)	Unconsolidated alluvial soil, sands and gravels; and some clays near lakes	
Kalahari Group			
Zambezi Formation	Tertiary - Recent	Ferricrete, evaporites, conglomerate and gravel	
Barotse Formation	Tertiary	Sandstone, Chert, Quartzite	Sedimentary bedding
Upper Karoo Group and Karoo Basalts			
Luano, Siavonga, Kato, Luangwa and Batoka formations	Jurassic - Early Cretaceous	Most of the sequence comprises consolidated sedimentary rocks: mudstone, sandstone, siltstone, coal, gritstone, tillite, mixtite and conglomerate. The uppermost Batoka Formation consists of basalt with interbedded sandstone, distinguished on the geology map above as Karoo Basalts.	Sedimentary bedding, laminations and ripple marks
Lower Karoo Group			
Siakandobo, Gwembe and Madumabisa formations	Carboniferous - Jurassic	Consolidated sedimentary rocks: sandstone, gritstone, siltstone, mudstone	Sedimentary bedding, laminations and ripple marks
Katanga Supergroup			
Including Upper Roan Dolomite, Lusaka, Kaleya, Chifumbu and Chafugoma formations and Kundelungu Limestone	Precambrian (870-620 Ma)	Variably metamorphosed mable, schist, argillite, quartzite, dolomite and limestone.	Sedimentary bedding; metamorphic foliation and banding; folding
Muva Supergroup			
Kankaluwe, Rufunsa and Chakwenga River formations	Precambrian (1355+/-28 Ma)	Metamorphic rocks: carbonatite, gabbro, amphibolite, granodiorite and schist	Metamorphic foliation; jointing and folding
Chitobe, Kabweluma, Nsama and Mbala formations	Precambrian (1355+/-28 Ma)	Variously metamorphosed conglomerate, quartzite, limestone and carbonates	Metamorphic foliation; jointing and folding
Basement Complex: Granite			
	Mainly older Precambrian	Granite	Quartz veins.
Basement Complex: undifferentiated			
	Mainly older Precambrian	Metamorphosed rocks; gabbro, basalt, granite, dolerite, aplite, andesite.	Quartz veins; faulted, folded and jointed

What's inside the Atlas: Hydrogeology

Summary of key aquifers



Aquifer Type and Productivity

- Unconsolidated - Low to Moderate
- Igneous Volcanic - Low
- Sedimentary Intergranular/Fracture - High and Variable
- Sedimentary Fracture - High
- Sedimentary Fracture - Low to High
- Basement - Low to Moderate

Answers to questions like:

- Where are the high yielding aquifers?
- Is groundwater storage and flow in pores or weathered zones or fractures?
- What are typical borehole yields from an aquifer?
- What is the groundwater quality?

Unconsolidated: Intergranular Flow

Named Aquifers	General Description	Water quantity issues	Water quality issues	Recharge
Alluvium (Quaternary)				Direct recharge from rainfall, and recharge from rivers.
Kalahari Group (Tertiary)	This aquifer comprises 20 to 40 m of unconsolidated sands, which are usually unconfined. Flow and storage are intergranular. The water table is usually at a depth of about 10 to 20 m below ground surface, but sometimes is as much as 30 m deep. Yields of 0.2 to 5 l/s are obtainable.		Sometimes brackish.	Largely direct recharge from rainfall.

Igneous

Named Aquifers	General Description	Water quantity issues	Water quality issues	Recharge
Karoo Basalts	The aquifer comprises basalts with interbedded sandstone. It is characterised by a weathered zone up to 20 m deep. Below this are fractures that allow groundwater flow, which are more common above about 45 to 50 m depth. The aquifer is unconfined, and the water table varies from about 10 to 25m deep. Boreholes are usually between 45 and 50 m deep, to the base of the most fractured zone. One transmissivity value quoted for the aquifer is 5.7 m²/day. Borehole yields are usually low, less than 2 l/s. Higher yields may be encountered in zones where low permeability crystallised quartz horizons have created 'dams' and increased local groundwater storage, although such higher yields may not be sustainable in the long term as groundwater storage is used up.		Usually good	Recharge can occur through fractures

Upper and Lower Karoo Groups: Consolidated Sedimentary Aquifer with Intergranular & Fracture Flow

Named Aquifers	General Description	Water quantity issues	Water quality issues	Recharge
Upper and Lower Karoo Groups	Sandstones in the Karoo sequence form high porosity, high permeability aquifers with significant intergranular flow. The aquifers are typically unconfined, but occasionally confined.The water table is often between 15 to 20 m below ground surface. Yields of up to 15 l/s are possible. Shales, mudstones and other fine grained lithologies in the Karoo sequence typically form low productivity aquifers, with yields of 0.2 to 2 l/s.		Sometimes fresh, but in most cases brackish.	Direct recharge.

