British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Gateway to the Earth

Africa Groundwater Atlas

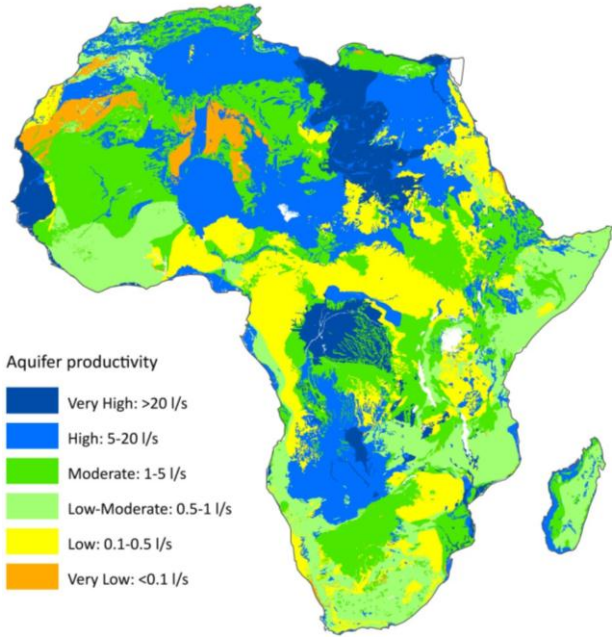
Making groundwater information and data available for Africa

UPGro Unlocking the Potential of Groundwater for the Poor

Brighid Ó Dochartaigh, Alan MacDonald, Kirsty Upton, Emily Crane, John Talbot

Aims:

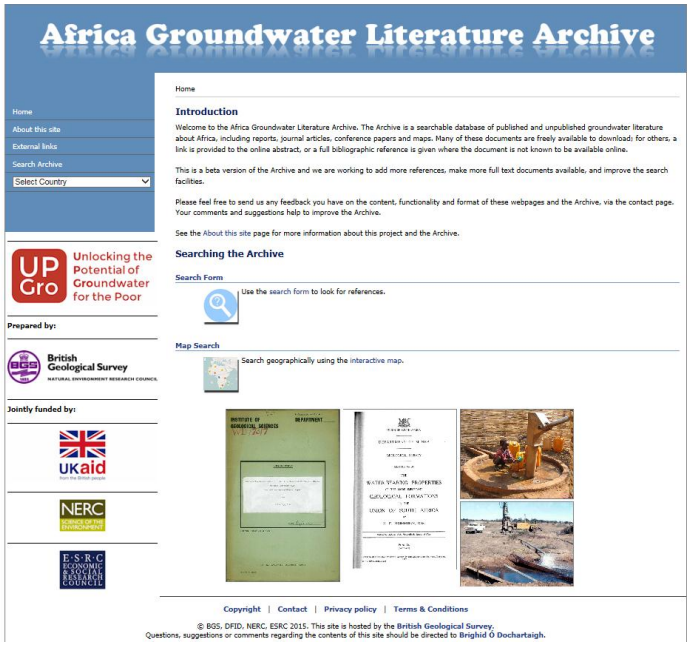
- to make groundwater information much more accessible for Africa
- to provide an introduction to African groundwater



1. Web-based database for georeferenced reports
2. Web-based groundwater atlas
3. Companion hard copy (IAH book) groundwater atlas
4. Long term (>10 yrs) groundwater datasets
5. Ensure long term maintenance of online resources

Africa Groundwater Literature Archive (AGLA)

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



- >6000 references
- Includes unpublished reports, journal articles, maps, conference papers & academic theses
- All with country & subject keywords
- ~1300 georeferenced with coordinates
- ~1000 weblinks to online documents – full text or abstract
- Searchable by keyword, country or map. Refined search by title or author

Africa Groundwater Literature Archive

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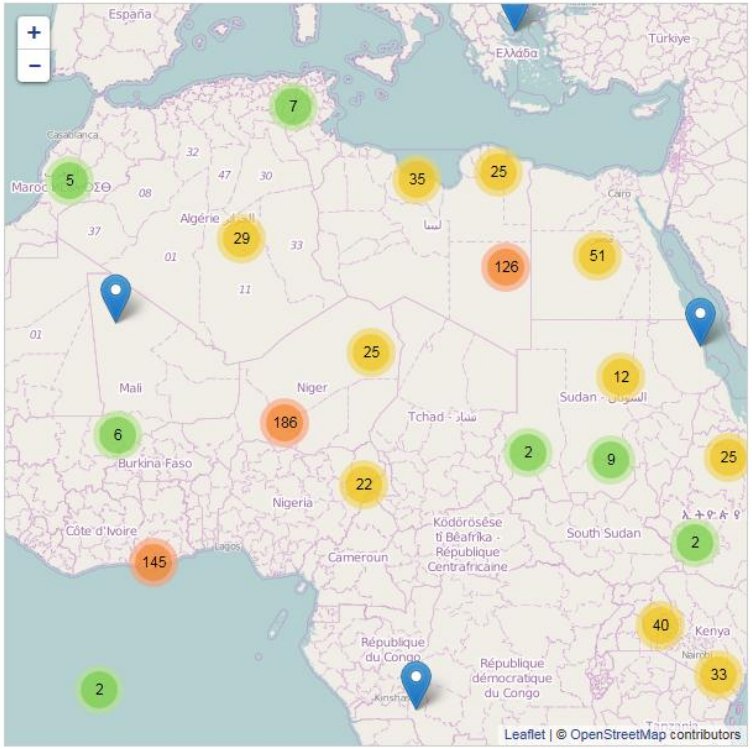
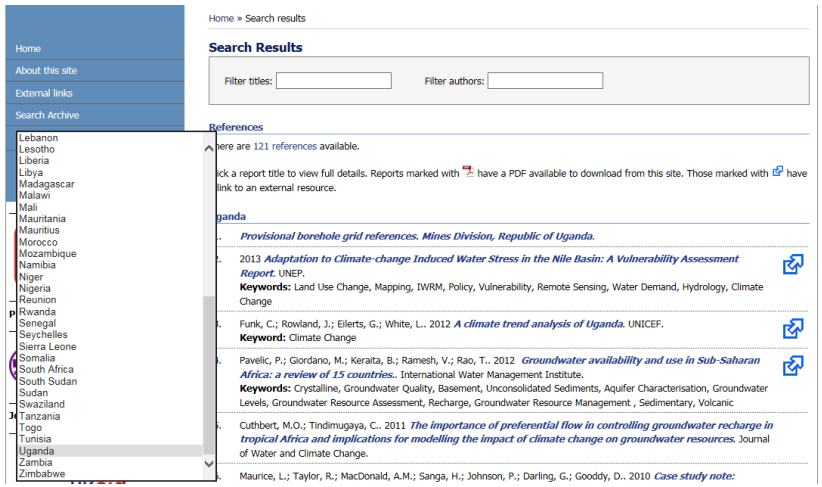
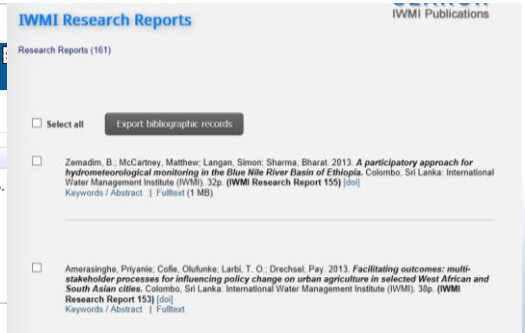
Search the Africa Groundwater Literature Archive

The map shows the locations of 1048 references that have been georeferenced so far, out of a total of 6274 references in the are working to georeference more and these will be added soon.

