

Africa, Groundwater and Sustainable Development Goals

Dr. Callist Tindimugaya

*Ministry of Water and Environment, Uganda/IAH
Regional Vice President, sub-Saharan Africa*

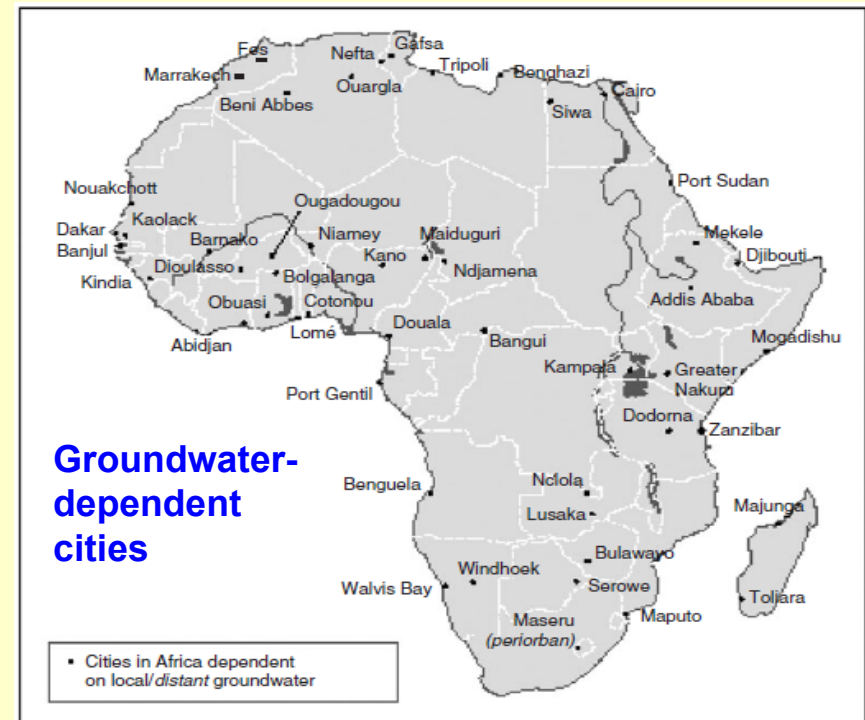
Email: callist_tindimugaya@yahoo.co.uk

**Ineson Lecture 2017, 25th October 2017, London,
UK**

Special thanks to the British Chapter of the International Association of Hydrogeologists (IAH) and Hydrogeology Group of the Geological Society for the invitation and financial support to attend this meeting

Groundwater resources in Africa

- 75 % of the African population dependant on groundwater for basic water supply
- Groundwater used for other activities (irrigation, livestock watering, urban and industrial development etc)
- Groundwater demands are set to increase in future with:
 - Population increase
 - Climate change
 - Need to combat growing food insecurity



**What is groundwater to an
African?**

Source of domestic water supply



Source of domestic water supply



Source of domestic water supply



Source of water for small scale irrigation



Source of water for large scale irrigation



Source of water for livestock



Source of support to development and livelihoods



Market and investment opportunities/innovations/Jobs for rural youth and entrepreneurs



Supporting rapid development and industrialization



Income generation, household food security

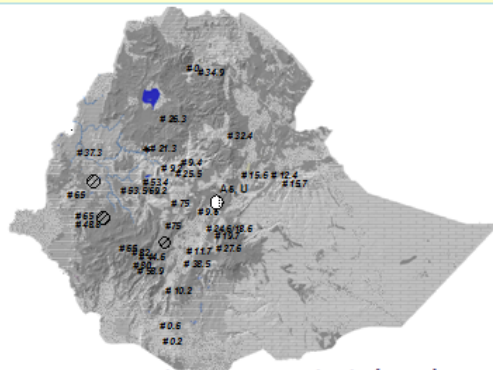
Contributor to human health



- Concentrations of fluoride above 1.5 mg/l in drinking water can cause dental and skeletal fluorosis. These clinical conditions are commonly encountered in the groundwaters of the Rift Valley.
- With dental fluorosis, the teeth have brown discolouration. Pitting and chipping of the teeth cause functional problems. Dental fluorosis is a life-long handicap
- Skeletal fluorosis is caused by high concentrations of fluoride in drinking water consumed over many years.

RiPPLE, Factsheet

Top figure- Dental fluorosis in Youngster in and Bottom photo showing people affected by skeletal fluorosis Photos from Gizaw- MAWARI Project



IDD prevalence map, Kebede (2009)

- Lack of adequate iodine in foods and drinking water could lead to Iodine Deficiency Disorder (IDD).
- This causes goiter, cretinism, poor pregnancy, still birth, mental retardation and infant mortality.
- Iodine deficiency is the world's most common cause of mental retardation and brain damage and goiter incidence

• According to ministry of health and UNICEF report in 1993, 42 million people (78%) of the total population of Ethiopia are exposed to iodine deficiency, 35 million (62%) are iodine deficient, 14 million (26%) have goiter and at least one in 1000 people is suffering with about 50,000 neonatal deaths



Meeting the Sustainable Development Goals in Africa: **role of groundwater**

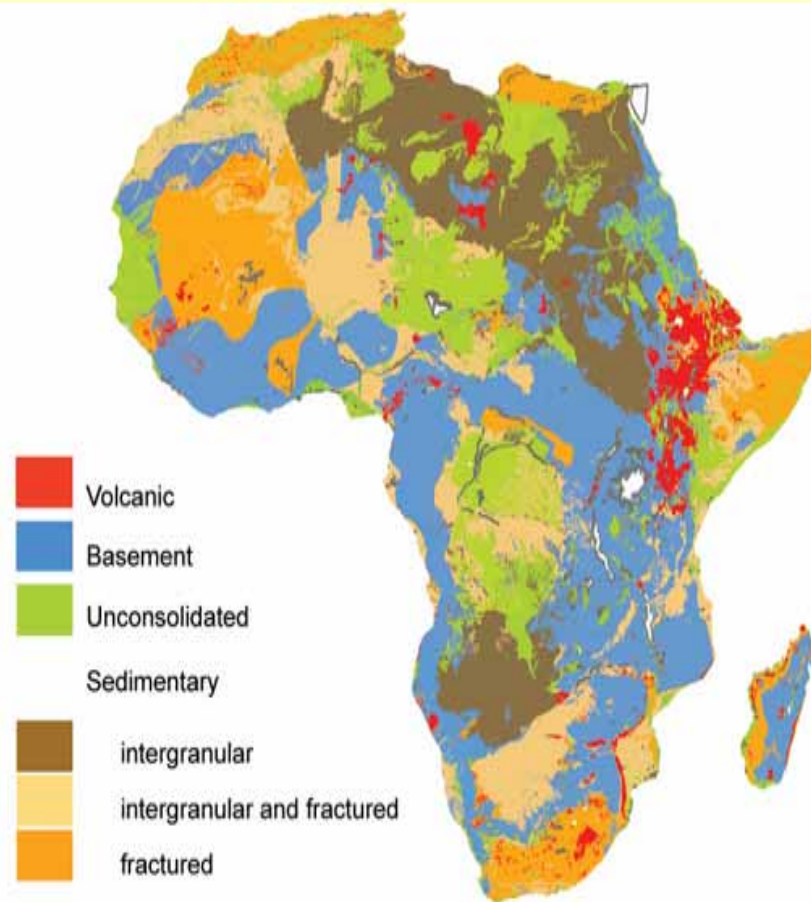


.. GW will be key in contributing to achievement of most of the
SDG Goals especially SDG6

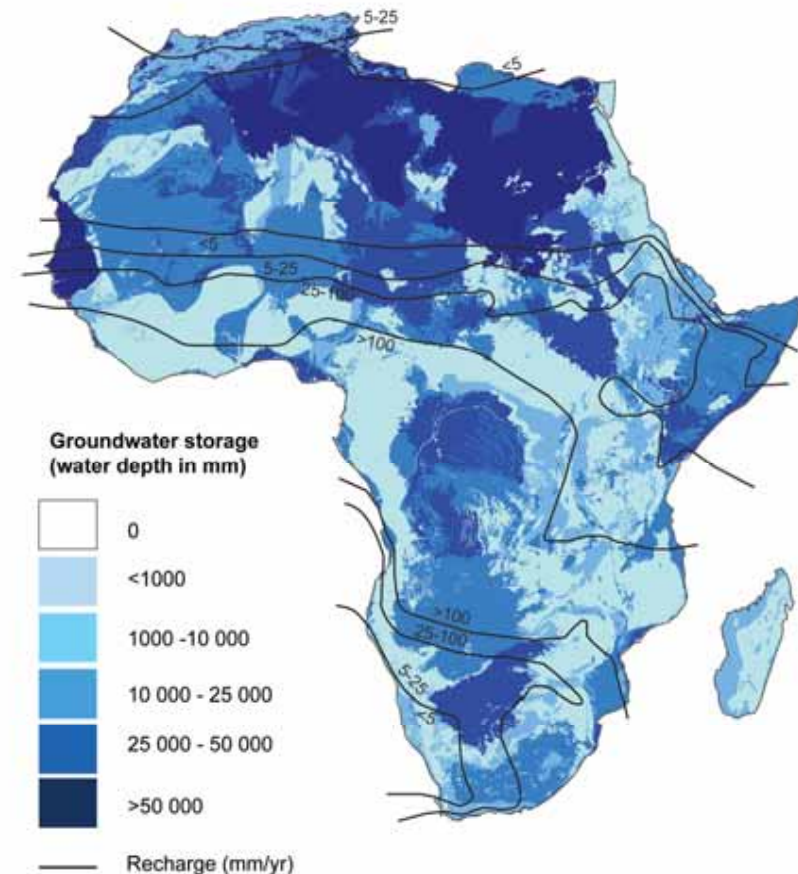
Dealing with diversity and extremes

Diverse Geology

Diverse groundwater



British Geological Survey © NERC 2011. All rights reserved.
Boundaries of surficial geology of Africa, courtesy of the U.S. Geological Survey.