What's inside the Atlas: Additional GW Info

- Quality
- Status
- Use
- Management

Answers to questions like:

- What are the main uses of groundwater?
- Are there any big groundwater problems? (water quality? over-abstraction?)
- Which institutions are involved with groundwater management?
- Is there groundwater monitoring?
- Are there national groundwater databases?

Groundwater use and management

Groundwater use

There are currently inadequate data to make an accurate assessment of Zambia's groundwater availability and use. Personal experiences and estimates would put groundwater usage at about 60% – 70% of total national water supplies, although this is highly variable spatially.

The groundwater resource has greatly suffered from unregulated exploitation and exposure to pollution – aspects that may threaten it as an important source of water in the future.

The National Water Master Plan (JICA-MEWD, 1995) estimated that the breakdown of groundwater use was:

- 30% irrigation
- 27% rural water supply
- 22% livestock
- 13% urban supply.

Groundwater is accessed from a variety of sources: boreholes equipped with electric pump, hand-pumps, windmills, solar pump, diesel pumps and rope and bucket. There are no recent statistics on the different pump technologies employed, but a nationwide inventory carried out by government in 1998 produced an estimated total of 11,000 boreholes (electric and hand pump) and 22,000 protected wells in the country (National Water Policy 2010).

Groundwater management

The key groundwater institutions are:

- Department of Water Affairs – for water policy formulation.
- Ministry of Local Government and Housing – for rural water supply
- Water Resources Management Authority (WARMA) – for water resources development, utilisation and management

The legal framework for groundwater monitoring in Zambia comprises the following:

- The Revised National Water Policy of 2010
- The Water Resources Management Act of 2011, which stipulates that there shall be no private ownership of water and that any permission to use water will be time-limited. The Act provides for permits to drill and abstract groundwater, but these have not yet been implemented. The greatest challenge to effective (ground)water resources management in the country is posed by poor institutional and legal frameworks; inadequate water resources data and information systems; poor coordination of various ministries, departments and institutions dealing with water; centralised management of water resources; and lack of monitoring and evaluation of programmes and projects relating to water (National Water Policy 2010).

There is much good information on water points, including boreholes and wells, but it is fragmented across several institutions. For example, there is a well-organised borehole database for the Southern region, including geological logs, related to a project carried out by GTZ.

Transboundary aquifers

Zambia has two transboundary aquifers identified by the SADC Hydrogeological Mapping Project (SADC, 2010). The "Medium Zambezi Aquifer" crosses the border with Zimbabwe, and the "Sands and gravel aquifer" crosses the border with Malawi.

For further information about transboundary aquifers, please see the Transboundary aquifers resources page

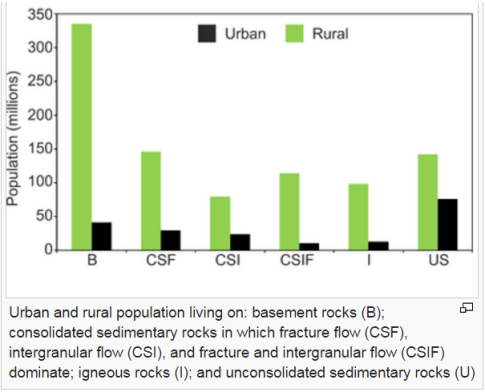
Groundwater monitoring

Groundwater level measurements are taken automatically at some stations in Lusaka on a daily basis, while in other places, these are read fortnightly.

There is no national or regional groundwater quality monitoring.

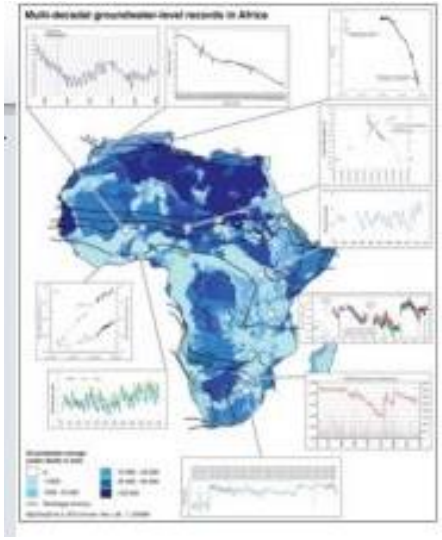
What's inside the Atlas: Additional Resources