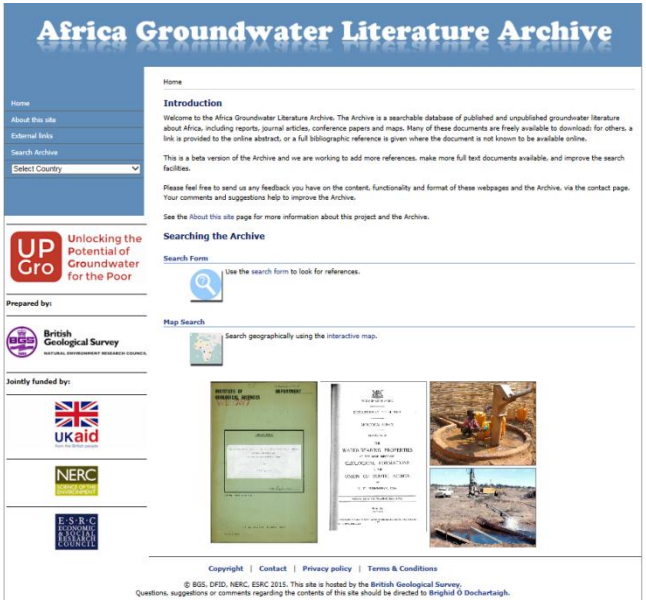






AGLA: Current Status

- Database being QA'd and online search facilities refined (Apr-May 2015)
- Additional key references being collated from Atlas country authors (Jan-May 2015)
- Additional references to be attributed and added to database (summer 2015)



Africa Groundwater Atlas

- Systematic summary of groundwater resources and management in each country
- Gateway to further information
- Online, Wikipedia-style
- Geology & hydrogeology written with African hydrogeologists
- New geology & hydrogeology downloadable maps for each country, refined in collaboration with African hydrogeologists
- Additional information for each country on climate, surface water, soil type and land cover
- Additional resources on issues such as groundwater quality, groundwater use and transboundary aquifers

Atlas: Development I

- Country authors (>110) invited to participate (Oct-Nov 2014)
- Templates sent to >50 authors in 47 countries (Nov-Dec 2014)

Atlas: Development II

- Webinars held with authors (Jan 2015)
- Templates returned (Jan 2015-ongoing):
  - **19 countries** returned so far
  - Discussions ongoing with authors from **16 more countries**
  - For 17 countries = no contact with potential authors yet
- Returned templates edited into online format (Mar-June 2015)
- Online pages agreed with country authors (May-July 2015)
- Pages made live (summer 2015)
- Remaining country pages written and made live (summer-autumn 2015)
- Content edited for printed Atlas (IAH publication) (winter 2015)

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Overview of Africa Groundwater Atlas

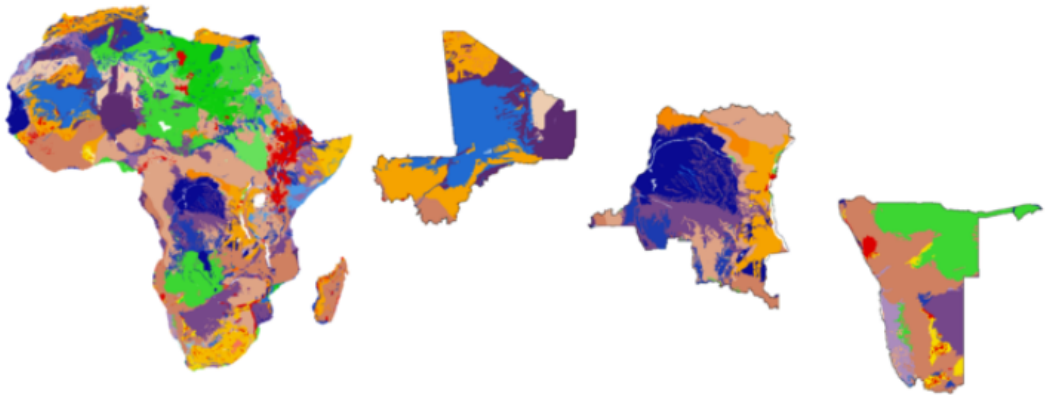
The Africa Groundwater Atlas is an online resource providing detailed information on groundwater for every country in Africa. The aim of the Atlas is to improve the availability and accessibility of robust information on groundwater, making it available to a wide range of stakeholders, so that this precious resource can be developed and used in a safe and sustainable way for many years to come.

There are two main parts to the Atlas:

1. the Africa Groundwater Atlas

This provides a gateway to the hydrogeology of every country in Africa and has been co-written by experts working within each country. The Atlas provides an overview of the hydrogeology of Africa at a continental scale, summarizing the main hydrogeological environments and some of the key issues related to groundwater use and management. The Atlas contains a profile on the hydrogeology of each country, which provides consistent information on groundwater, as well as climate, hydrology, soil, land use and geology. Links to data and further information are provided in a series of resource pages, which give background information on many related issues, such as recharge and transboundary aquifers.

The links below can be used to navigate the main sections of the Atlas:



Overview of Groundwater in Africa

- Hydrogeological Environments
- Groundwater Quality
- Groundwater Use and Management

Hydrogeology by Country

This includes links to profiles on the hydrogeology of each country in Africa

To view a full list of all contributing authors please see here

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Hydrogeology by country

This page provides links to the hydrogeology profile of each country in Africa. The profiles have largely been written in collaboration with hydrogeologists or groundwater experts working in the relevant countries. The amount of information available for each country varies considerably but the profiles are designed to provide consistent and reliable information. Where additional information is available elsewhere, links or references have been provided where possible.