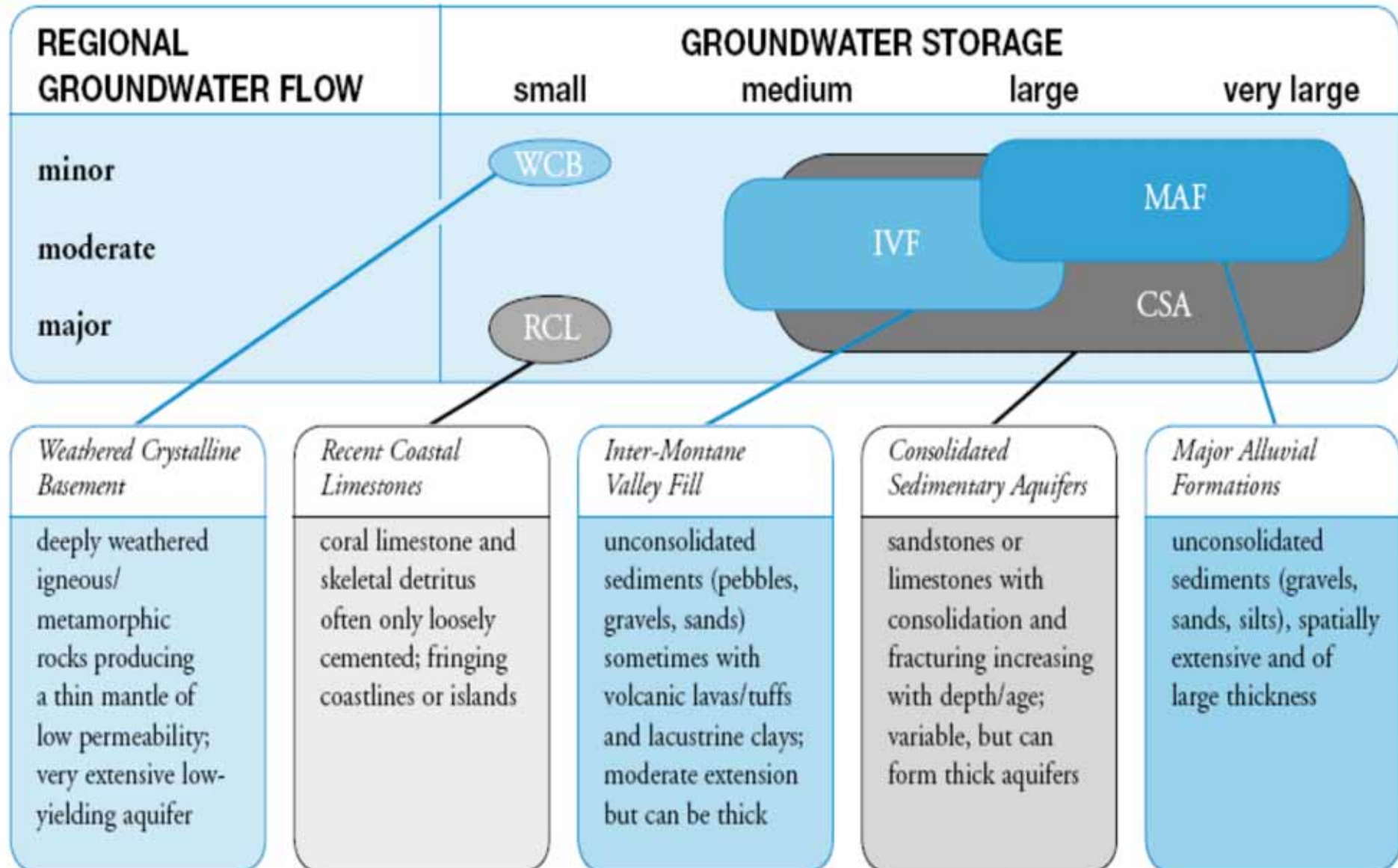


British Geological Survey © NERC 2011. All rights reserved.
Boundaries of surficial geology of Africa, courtesy of the U.S. Geological Survey.
Country boundaries sourced from ArcWorld © 1995-2011 ESRI. All rights Reserved.
Modern annual recharge data (Doll and Fielder 2008)

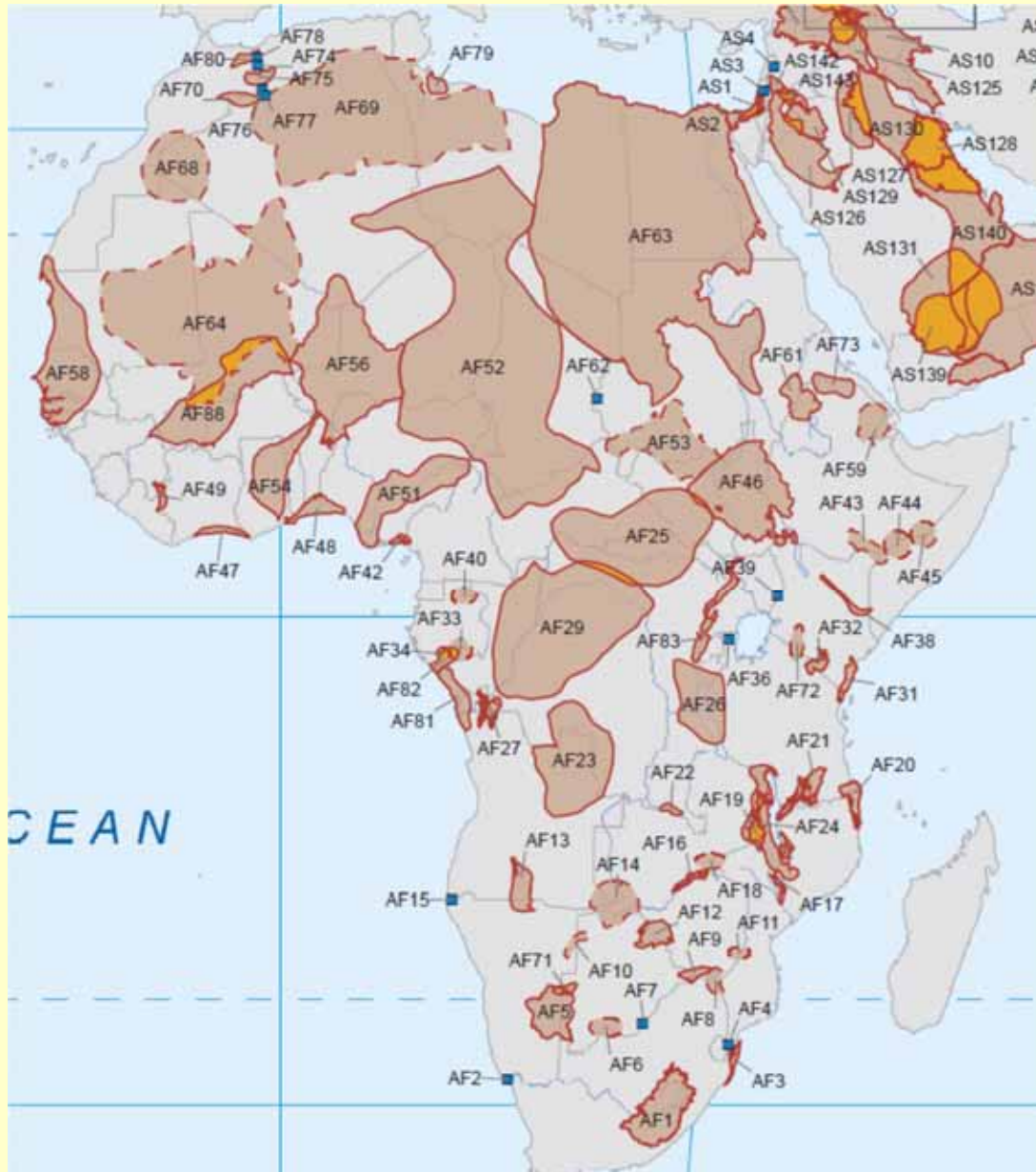
MacDonald et al. (2012)

0.66 million km³ of storage (not all available for abstraction)

Hydrogeological diversity and complexity

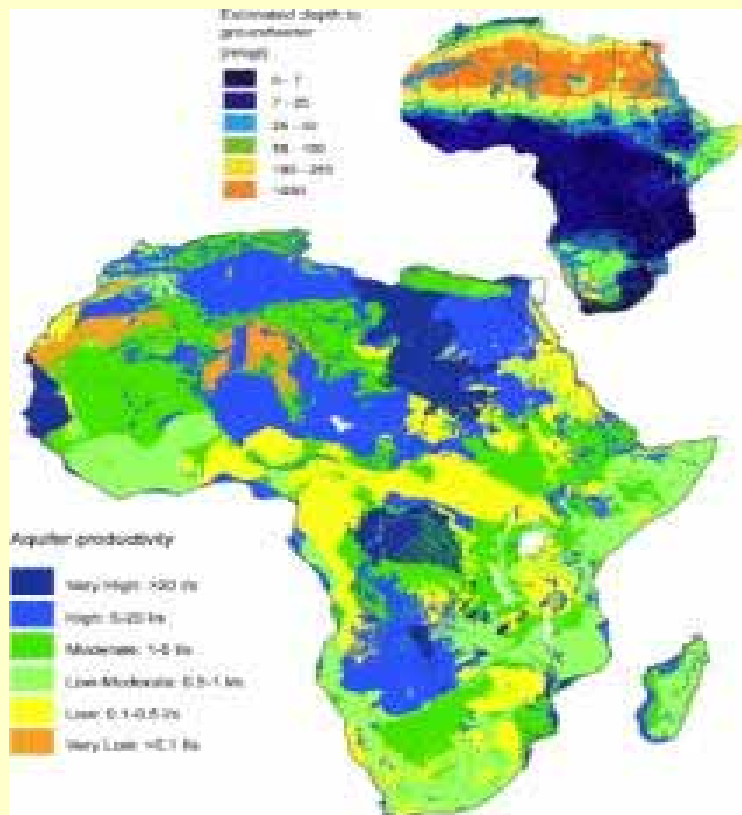


Transboundary groundwater aquifers

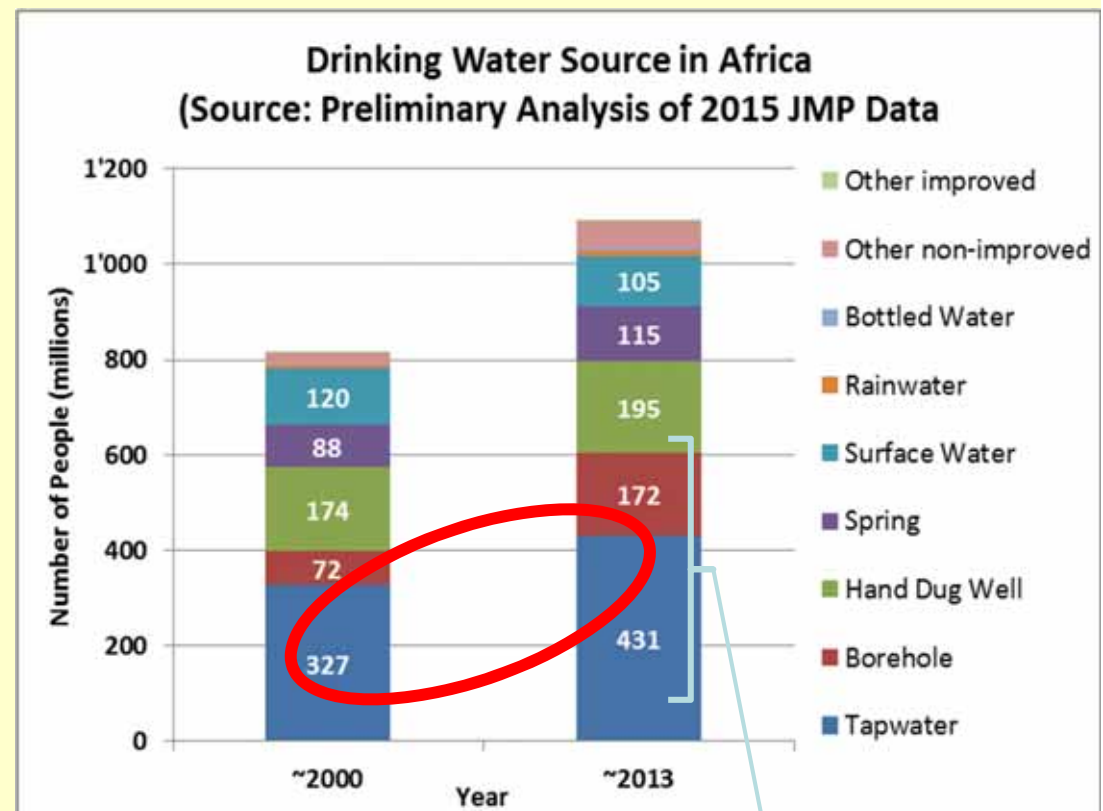


- Over 80 transboundary aquifers mapped in Africa
- Great lack of scientific knowledge on characteristics of TBA