Groundwater use

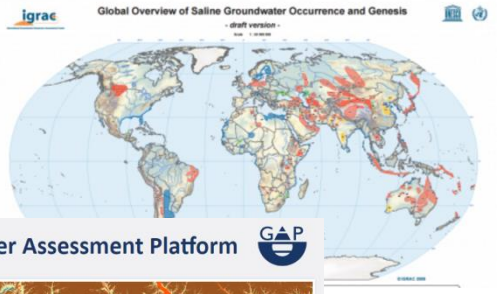


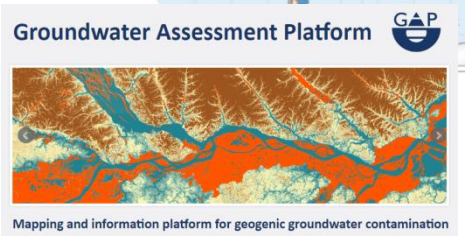
Urban and rural population living on: basement rocks (B); consolidated sedimentary rocks in which fracture flow (CSF), intergranular flow (CSI), and fracture and intergranular flow (CSIF) dominate; igneous rocks (I); and unconsolidated sedimentary rocks (U)

Groundwater monitoring



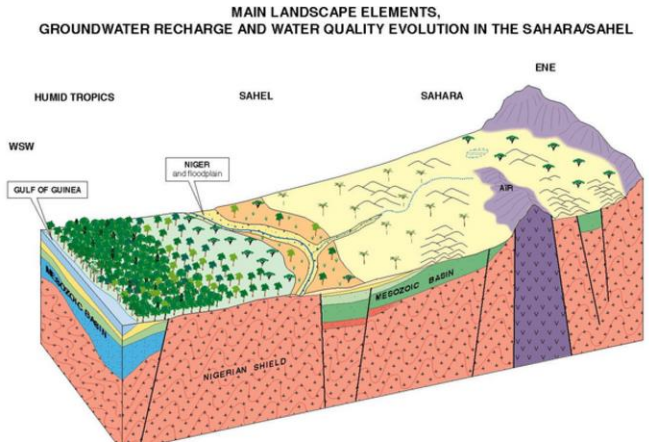
Groundwater quality





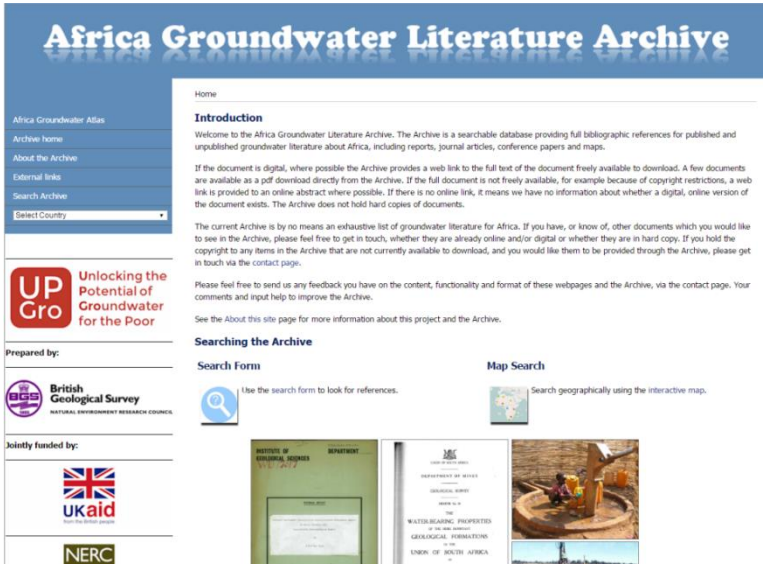
Mapping and information platform for geogenic groundwater contamination

Recharge



Where to find more information: Africa Groundwater Literature Archive

- The most comprehensive yet index of African groundwater literature: ~7000 entries (so far!)
- Full text download if available; or for copyrighted documents, link to online abstract if available
- Full bibliographic references
- Complements other literature archives: e.g. WRC; IRD; SADC Grey Literature Archive



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What's new and coming?

- Digital (GIS) hydrogeology and geology maps should be ready in November
- Translation into French of all Francophone countries
- Increasing relevant social science information
- Adding new references & documents to the Literature Archive – as many as possible with full text digital copies
- Water statistics (from AQUASTAT) on each country page
- Case studies illustrating a range of GW issues, and demonstrating how GW info can be used practically for management purposes at different scales

The Consortium Projects (2015-19)

- BRAVE
- Hidden Crisis
- T-GroUP
- Gro for GooD
- *Grofutures*

Working in **Benin, Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Niger, Nigeria, South Africa, Tanzania, Uganda**

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If you have any comments on the Atlas or Archive, please get in touch.

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Email us on **AfricaGWAtlas@bgs.ac.uk**

The Africa Groundwater Atlas is at:

http://www.bgs.ac.uk/africagroundwateratlas/index.cfm

skat Swiss Resource Centre and Consultancies for Development

RWSN

UPGro Knowledge Broker:
Skat Foundation, Vadianstrasse 42, CH-9000, St Gallen, Switzerland
in association with the Rural Water Supply Network (RWSN)

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