Profiles are available for the following countries:

A

- Hydrogeology of Algeria
- Hydrogeology of Angola

B

- Hydrogeology of Benin
- Hydrogeology of Botswana
- Hydrogeology of Burkina Faso
- Hydrogeology of Burundi

C

- Hydrogeology of Cameroon
- Hydrogeology of Central African Republic
- Hydrogeology of Chad
- Hydrogeology of Comoros
- Hydrogeology of Cote d'Ivoire

D

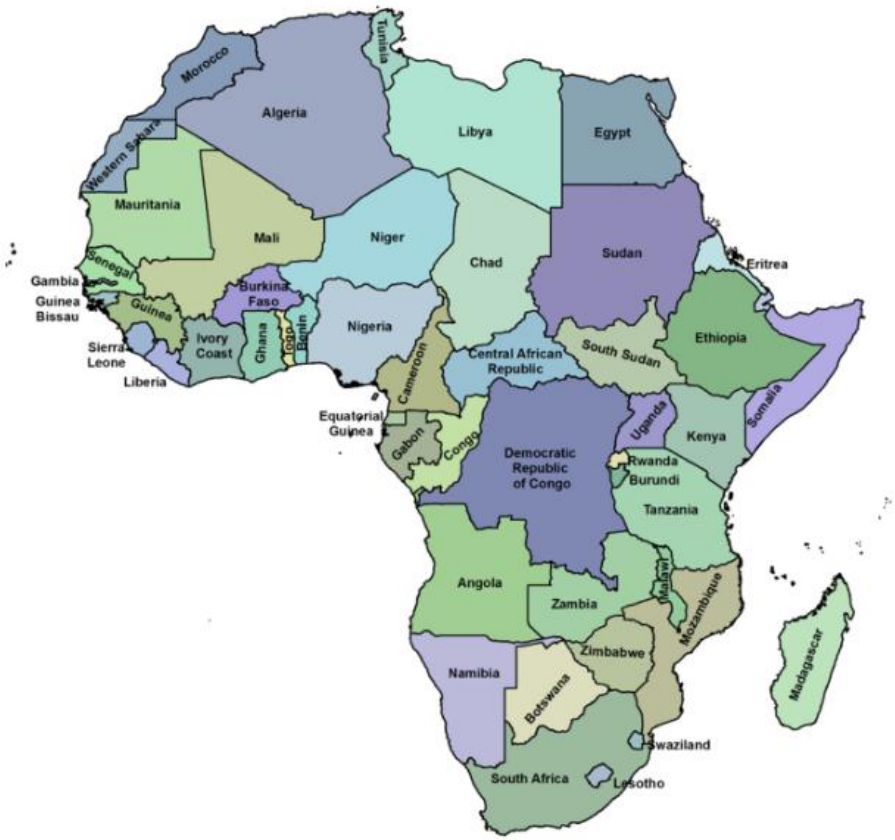
- Hydrogeology of Democratic Republic of the Congo
- Hydrogeology of Djibouti

E

- Hydrogeology of Egypt
- Hydrogeology of Equatorial Guinea
- Hydrogeology of Eritrea
- Hydrogeology of Ethiopia

G

- Hydrogeology of Gabon
- Hydrogeology of Gambia
- Hydrogeology of Ghana



Hydrogeology of Uganda

Contents [hide]

Authors [edit]

Michael Owor, Makerere University, Uganda

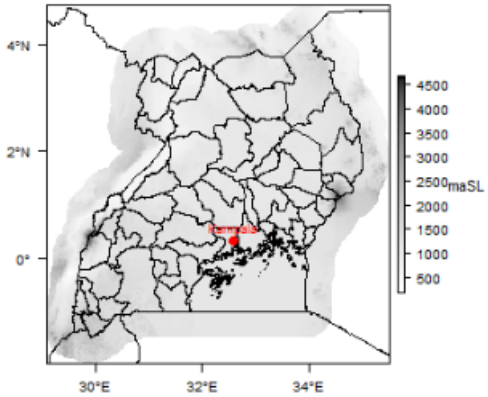
Callist Tindimugaya, Ministry of Water and Environment, Uganda

Geographical & Political Setting [edit]

General [edit]

Much of Uganda is located on the East African plateau, which has an elevation of 800-2000 m above sea level. Mountainous regions along the western (Ruwenzori Mountains) and eastern borders reach an elevation of over 4000 m.

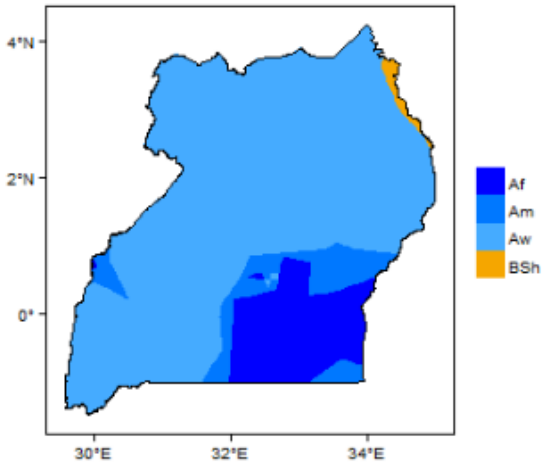
Estimated Population in 2013*	37,578,876
Rural Population (% of total)*	85%
Total Surface Area*	199,810 sq km
Agricultural Land (% of total area)*	71%
Capital City	Kampala
Region	Eastern Africa
Border Countries	South Sudan, Democratic Republic of the Congo, Rwanda, Tanzania, Kenya
Annual Freshwater Withdrawal (2013)*	317 Million cubic metres
Annual Freshwater Withdrawal for Agriculture*	38%
Annual Freshwater Withdrawal for Domestic Use*	48%
Annual Freshwater Withdrawal for Industry*	14%
Rural Population with Access to Improved Water Source*	71%



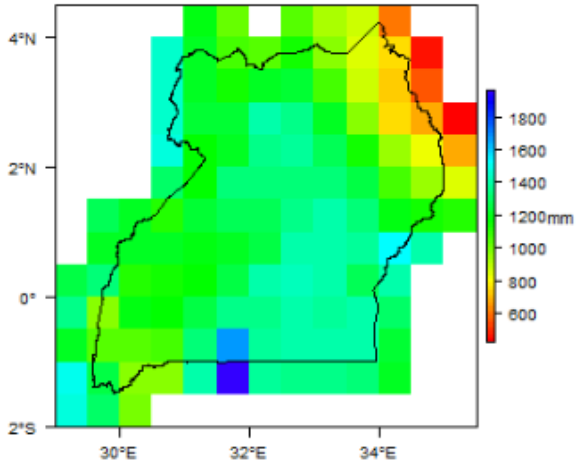
Political Map of Uganda (For more information on the datasets used in the

Climate [edit]