Groundwater Potential and use in Africa



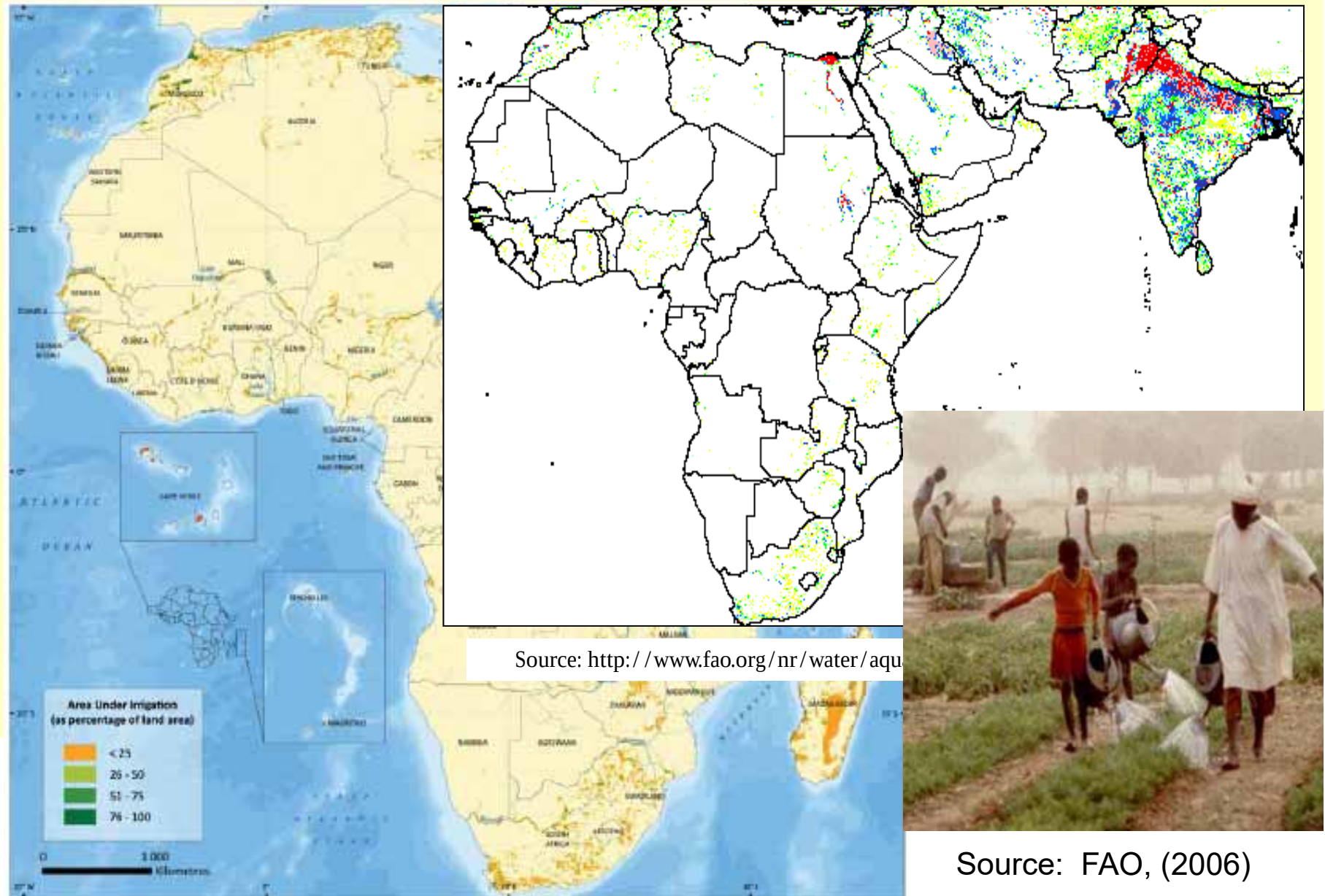
Groundwater potential



Growth in groundwater use

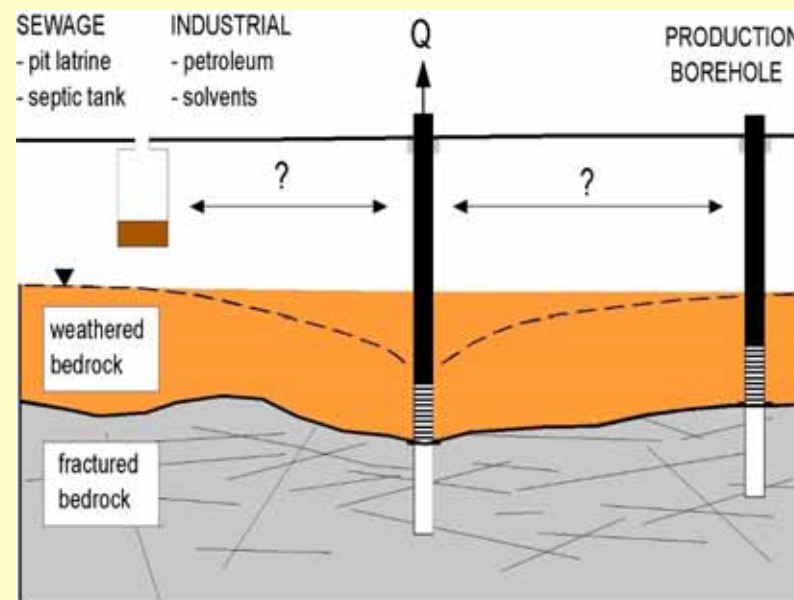
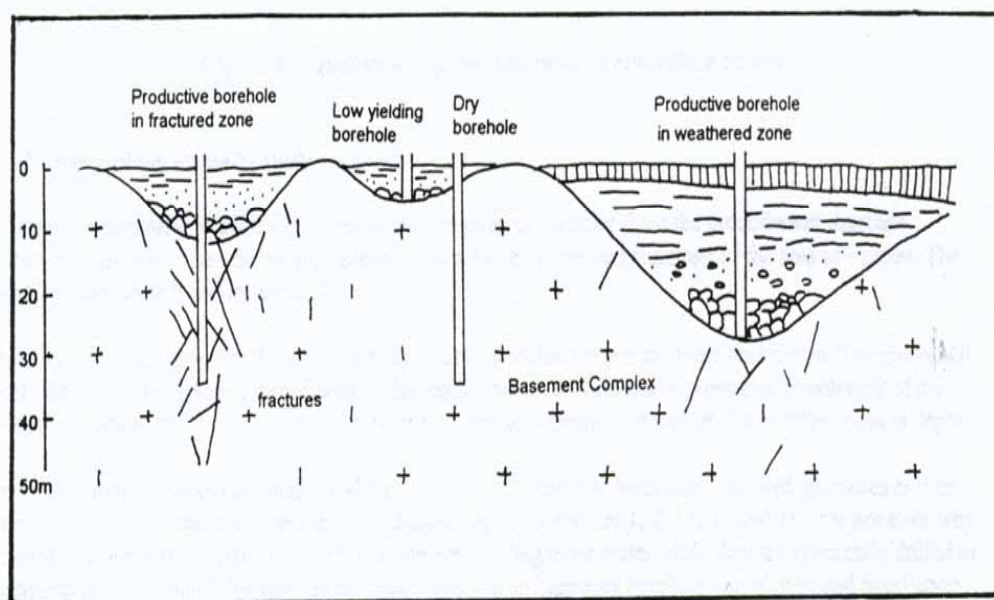
Groundwater!!

GW in Greening Africa



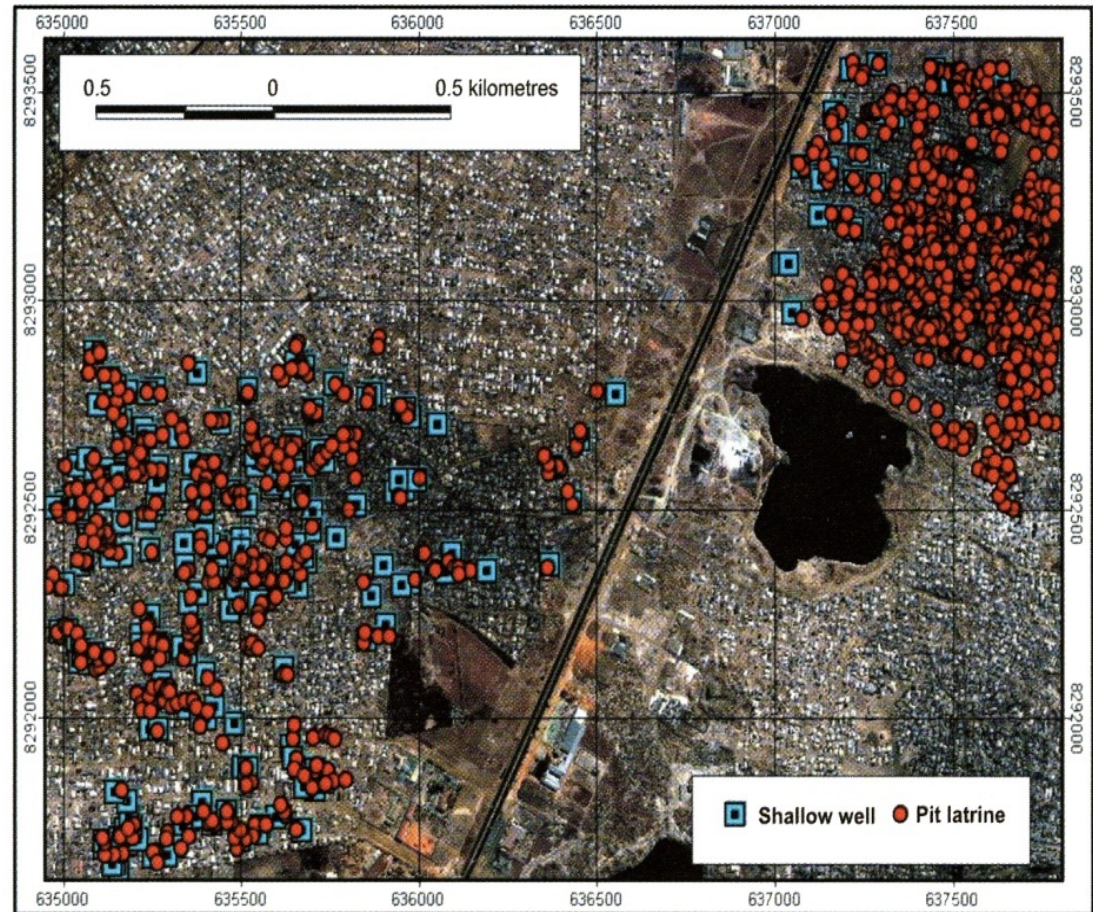
Groundwater Management Challenges

Knowledge of the resource base and its characteristics



- **Limited understanding** of groundwater resources
- **Project** design & implementation often below standard & regulation is weak
- Lack of **appreciation** that groundwater resources is very important for WASH
- Insufficient **understanding** of drilling and associated risks by non-technical decision-makers and project/programme managers
- **Drilling logs** not always systematically collected, collated and available
- **Lack of quantitative national hydrogeological maps** in most of Africa
- Inadequate information about the **causes of borehole and pump failure** and thus lack of feedback to project design and implementation
- **Disconnect** between groundwater research and groundwater practice