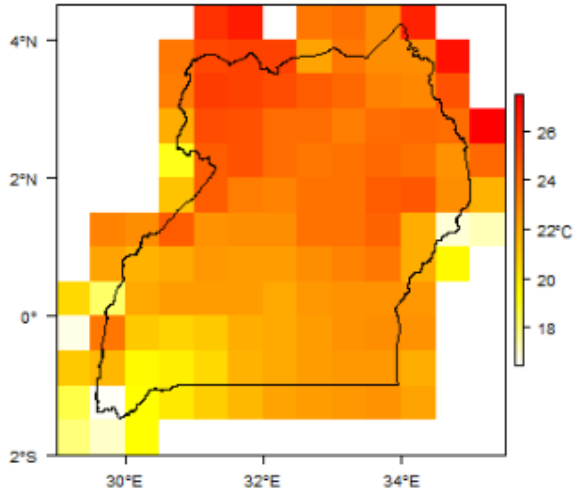
The climate of Uganda is classified as tropical, but varies from rainforest or monsoon in the southeast to drier and hotter savannah in the north. Average annual precipitation in the north is around 600 mm, while in the south it is more than 1600 mm.



Koppen Geiger Climate Zones



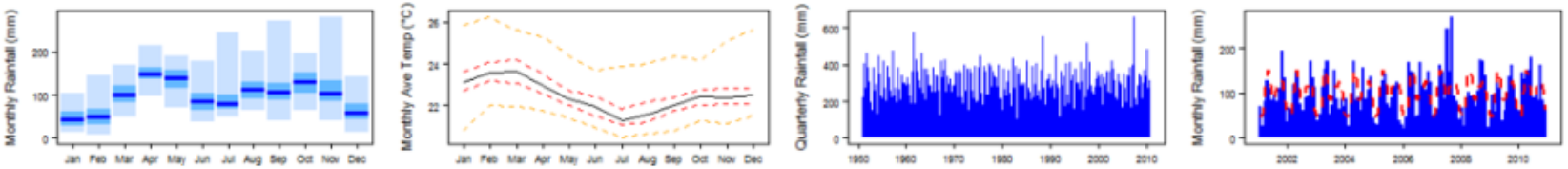
Average Annual Precipitation



Average Temperature

Rainfall generally occurs throughout the year, particularly in the south of Uganda. There are two wetter seasons between March and May, and September and November. Temperatures are slightly higher during the wet seasons.

Rainfall time-series and graphs of monthly average rainfall and temperature for each individual climate zone can be seen on the Uganda Climate Page.



For further detail on the climate datasets used see the climate resources section.

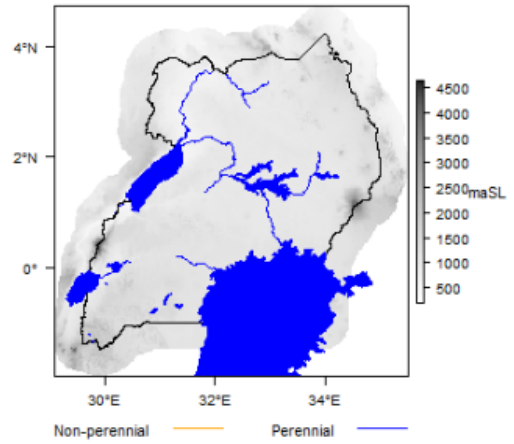
Surface water [edit]

The southeast of Uganda is dominated by Lake Victoria, which also extends into neighbouring Kenya and Tanzania.. Several lakes are also located within the Western Rift Valley, which runs approximately north-south along the western border of the country.

The majority of Uganda sits within the drainage basin of the River Nile. Lake Victoria is the source of the White Nile, which runs north through Uganda as the Victoria Nile, through Lake Kyoga in central Uganda and into Lake Albert in the west. From Lake Albert, the Albert Nile runs northwards towards the border with South Sudan.

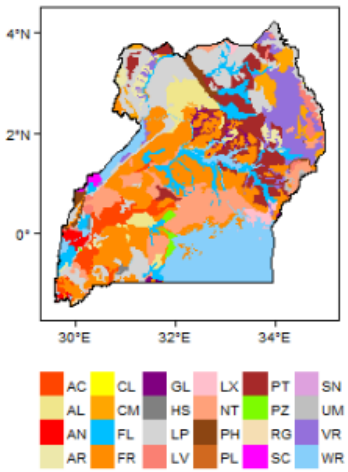
Lake Albert, Lake George and Lake Edward are situated in the Western Rift Valley along the border with the Democratic Republic of the Congo.

River flow gauging has been carried out at various locations in Uganda since the early-mid 1950s. Most stations provide daily measurements, which are held by the Directorate of Water Resources Management, Ministry of Water and Environment (Entebbe).



Surface Water Map of Uganda (For more information on the datasets used in the map see the surface water resources section)

Soil [edit]



Soil Map of Uganda (For more information on the datasets used in the map see the soil resources section)

Fluvisols are present along the main river systems, particularly the Victoria Nile as it flows towards the Western Rift Valley.

The south and centre of Uganda is dominated by Ferrasols, Acrisols, and Nitisols. Ferrasols are widespread in central and eastern Africa and are generally associated with high rainfall and relatively old (Tertiary) land surfaces. As a result, they are highly leached. Acrisols, which are acidic and clay-rich, also form in areas with high rainfall and are generally nutrient-deficient.

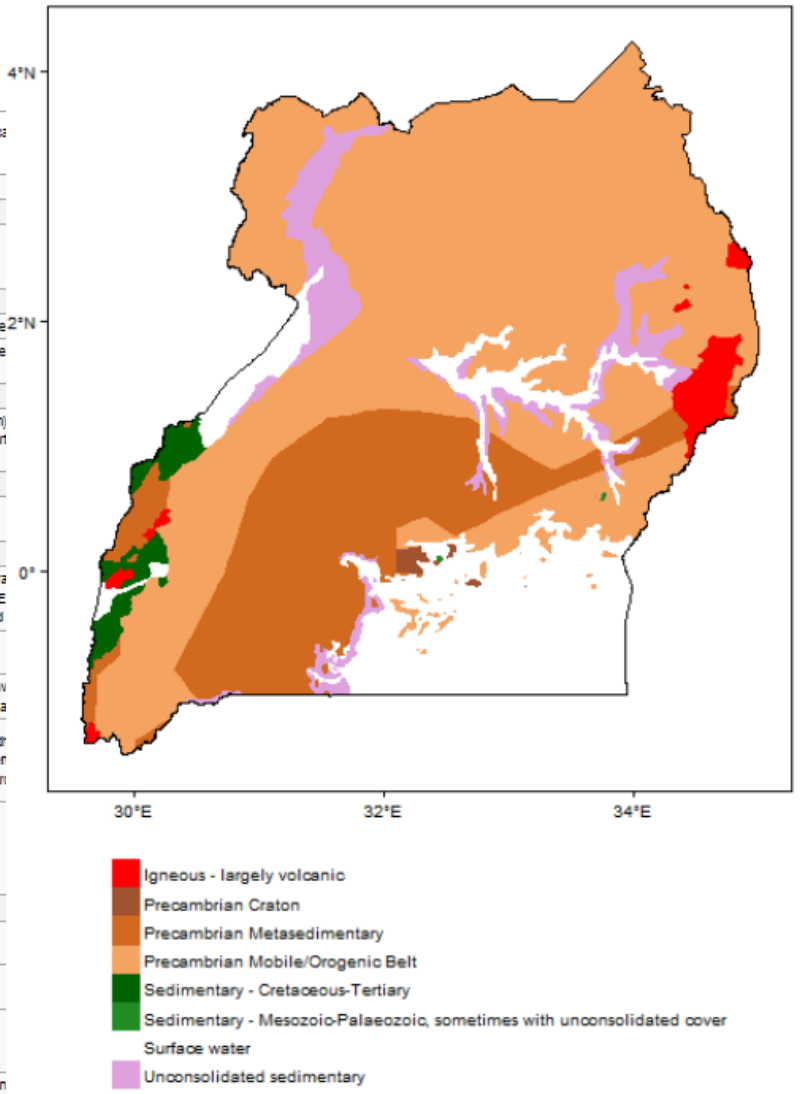
Nitisols are commonly found on iron-rich basic rocks with gently sloping ground. They have a high clay content and are very fertile. Clay-rich Vertisols have also developed over weathered basic rocks, but are more commonly found on valley floors in the north-east of Uganda.

Leptosols, which are generally shallow and form over hard rock or gravelly material, are common in the northwest of Uganda.

Geology [edit]

The geology of Uganda has been described in detail in a report by the Geological Survey of Finland: "Geology and Geodynamic Development of Uganda with Explanation of the 1:1,000,000 Sca

Geological Environments			
Key Formations	Period	Lithology	Structure
Unconsolidated Sedimentary			
Lake Victoria strandline deposits, Lake Kyoga raised beach deposits, and Albertine Nile deposits	Pleistocene-Holocene	Discontinuous deposits, predominantly beach sands and gravels, with finer silts and clays.	
Igneous			
Elgon Complex	Neogene	Pyroclastic and lahar-type alkaline/sodic volcanic rocks and associated carbonatite plugs and fenites	Deposited in the
Albertine Group	Pleistocene-Holocene	Ultrapotassic and carbonatitic volcanic rocks	Deposited in the Western Rift
Sedimentary – Cretaceous-Tertiary			
Albertine Graben	Late Eocene-Neogene	This is a hydrocarbon-bearing sequence of terrigenous sediments, alkaline/sodic volcanics and ultra-potassic and carbonatitic volcanics.	This thick (4 km) which forms part System.
Sedimentary – Mesozoic-Palaeozoic			
Karoo Basins	Mesozoic-Palaeozoic	Karoo deposits are restricted to a few small occurrences in southern Uganda and comprise clays, minor arenaceous and carbonaceous beds, siltstone, diamictites and dropstones.	
Precambrian Metasedimentary			
Rwenzori Fold Belt	Palaeoproterozoic	Gneissose-granitoid basement in southern Uganda formed during the Eburnian Orogenic Cycle.	The fold belt wra predominantly E into a N-S trend
Buganda Group	Palaeoproterozoic	Metasediments and mafic, partly pillow-textured volcanics overlying the Rwenzori fold belt. The Buganda group is intruded by syn- and post-tectonic granitoids of the Sembabule and Mubende-Singo suites.	
Kagera-Buhweju Supergroup	Palaeoproterozoic	Deposited following the Eburnian Orogenic Cycle, these platform deposits comprise post-tectonic molasse-type sediments, including quartzite, pelite, conglomerate, shale and phyllite.	These rocks hav processes and a
North Kibaran Belt	Palaeoproterozoic	This belt in southwest Uganda, which is younger than the Kagera-Buhweju Supergroup, includes metasediments of the Akanyaru-Ankole Supergroup and the North Kibaran Igneous Province. The North Kibaran Igneous Province consists of an alignment of mafic and ultramafic layered complexes and mafic dykes and sills, including the Lake Victoria Arcuate Dyke Swarm.	The estimated th 9-14.5 km in cen North Kibaran tr
Mityana Group & Bunyoro Group	Palaeoproterozoic	The Mityana Group overlies the Buganda Group and consists of platform sediments including conglomerate, sandstone, siltstone and gritstone. It is not intruded by dykes of the Lake Victoria Arcuate Dyke Swarm and is therefore younger than the metasediments of the North Kibaran Belt. The younger Bunyoro Group comprises rocks of glacial and periglacial origin related to the Sturtian glaciation.	
Precambrian Mobile/Orogenic Belt			
West Nile Block	Archean	This forms the Ugandan section of the Bomu-Kibalian Shield of northeastern Congo. It is predominantly composed of Mesoarchean granulite, gneiss, granitoid and charnockite, and is intruded by younger (Neoarchean) mafic volcanics.	
North Uganda Terrane	Archean	This unit is mainly composed of Neoarchean gneissose-migmatic rocks and is separated from the western Nile Block by the Madi-Igisi Belt.	
Madi Igisi Belt	Archean-Proterozoic	This is a narrow thrust and shear belt trending north-south between the West Nile Block (WNB) and North Uganda Terrane (NUT). It is composed of reworked rocks of the WNB and NUT and younger Proterozoic meta-volcanics, metasediments and ultramafics.	
Karamoja Belt	Proterozoic	The Karamoja Belt is found along the border with Kenya and is a representation of the East African Orogen. It comprises a west to north-west trending thrust belt of amphibolite-grade supracrustals, granitoids and ophiolites.	This belt contain ductile, north-we complex, anasto
Midigo-Adjumani Suite	Proterozoic	This suite of granitoids is found in the West Nile Block and North Uganda Terrane in northern Uganda.	
Precambrian Craton			
Lake Victoria Terrane	Neoarchean	Forms part of the Tanzania Craton and is a predominantly a granite-greenstone terrane with nepheline syenite and gabbro intrusions.	
West Tanzania Terrane	Neoarchean	Also forms part of the Tanzania Craton comprising granitoid-gneissic-migmatic rocks.	