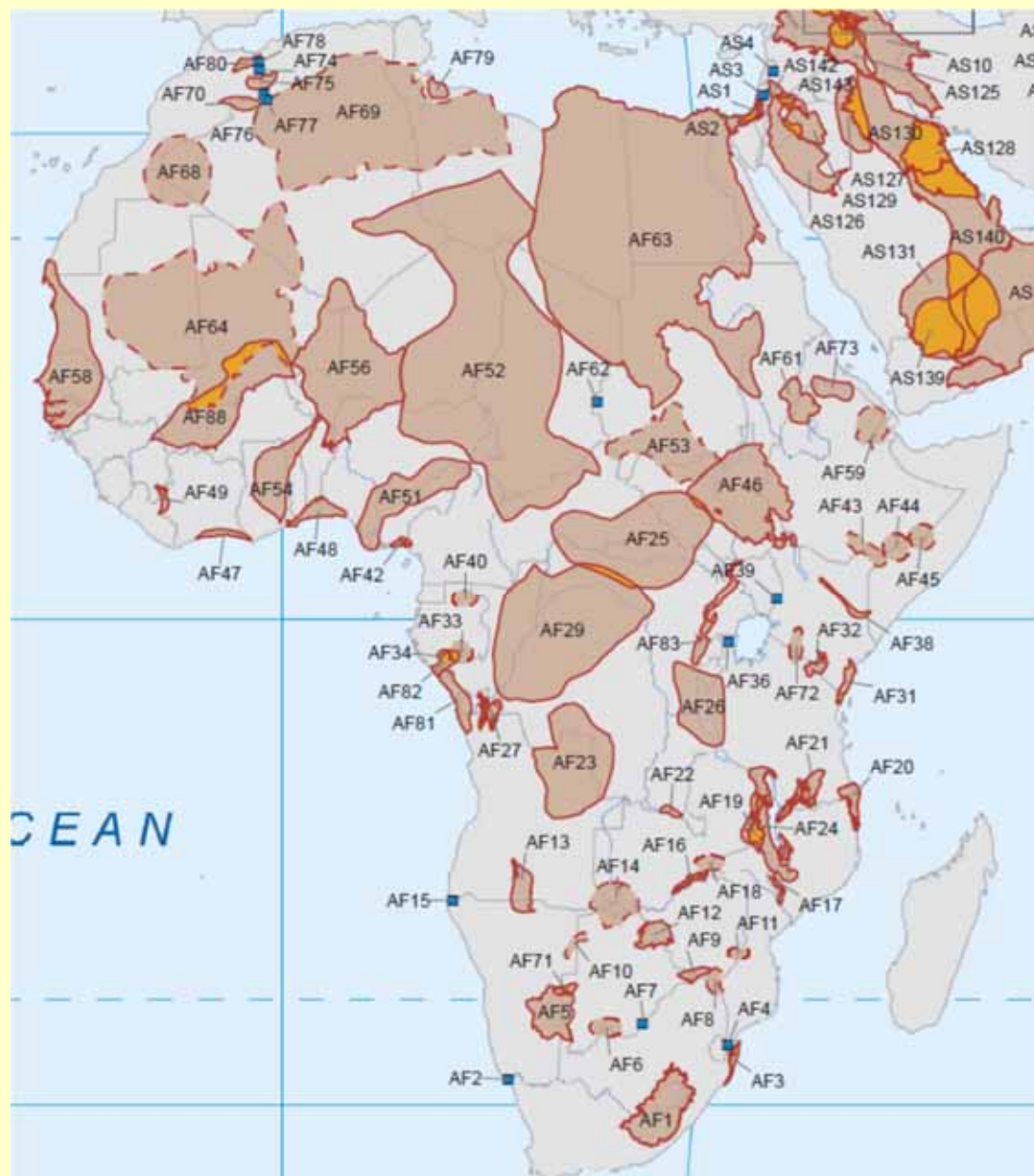
Pollution of groundwater esp. in large cities



Groundwater pollution in Lusaka City, Zambia (adopted from Nkhuwa)

Groundwater aquifers that supply many African mega cities are often heavily polluted (e.g. Dakar, Abidjan, Lagos, Accra, Lomé, Lusaka, Nairobi, Addis Ababa)

Management of transboundary aquifers



- Over 80 transboundary aquifers exist in Africa
- Need to establish transboundary aquifer management organisations or integrate GW in RB management
- Promote transboundary aquifer monitoring and assessment to improve scientific knowledge on TBA
- Operationalise UNGA on the management of transboundary aquifers

Communicating groundwater information and impacts

BBC Sign in News Sport Weather iPlayer TV Radio

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20 April 2012 Last updated at 11:48 11K Share

'Huge' water resource exists under Africa

COMMENTS (386)

By **Matt McGrath**
Science reporter, BBC World Service

Scientists say the notoriously dry continent of Africa is sitting on a vast reservoir of groundwater.

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Hope Found Beneath War-Torn Darfur

By **MIKE NIZZA** JULY 19, 2007 9:45 AM

Darfur lake is a 'mirage'. - ResearchGate
www.researchgate.net/publication/6185951_Darfur_lake_is_a_mirage
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AFRICA

Huge Aquifers Are Discovered in North Kenya

By NICHOLAS KULISH SEPT. 11, 2013



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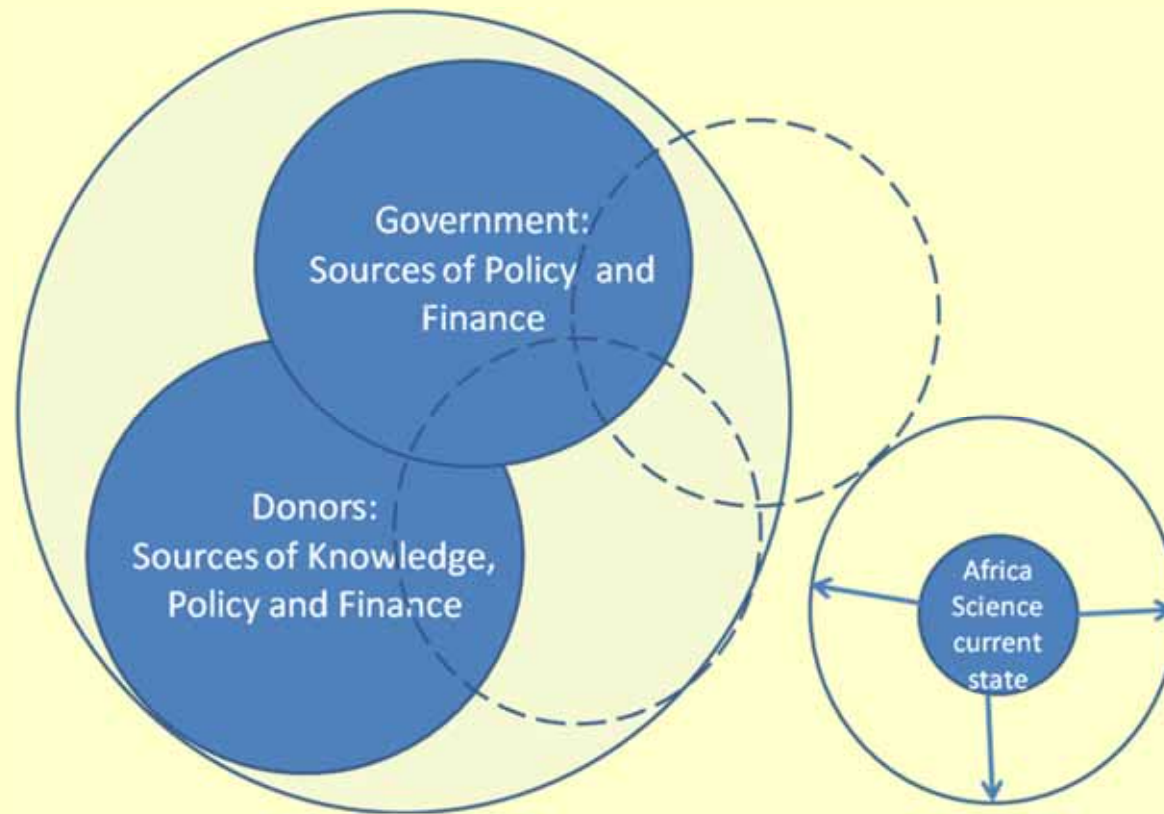
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First test shows Kenya's huge water find too salty to drink - TRFN

Uncertainty in hydrogeology impacts policy articulation

Integrating science and policy



Need for integration

Economics and financing

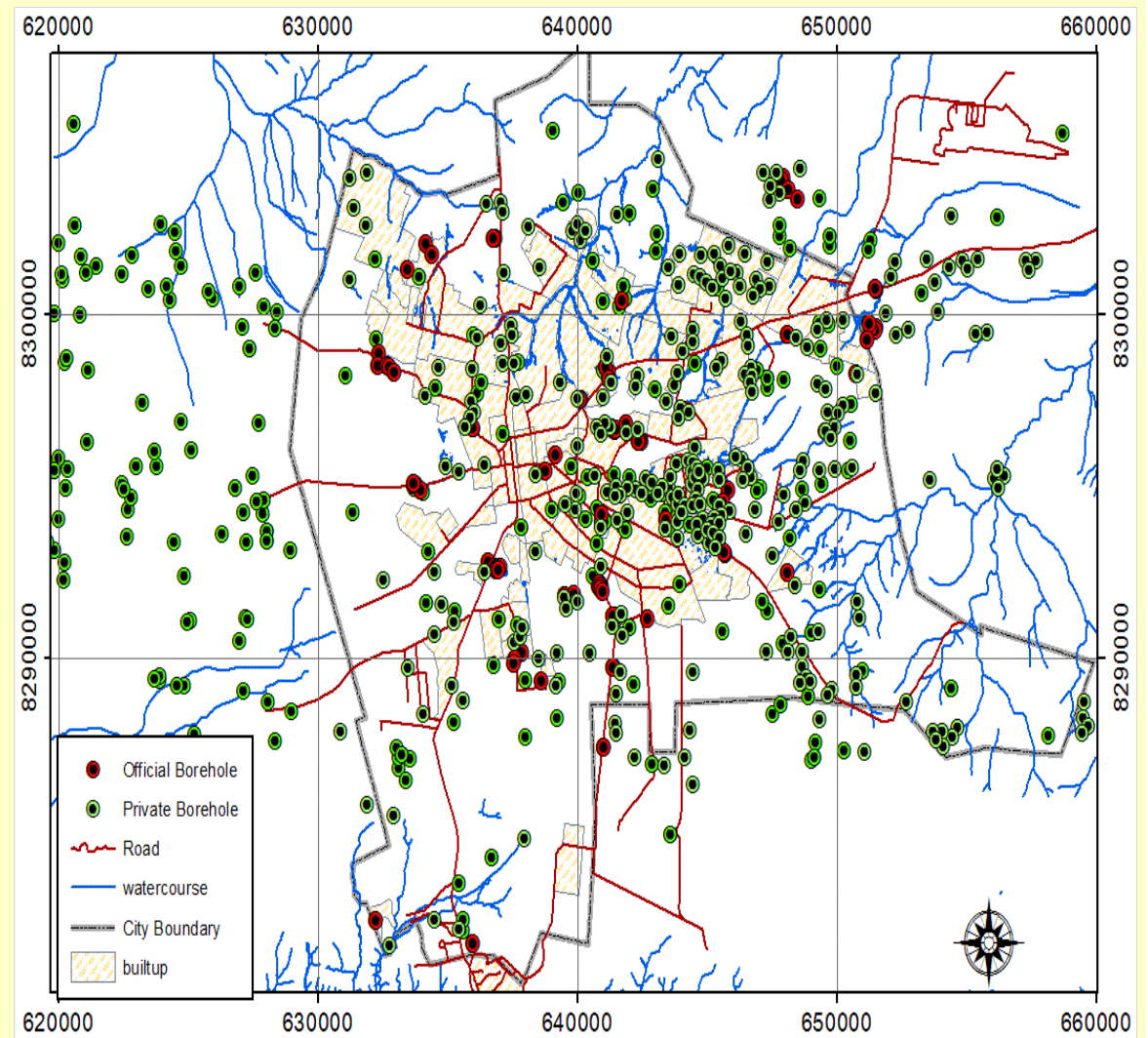
- Limited information on the contribution of groundwater to economic and social development
- Limited financing for groundwater development and management