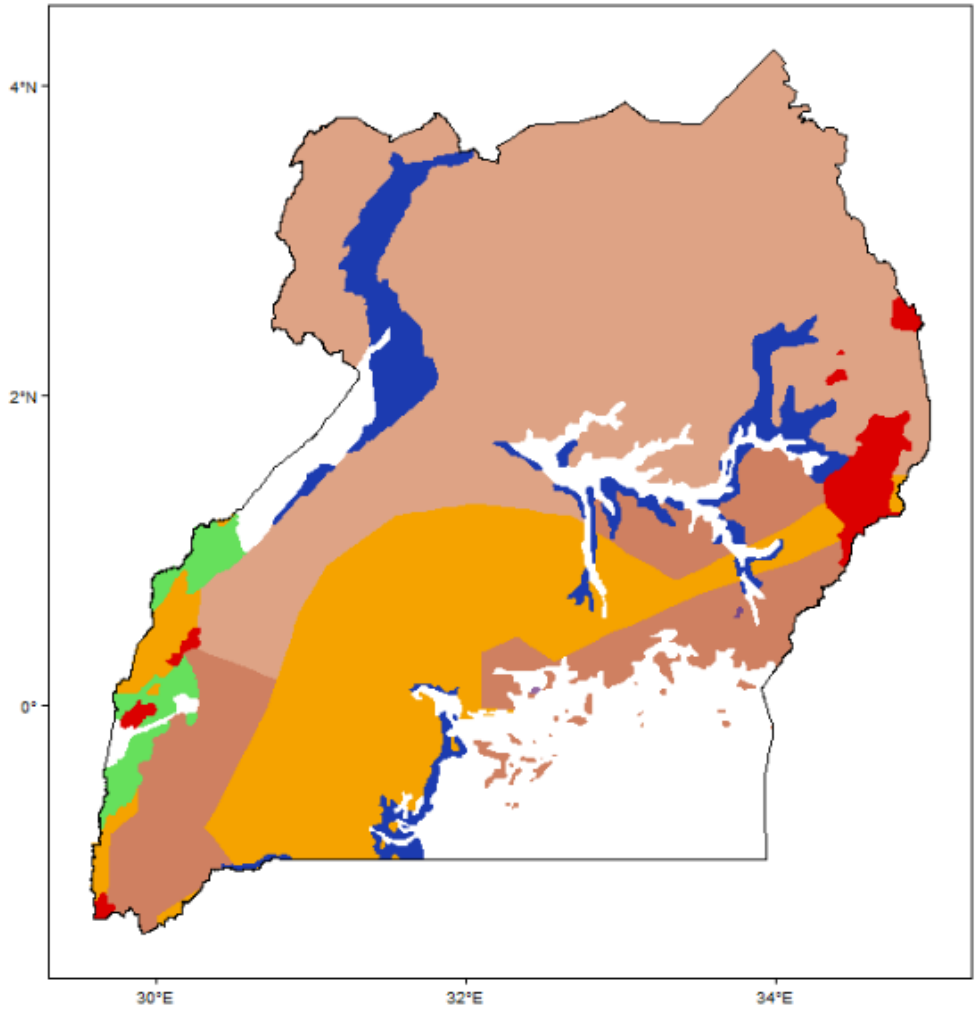


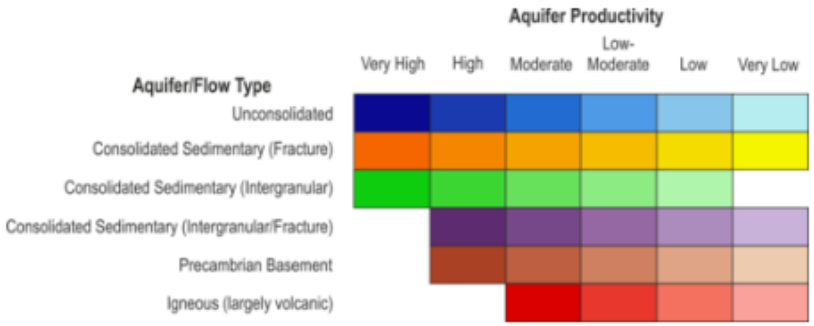
Hydrogeology [edit]

The main aquifers in Uganda are found in weathered crystalline basement rocks. These are generally low-permeability and low-storage aquifers, and the physical properties are largely a function of tectonic history and long-term cycles of weathering and erosion. Unconsolidated deposits also form aquifers of local importance.

Igneous, sedimentary and metasedimentary rocks are not widely used as aquifers and little is therefore known about their properties.

Aquifer properties [edit]





Unconsolidated [edit]

Named Aquifers	General Description	Water quantity issues	Water quality issues	Recharge
Fluvial aquifers	Unconsolidated aquifers are generally found along current river channels or palaeochannels in which fluvial/alluvial gravel, sand and silt have been deposited. Yields of more than 50 m³/hour are possible in the unconsolidated fluvial aquifers. Hydraulic conductivity typically varies between 0.02 and 15 m/day, while average transmissivity is 34 m²/day. Average storage is 0.1. Unconsolidated aquifers in Uganda are generally unconfined or semi-confined. They can be greater than 50 m thick where there are significant palaeochannel deposits. Water table depths are highly variable and may be up to 20 m below the ground surface. Borehole depths are also variable, but may be up to 60 m when drilled into palaeochannels.		Groundwater from the unconsolidated fluvial aquifers typically has low total dissolved solids (<1000 mg/l). The shallow aquifers are highly vulnerable to pollution; microbial contamination has been observed in many urban areas as a result of inadequately contained faecal waste.	The unconsolidated fluvial aquifers are actively recharged by rainfall.

Basement [edit]

Named Aquifers	General Description	Water quantity issues	Water quality issues	Recharge
Basement Complex	The basement complex generally forms discrete aquifers of limited spatial extent. They occur within the unconsolidated weathered regolith (saprolite), or underlying fissured bedrock (saprock). The bedrock permeability is greatest close to the saprock-saprolite interface and decreases with depth. It is largely controlled by the number, distribution, and connectivity of fissures/fractures. The permeability of the saprolite is highly variable, but is an important source of groundwater storage. Yields in the basement complex vary between 0.5 and 12 m³/hour, with higher yields generally found in the fissured granites and gneiss. The bedrock aquifer have an average transmissivity of 14 m²/day and an average storage coefficient of 0.014 (although it can be as low as 10-4). The transmissivity of the weathered zone typically ranges from 0.1 to 20 m²/day, with an average of 16 m²/day. Average storage in the weathered zone is 0.21. The basement aquifers are generally semi-confined or leaky. The depth of the piezometric surface or water table can range from 1 to 45 m, but is typically 5-20 m below the ground surface. The aquifers are typically between 20 and 45 m thick and boreholes are generally drilled to depths of 45-70 m.	Abstraction from the basement aquifers is usually by hand pump and rates are therefore low. Some towns with motorised pumps, which are able to abstract at higher rates, are experiencing declining water levels, for example Rukungiri in southwestern Uganda.	There are no widespread water quality issues. However, elevated iron and manganese are common in groundwaters from alumina-enriched laterite deposits. High salinity is occasionally reported, total dissolved solids are typically around 500 mg/l, and pH is usually neutral to slightly acidic. Where the weathered aquifer is shallow, it is likely to be vulnerable to contamination, e.g. from latrines.	Groundwater in the basement aquifers is actively replenished through recharge from rainfall, particularly during the wetter monsoon periods, at an estimated rate of 12-200 mm/year.

Groundwater Status [edit]

Groundwater monitoring and the collation and archiving of groundwater data in the National Groundwater Database have led to a better understanding of groundwater resources in Uganda.

There are currently no widespread issues with groundwater quantity, although localised groundwater depletion may be an issue where the low permeability basement aquifers are exploited by high yielding electric pumps.

Groundwater quality is generally good, although high concentrations of iron and manganese are common in the crystalline basement aquifers and microbial contamination related to faecal waste has been observed in shallow urban aquifers. High fluoride concentrations are often observed in igneous groundwaters, for example at Kisoro and Mbale.

Groundwater is known to maintain baseflow to rivers, lakes and wetlands in several areas, although the magnitude of these contributions is poorly constrained. The contribution of groundwater is particularly important in the low-relief wetlands along the Katonga River and in the semi-arid Karamoja Region. Groundwater-fed springs are also important in the eastern and western highlands of Uganda.

Groundwater use and management [edit]

Groundwater use [edit]

73 of the 98 operational water supply systems in Uganda are based on groundwater. This accounts for around 75% of all towns and cities. In Kampala City several industries are also reliant on groundwater, including mineral water and chemical industries.

Groundwater abstraction permits are provided to users of motorised pumps by the Directorate of Water Resources Management. **Add estimates by sector and source type.**

Groundwater management [edit]

The key legislation governing groundwater management in Uganda is The Water Act, Cap 152, and The Environment Act.

The main regulations under The Water Act are:

- Water Resources Regulations (1998)
- Waste Discharge Regulations (1998)

The main regulations under The Environment Act are:

- Environmental Impact Assessment Regulations (1998)
- The National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations (1999)
- The National Environment (Waste Management) Regulation (1999).

These regulations were put in place to ensure the sustainable use of the environment and natural resources across Uganda. They are implemented by two main institutions: the Directorate of Water Development (DWD) and the Directorate of Water Resources Management (DWRM). These directorates sit within the Ministry of Water and Environment.

The DWD is responsible for groundwater regulation, and for the coordination, planning and development of groundwater sources.

The DWRM is responsible for:

- Developing and maintaining national water laws, policies and regulations
- Managing and monitoring groundwater resources through issuing permits for water use, water abstraction (by motorised pump and canals), drilling and waste water discharge
- Integrated Water Resources Management
- Management of transboundary water resources

Transboundary aquifers [edit]

The Transboundary Water Resources Management Division promotes regional transboundary cooperation for the equitable and reasonable utilisation of the shared water resources of the Nile and Lake Victoria Basins. It does this through active participation in the Nile Basin Initiative (NBI) and the Lake Victoria Basin Commission (LVBC), as well as other international water resources management programmes, such as the Global Water Partnership (GWP).

The main activities of the NBI, LVBC and GWP are:

- Policy formulation, review, implementation and advice related to transboundary water resource management
- Regional coordination and evaluation of transboundary projects and programmes
- Monitoring
- Raising awareness and capacity-building on transboundary water resources management issues

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

Groundwater monitoring [edit]

The national groundwater level monitoring programme is managed by the Directorate of Water Resources Management in Entebbe. Monitoring started in 1998 and daily observations are available for 30 stations across a range of

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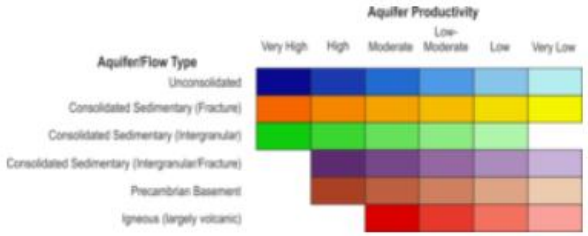
Hydrogeological environments of Africa

The main hydrogeological environments across the African continent are:

1. Unconsolidated Sedimentary Aquifers
2. Consolidated Sedimentary Aquifers (which may be characterized by fracture and/or intergranular flow)
3. Basement Aquifers
4. Igneous Aquifer



Groundwater quality in Africa

Groundwater quality can be influenced by both natural and anthropogenic processes. A detailed review of groundwater quality issues in Africa can be found in:

Xu Y and Usher B (eds). 2006. Groundwater pollution in Africa. Taylor & Francis/Balkema, Netherlands.

Some of the key issues and studies related to groundwater quality in Africa are described below.

Contents [hide]

Geogenic Contamination [edit]

Geogenic contamination refers to naturally occurring elements that are generally present in groundwater due to di
contaminants in groundwater, such as arsenic and fluoride, have a negative effect on human health, particularly w

The Swiss Federal Institute of Aquatic Science and Technology (Eawag) are currently developing global probabilit
of these maps use measured concentrations of arsenic and fluoride from around 20,000 and 60,000 globally distri
combine this data with available environmental information on soil, geology, climate, and topography, and use sta
occurrence of groundwater fluoride and arsenic concentrations above the WHO guidelines.

The global probability maps can be downloaded from the Eawag website:

http://www.eawag.ch/forschung/qp/wrq/mitigation_framework/water-quality/risk-maps/index_EN

Further information on the methodology can be found in the following publications:

Amini M, Mueller K, Abbaspour KC, Rosenberg T, Afyuni M, Moller KN, Sarr M, Johnson A. 2008. Statistical Mode
in Groundwaters. Environmental Science and Technology, 42, 3662-3668.

Amini M, Abbaspour KC, Berg M, Winkel L, Hug SJ, Hoehn E, Yang H, Johnson A. 2008. Statistical Modeling of G
Groundwater. Environmental Science and Technology, 42, 3669-3675.

Salinity [edit]

Salinity is another important groundwater quality issue that can be driven by both natural and anthropogenic processes. Processes such as sea level rise and intense evaporation can lead to naturally high salinity in groundwater, while over-abstraction, irrigation and waste disposal can exacerbate groundwater salinity issues. Salinity has important consequences for human health and agricultural productivity.

IGRAC have compiled a global map of groundwater salinity occurrence by extrapolating documented cases into larger areas of high probability of saline occurrence. The global salinity map can be downloaded from the IGRAC website:

http://www.un-igrac.org/publications/344

Nitrate [edit]

Nitrogen occurs naturally in the environment and is essential for plant growth. Nitrogen-based fertilisers are therefore often applied to increase crop yields. Leaching from agricultural land can lead to high concentrations of nitrogen in groundwater, which can have a negative impact on both the environment and human health.