Technology – access and lifting



Regulation and governance

- Groundwater development in SE Asia was a hidden revolution! This is coming to an unprepared Africa
- Allocation, regulation and governance of groundwater-challenging to implement/tragedy of the commons



Partial spread of private and public boreholes in Lusaka

Data Source: Lusaka Water & Sewerage company and Department of Water Affairs

***Prospects for improving
groundwater management in Africa:
Africa not short of Initiatives***

Many ongoing groundwater related initiatives in Africa

- A number of national and regional groundwater related programs: development, monitoring, assessment, regulation, information management etc
- AGWC - Africa Groundwater Commission
- AGWNET- Africa Groundwater Network
- IAH Burdon Network- IAH Burdon Groundwater Network for International Development
- UNESCO-IHP- UNESCO International Hydrological Program
- UPGro - Unlocking the Potential of Groundwater for the Poor
- GroFutures- Groundwater Futures in Sub-Saharan Africa
- GRIPP- Groundwater Solutions Initiative for Policy and Practice
- AGM- African Groundwater Movement
- SDG Monitoring- Sustainable Development Goals indicator monitoring

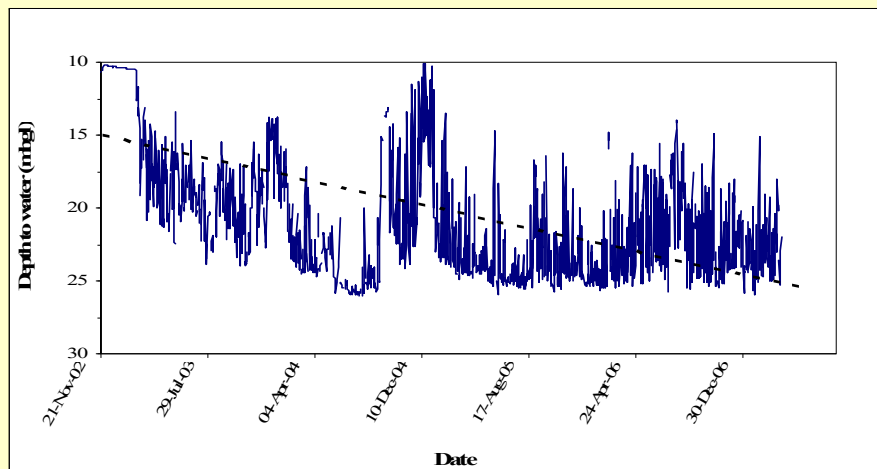
***Many national groundwater management
and development programs in Africa***

Groundwater management strategies



**Groundwater resources
assessment**

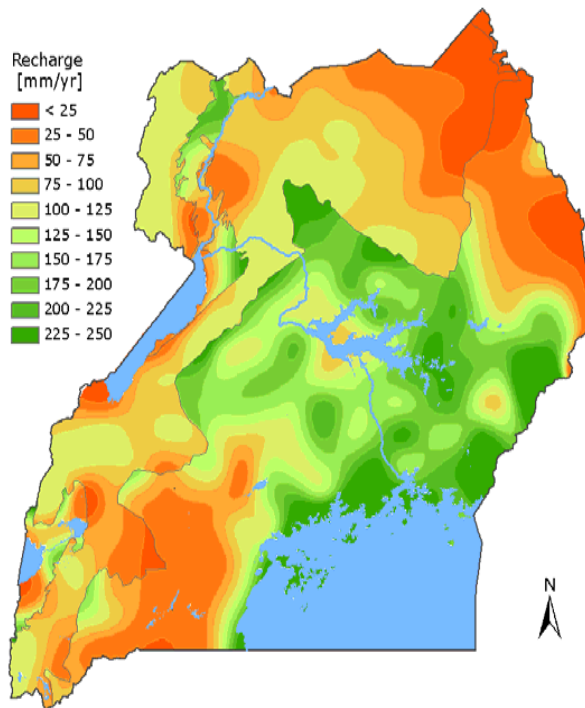
**Groundwater resources
monitoring**



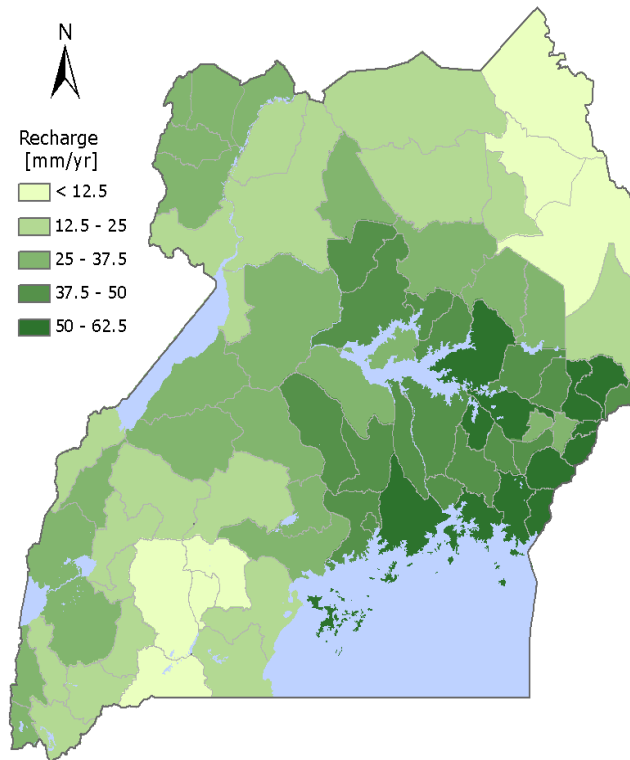
**Groundwater resources
regulation**

Assessing and quantifying groundwater resources

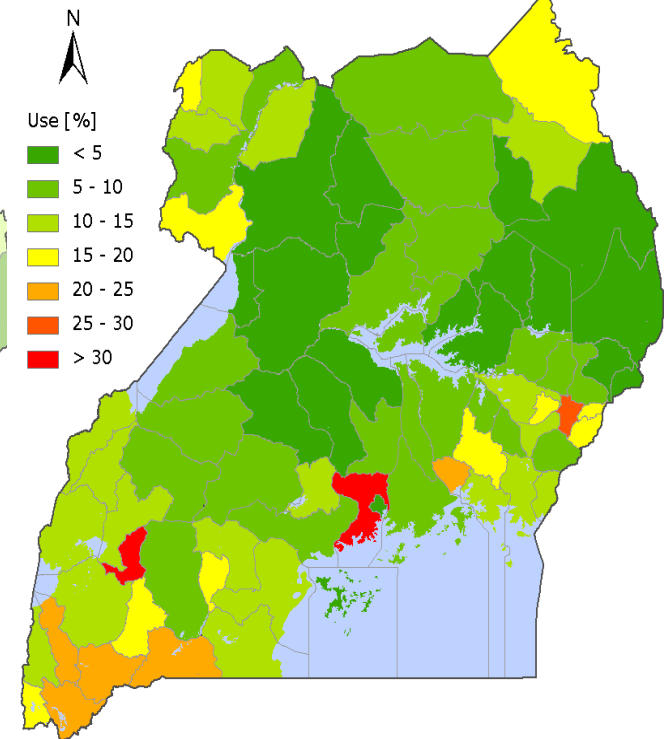
Generalized Average Groundwater Recharge



Sustainable Available Groundwater



2030 Groundwater Sustainable Resource Utilization for Domestic Water Supply

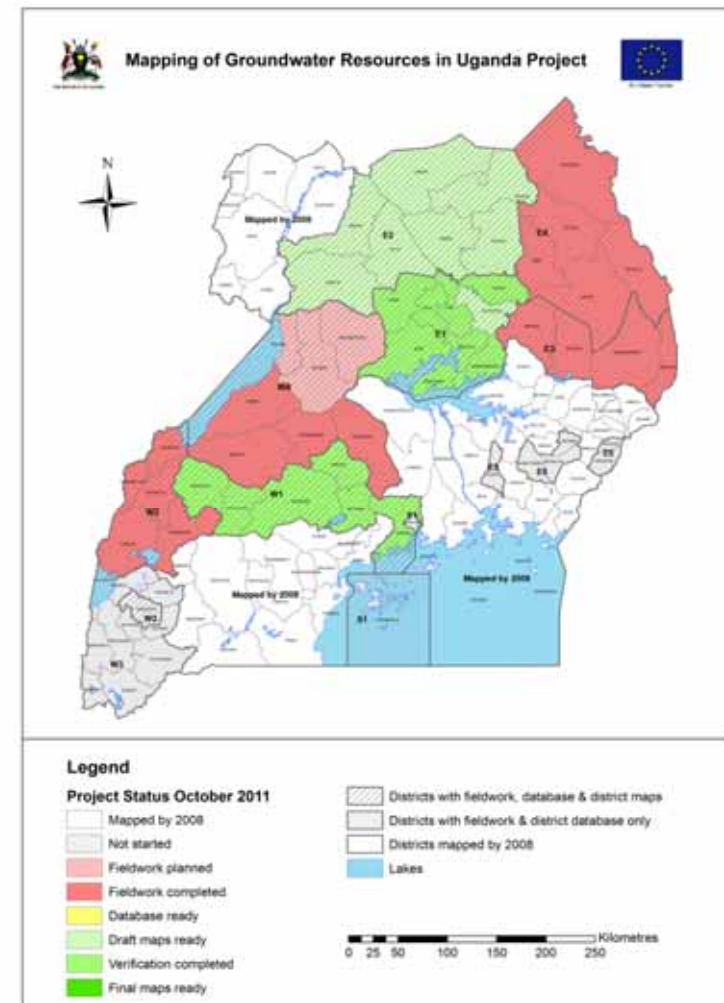


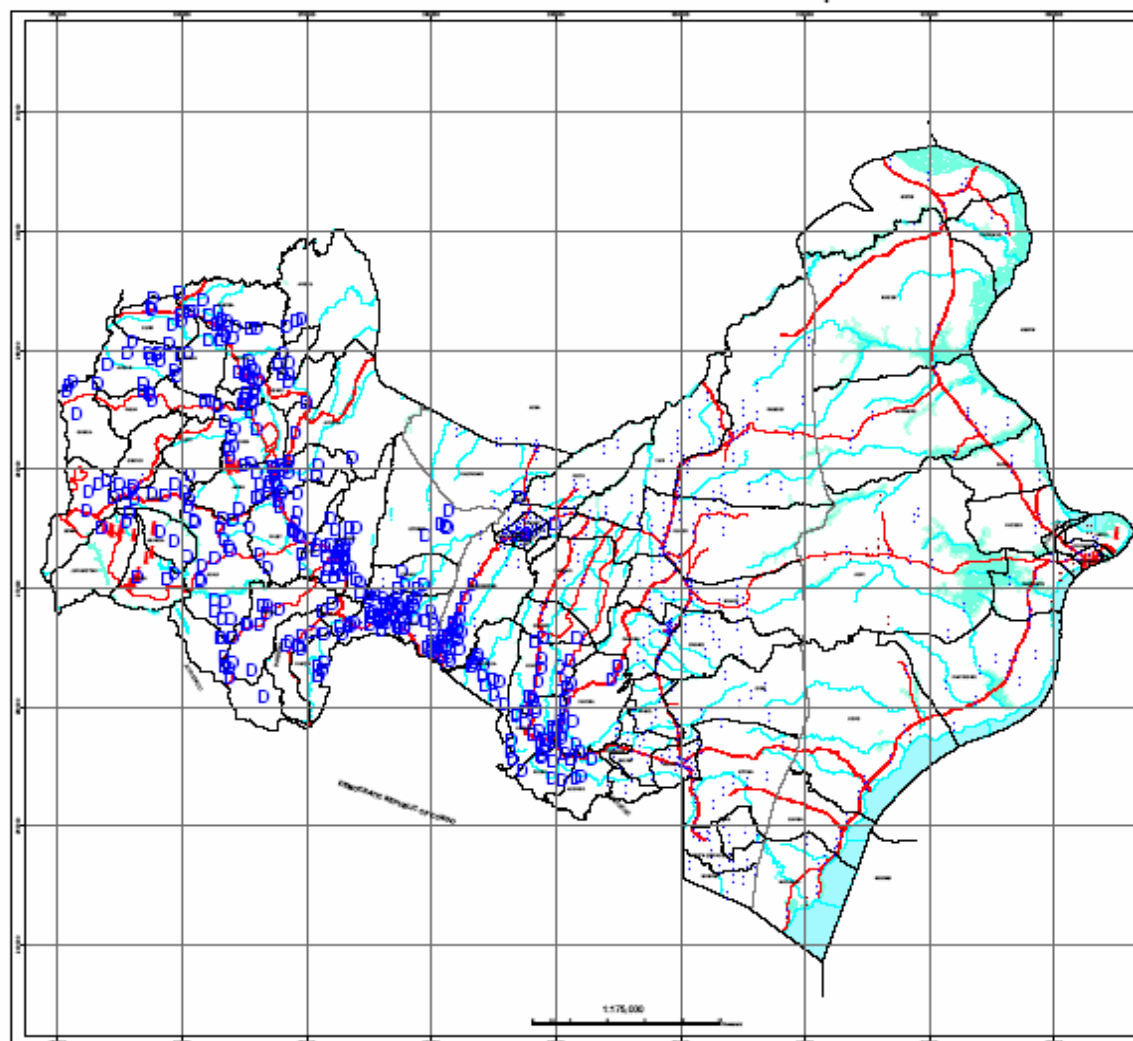
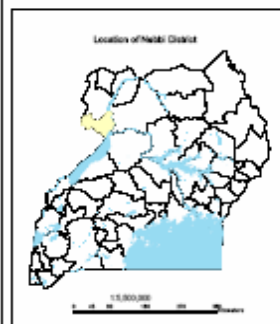
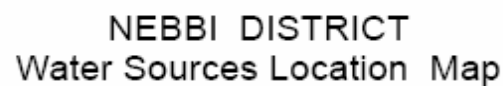
Mapping of groundwater resources

Produces tools in form of maps and reports to guide planning and implementation of groundwater development activities at both the national and district levels.

6 different types of maps are produced:

- (i) water supply coverage map
- (ii) hydrogeological characteristics map
- (iii) hydrochemical characteristics map
- (iv) water quality map
- (v) groundwater development technology options map
- (vi) groundwater potential map





LEGEND

- Common bond
- Deep foundation
- Glu/Glu
- Protected opening
- Shallow well

3. Central administrative level

Abstract

- International boundary
 ————— District boundary
 ————— County boundary
 ————— Subcounty boundary
 ————— Parish boundary

Antibiotic resistance

- ☐ All-weather tennis road
- ☐ All-weather mountain road
- ☒ Dry weather mountain road
- ☐ All-weather track
- ☐ Wet weather

- Open water
- Perennial wetlands (papyrus) in water valleys

55

- **Alteze perimetrului drum**
 Alteze perimetrului drum

DATA SOURCES

Inferred borehole yields: Based on analysis of water source data from Field DWD, National Groundwater Database and District groundwater divisions.
Administrative boundary, infrastructure and land cover: Provided by the National Forestry Authority (NFA).

NOTE

This map is meant to act as a guide to planners in local government for the planning of groundwater programmes and, due to scale, not suitable for site-by-site use. The latter should be based on much more detailed and site specific information. This map should be used together with the District report.

PUBLISHER

Compiled and published by the Directorate
of Water Resources Management.
Funded by the Government of Uganda
and DANIDA.

DISCLAIMER

Although great care was taken in the preparation of these maps, the authors cannot be held responsible for any loss or damage arising from their use.

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NOTE

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PO Box 10, Brisbane
Tel (+260) 0414 320342, 320816
Fax (+260) 0414 323380
Email: director@zimbabweco.gov.zw

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ARUA DISTRICT Water Supply Technology Options Map



Ministry of Water and Environment

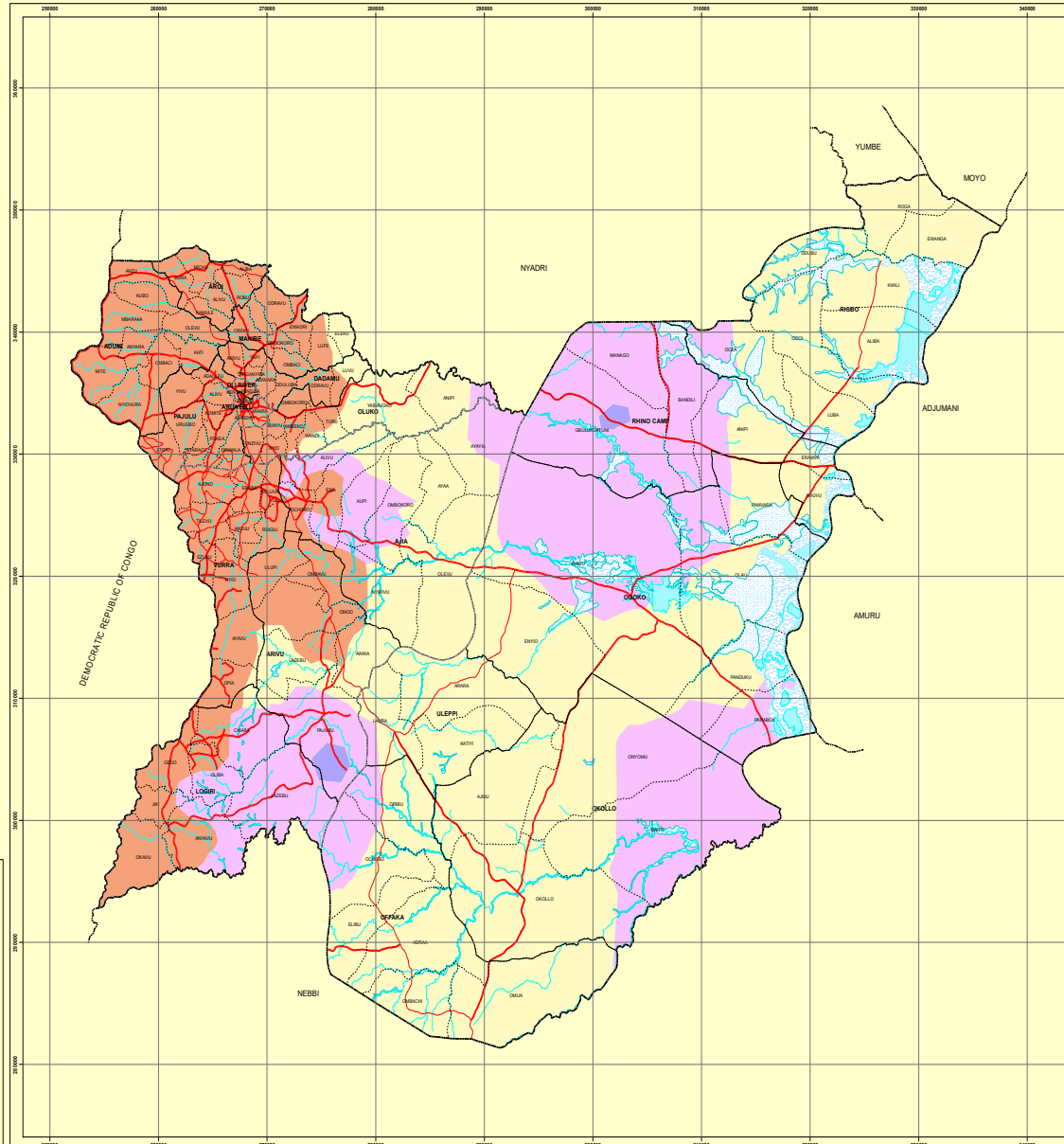
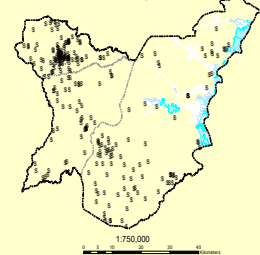


Directorate of Water Resources Management

Location of Arua District



Data Density



LEGEND

- 0-15m, Shallow well
- 15-30m, Shallow well
- > 30m, deep bore hole
- Spring zone
- District administrative town

Administrative Boundaries

- International boundary
- District boundary
- County boundary
- Subcounty boundary
- Parish boundary

Infrastructure

- All weather tarmac road
- All weather murram road
- Dry weather murram road
- Motorable track
- Railway

Water Resources

- Open water
- Permanent wetlands (papyrus) in main valleys
- Seasonal wetlands in secondary valleys
- Major permanent river
- Minor permanent river

DATA SOURCES

Inferred Water Supply Technology options: Based on analysis of water source data from Arua DWO, National Groundwater Database and District groundwater developers
Administrative boundary, infrastructure and land cover: Provided by the National Forestry Authority (NFA).