IGRAC are currently carrying out a global assessment of nitrate contamination which will result in global scale maps of nitrate in groundwater. Further information can be found on the IGRAC website:

http://www.un-igrac.org/publications/498

Urban Pollution [edit]

Urban and peri-urban areas are expanding in many parts of Africa, particularly across sub-Saharan Africa. Groundwater is often a very important source of improved drinking water in urban and peri-urban environments however high population densities put pressure on these resources in terms of both quantity and quality.

Groundwater quality can be influenced by a large number of contaminants in the urban environment, from microbiological pathogens and heavy metals to macronutrients, herbicides and pesticides.

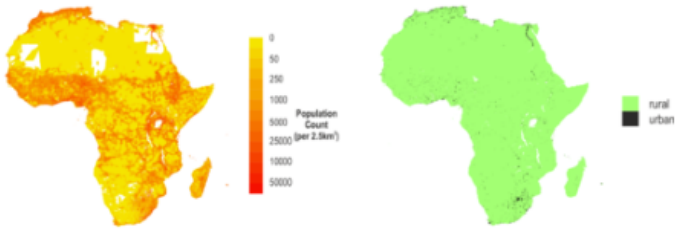
Some of the key sources of urban pollution include:

- Pit latrines, which are often located close to abstraction points, particularly in densely populated peri-urban or unplanned urban settlements
- Sewer leakage and sewage effluent
- Uncontrolled disposal of household and industrial waste
- Peri-urban agriculture, which includes pesticides/fertilisers and livestock waste

Groundwater use

Dataset Description [edit]

Rural and urban population data has been used as an indicator of groundwater use. Gridded datasets of population and urban extent have been processed to provide an estimate of the number of people living on each aquifer type, and what proportion of this population lives in rural and urban areas.



The gridded population data is derived from the United Nations Environment Programme/Global Resource Information Database (UNEP/GRID) Africa Population Distribution Database (4th edition). This dataset uses population data from 109,000 administrative units across the whole of Africa, the most recent of which is compiled for the year 2000. The regional data is gridded using an interpolation method based on settlement locations and transport infrastructure, which helps to distribute the population across an administrative area. The gridding approach and the key sources of uncertainty in the dataset are discussed in detail in the data documentation (Nelson, 2004).

The gridded rural-urban data (Balk et al., 2006) is derived from the Global Rural-Urban Mapping Project (GRUMP) Urban Extents Grid (v1). This dataset is produced by the Centre for International Earth Science Information Network (CIESIN) at Columbia University, the International Food Policy Research Institute (IFPRI), The World Bank, and the Centro Internacional de Agricultura Tropical (CIAT). The dataset is based on a combination of population counts, settlement points, and the presence of nighttime lights as observed by a series of US Department of Defence meteorological satellites over several decades.

Citations:

Nelson A. 2004. African Population Database, UNEP GRID Sioux Falls. Retrieved 29th October 2014. (see external links below)

Nelson A. 2004. African Population Database Documentation, UNEP GRID Sioux Falls. Retrieved 29th October 2014. (see external links below)

CIESEN, IFPRI, The World Bank and CIAT. 2011. Global Rural-Urban Mapping Projectm Version 1 (GRUMPv1): Urban Extents Grid. Palisades, NY: NASA Socioeconomic Data and Applications Centre. Accessed 30th October 2014.

Balk DL, Deichmann U, Yetman G, Pozzi F, Hay SI and Nelson A. 2006. Determining Global Population Distribution: Methods, Applications and Data. Advances in Parasitology 62, 119-156. (http://dx.doi.org/10.1016/S0065-308X(05)62004-0)

Links to External Data [edit]

The UNEP/GRID Africa Population Distribution Database can be accessed via the UNEP website

The GRUMP Urban Extents Grid can be accessed via NASA's Socioeconomic Data and Applications Centre (SEDAC)

Further Sources of Information [edit]

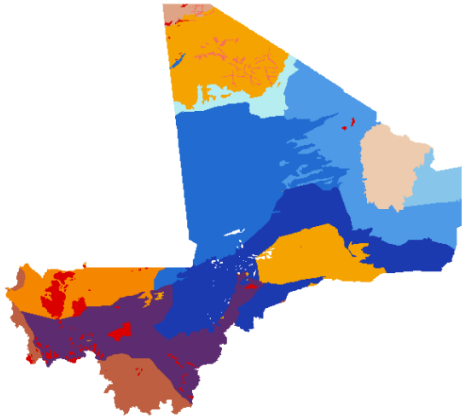
AQUASTAT is the FAO's global water information system, providing data for countries in Africa, Asia, Latin America, and the Caribbean.

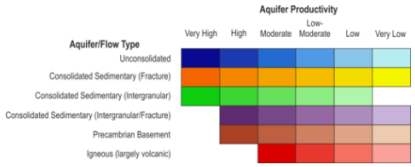
Each country profile contains general information on the geographical and economic situation of the country, and more detailed information on water resources (major sources of surface water and groundwater), water use (with a particular focus on irrigation), and water management.

Country profiles and other useful information can be accessed via the AQUASTAT website

Category: Additional resources

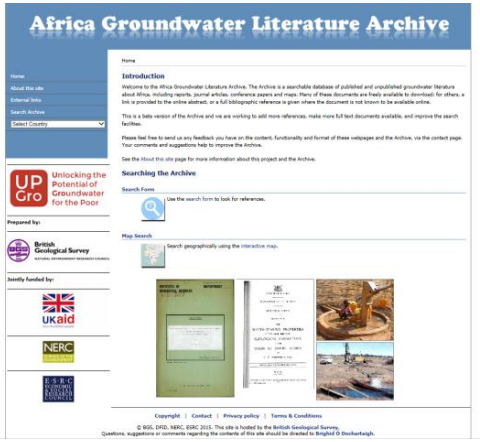
Atlas: Future Development





- Printed version of Atlas with IAH (2016)
- Long term home, maintenance & development online Atlas:
  - Updated information
  - Translation of relevant pages (French/Portuguese)
  - Additional material on specific subjects?
  - Presenting information for different audiences?
- Discussions on possible joint future developments with IGRAC

AGLA: Future Development



- Links with other key organisations with large document databases – e.g. BRGM, BGR
- Translation of key parts (front pages, keywords)
- UPGro project outputs and bibliographies to be added!

Please use and give us feedback!
http://www.bgs.ac.uk/africagroundwateratlas

More information

Africa Groundwater Literature Archive:

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

BGS project webpage:

http://www.bgs.ac.uk/research/groundwater/international/africaGwAtlasArchive.html