NOTE

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P.O. Box 18, Entebbe
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Fax: (+256) 0414 321368
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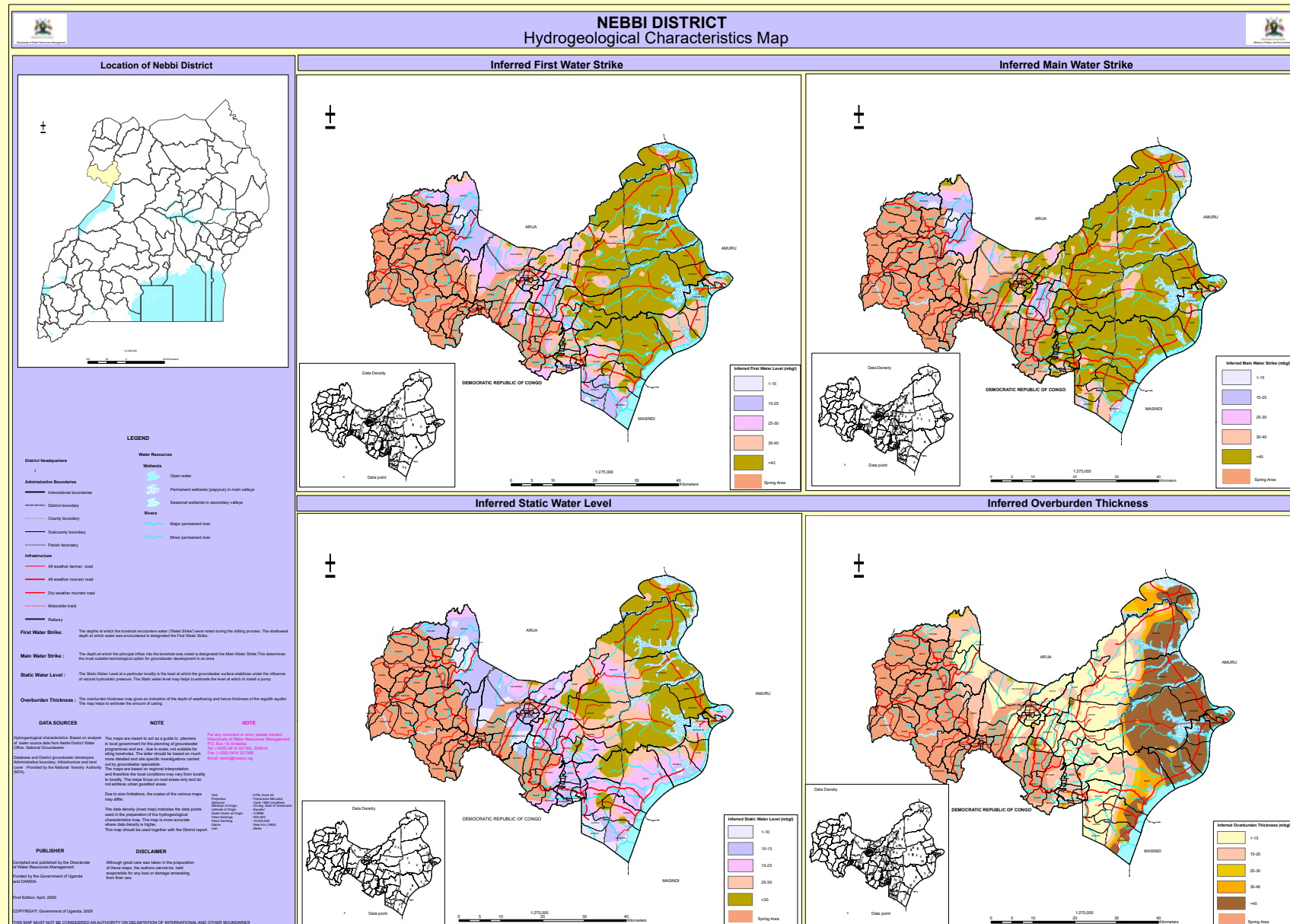
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Grid: UTM, Zone 36
Projection: Transverse Mercator
Spheroid: Clark 1880 (modified)
Meridian of Origin: 33 deg. East of Greenwich
Scale Factor at Origin: 0.9998
False Easting: 500,000
False Northing: 10,000,000
Datum: New Africa 1960
Unit: Metre

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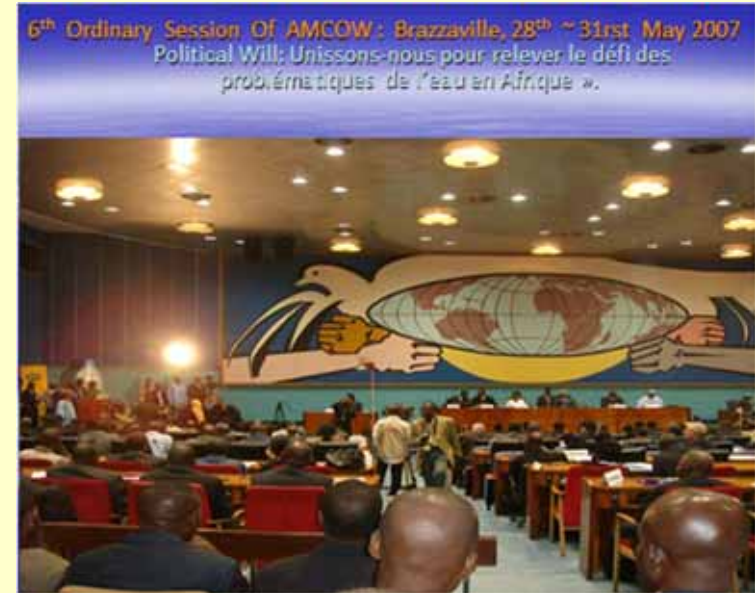
Hydrogeological characteristics map: made up of 4 inset maps- First water strike, Main water strike, Static water level, Overburden thickness

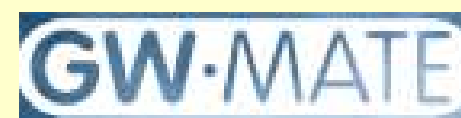
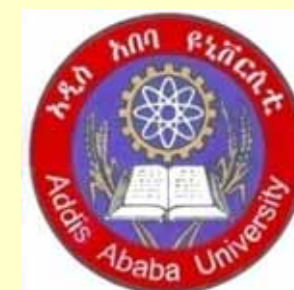
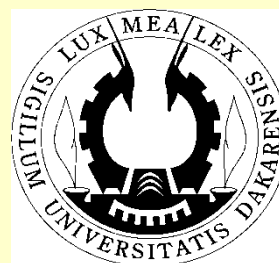


***Regional groundwater management and
development programs in Africa***

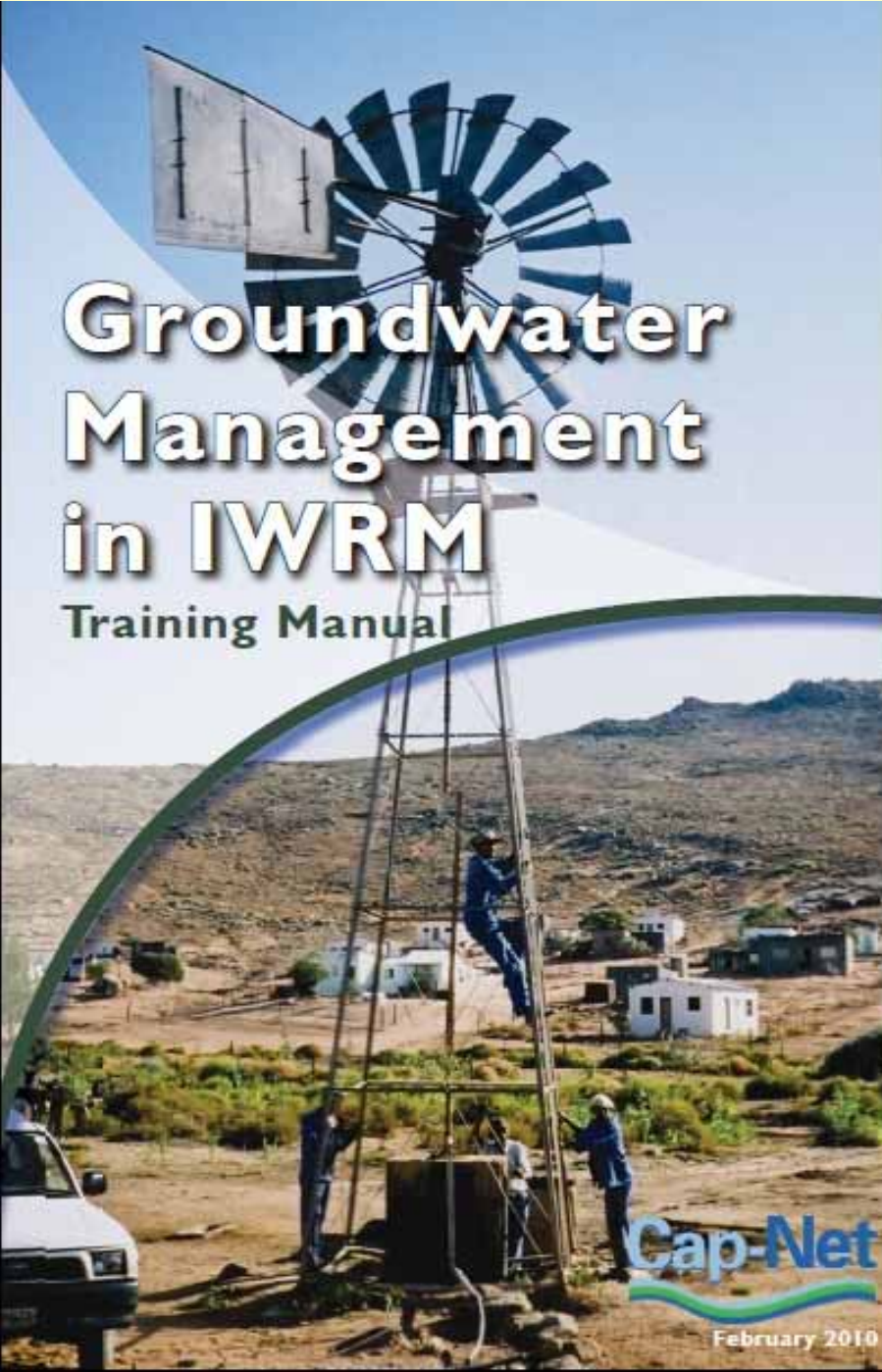
Africa Groundwater Commission

- Groundwater high on political agenda in Africa through AMCOW
- AMCOW Declaration on Groundwater Initiative (Brazzaville, May 2007)
- African Groundwater Commission (AGWC) established under AMCOW (Nairobi, Nov 2008)
- AGWC aims to support AMCOW to promote sustainable groundwater governance in Africa as a whole and at national and local levels
- Supported by various partners: UNESCO, BGR, AGWN, IAH, IGRAC, RWSN
- AGWC not been very active, needs reactivation
- AMCOW plans to work with partners to fully operationalize the AGWC and bring value to groundwater sector in Africa





Africa Groundwater Network (GW CB network)



Groundwater Management in IWRM

Training Manual

Cap-Net

February 2010



GW-MATE
LOGO



1. IWRM & groundwater management framework
2. Aquifer system characterization for management
3. Integrated groundwater management in practice
4. Groundwater legislation and regulation
5. Groundwater allocation and licensing
6. Economic and financial instruments in groundwater management
7. Stakeholder participation in groundwater management
8. Groundwater quality protection and management
9. Groundwater monitoring
10. Groundwater and climate change
11. Information management and communication.

Integration of Groundwater in basin organisations in Africa

**INTEGRATION OF
GROUNDWATER MANAGEMENT**
into Transboundary Basin Organizations in Africa



TRAINING MANUAL

1. GW-Management in Transboundary Basin Organizations in Africa (Needs assessment)
2. IWRM and GW
3. Aquifer Systems Characterisation
4. Management of Transboundary GW
5. GW Monitoring and Information Management
6. GW regulation, licensing, allocation and institutions
7. Stakeholder participation and communication
8. GW Hazards
9. GW and Food Security
10. GW and Environment
11. GW and Climate Change

IAH Burdon Groundwater Network for International Development

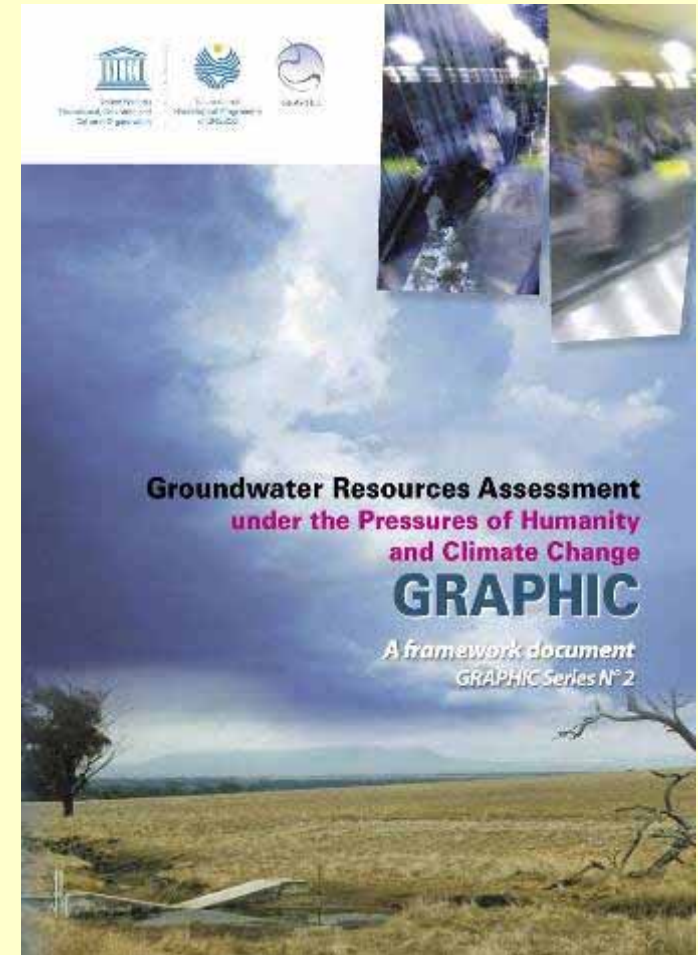
- Making existing and new groundwater knowledge more widely and easily accessible.
- Connecting people: increasing networking and experience sharing
- Advocacy, of the role of groundwater and hydrogeologists in reducing poverty.
- Supporting groundwater training
- Free Book Scheme
- Africa Groundwater Atlas
- Africa Groundwater Literature Archive
- Support in establishment of new IAH chapters (Zambia, Tanzania and Malawi targeted)



UNESCO- IHP: Groundwater focal areas under IHP8

- **Focal Area 2.1** - Enhancing sustainable groundwater resources management
- **Focal Area 2.2** - Addressing strategies for management of aquifers recharge
- **Focal Area 2.3** - Adapting to the impacts of climate change on aquifer systems
- **Focal Area 2.4**– Promoting groundwater quality protection
- **Focal Area 2.5** - Promoting management of transboundary aquifers

All the focal areas are priorities to Africa
due to high dependence on
groundwater





UPGro: A social and natural science approach to enabling sustainable use of groundwater for the benefit of the poor

A seven-year international research programme
(2013-2020)

Focuses on improving the evidence base around groundwater availability and management in sub-Saharan Africa (SSA) to enable use of groundwater in a sustainable way in order to benefit the poor.



Richard Carter

Consortium Projects (2015-19)



Building understanding of climate variability into planning of groundwater supplies from low storage aquifers in Africa



Hidden Crisis

Unravelling current failures for future success in rural groundwater supply



Experimenting with practical transition groundwater management strategies for the urban poor in Sub Saharan Africa



Groundwater Risk Management for Growth and Development

GroFutures

Groundwater Futures in Sub-Saharan Africa

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

Groundwater Solutions Initiative for Policy and Practice (GRIPP) Partners



Objective: Sustainable groundwater management for livelihoods, food security, climate resilience and economic growth

GRIPP Program Areas/Themes

1. Groundwater and Food Security
2. Groundwater for Sustainable Development
3. Groundwater, Water Security and Climate Change Adaptation
4. Groundwater and Energy
5. Transboundary Aquifers
6. Groundwater Governance



Top

Irrigation project near Ziway, Ethiopia

Picture credit: Petterik Wiggers

Bottom

Pumping groundwater to irrigate fields in Nepal

Picture credit: Fraser Sugden

The African Groundwater Movement - Who is involved?

- **International champions:** Skat, UNICEF, WaterAid, USAID, WSP, RWSN and International Association of Hydrogeologists (IAH)
- **Continental Champions:** Africa Groundwater Network (AGWNet)
- **In-country:** Drillers, consultants, national government agencies, universities, training agencies, drillers associations and UNICEF country offices
- **New:** UK funders (DFID, NERC, ESRC) with UPGro, British, Dutch and Africa-based universities
- **Numerous individual and organisational champions - but not all are connected!**

Movement aims to keep on drawing stakeholders closer together, learning from each other & sharing experiences of capacity strengthening.

Groundwater relevant institutional frameworks in Africa

- **AU-** African Union
- **AMCOW-** African Ministers' Council on Water
- **RECs** – Regional Economic Communities (8No.)
- **RBO-** River Basin Organisations
- **MS-** Member States (Ministries responsible for water)
- **Sub-national:** Basins/States, Counties/Districts
- **Local level:** Sub-basin/community

***Role of British Hydrogeologists in
improving the understanding of
groundwater resources in Africa***

Historical and current perspectives

- Most of the work done to improve understanding of groundwater resources and stimulate groundwater development especially in Anglophone countries originates from the British hydrogeologists
- Work in Francophone countries largely spearheaded by French hydrogeologists
- Recent developments point to more collaborative work among the British, French, German and African hydrogeologists as well as hydrogeologists from other countries
- This new way of doing things has great promise for groundwater but coordination still a challenge

Key contributions to GW knowledge in Africa

- John Chilton, Stephen Foster, Mike Jones, Ed Wright, Ian Acworth - Weathered aquifer profile.
- Mike Edmunds- Groundwater recharge mechanisms and rates using several methods
- Robin Hazell- use of geophysics to find groundwater in basement rocks in Nigeria
- Alan MacDonald et al. – brought to the fore the drought susceptibility concept and the map of this produced for Ethiopia as an example
- Alan MacDonald et al. - more recent maps of groundwater storage and yields in Africa.
- Richard Taylor- conceptual cross-sectional models of surfaces of deep weathering and stripping

Weathered basement aquifers –

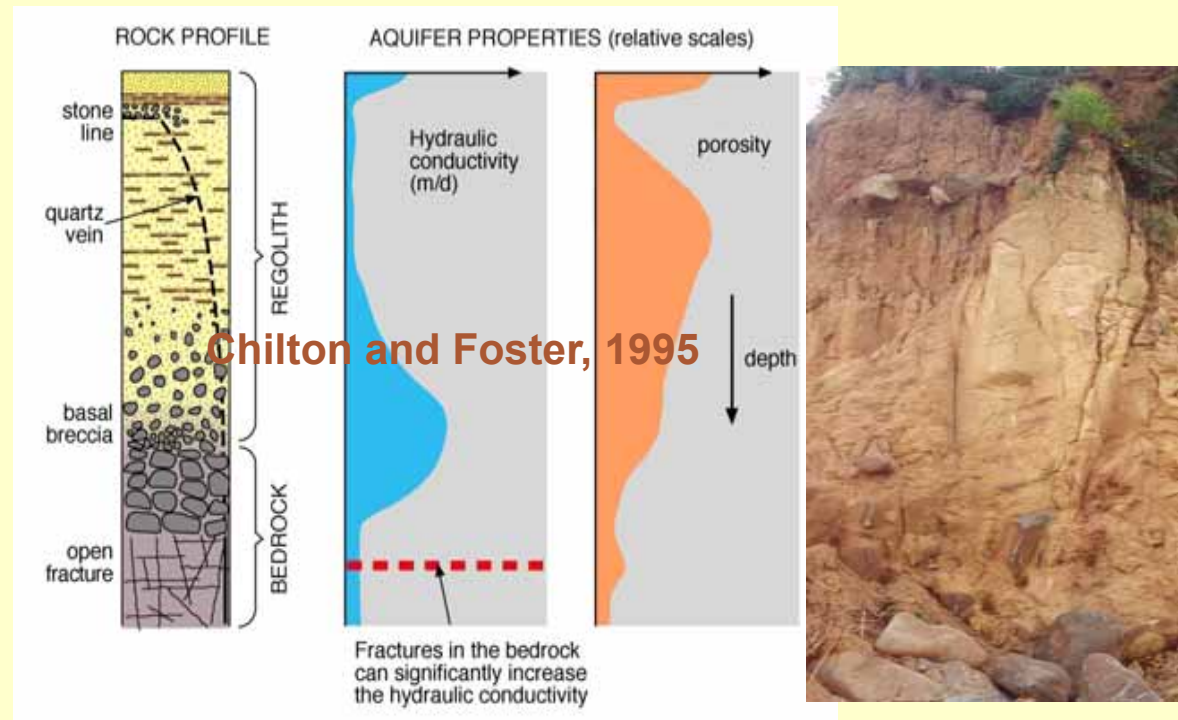
saturated thickness > 15 m will usually provide handpump yield

- Work was done in the 1980s on the basement in Malawi leading to an understanding of the value of the weathered regolith as an aquifer in itself.

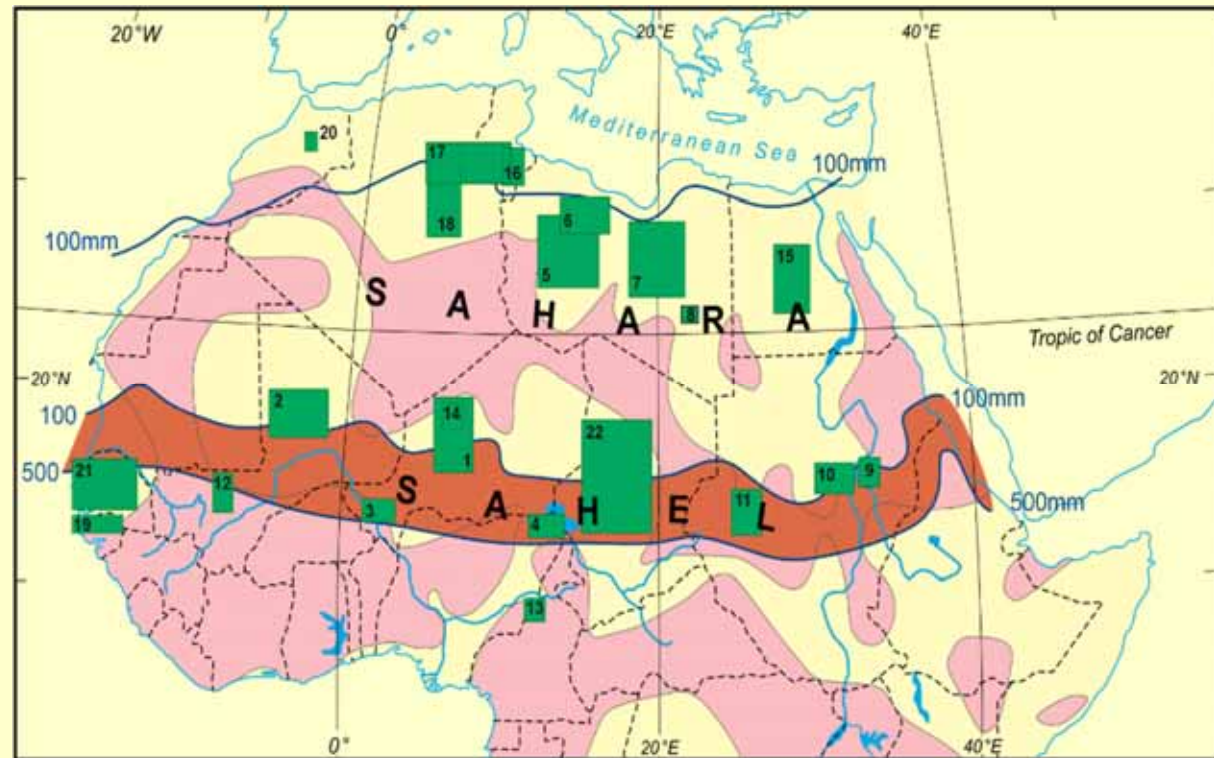
Weathered aquifer profile developed.



- Conclusion reached was that the regolith could meet domestic needs from shallow handpump boreholes at the design yields and for the quite high rural population densities

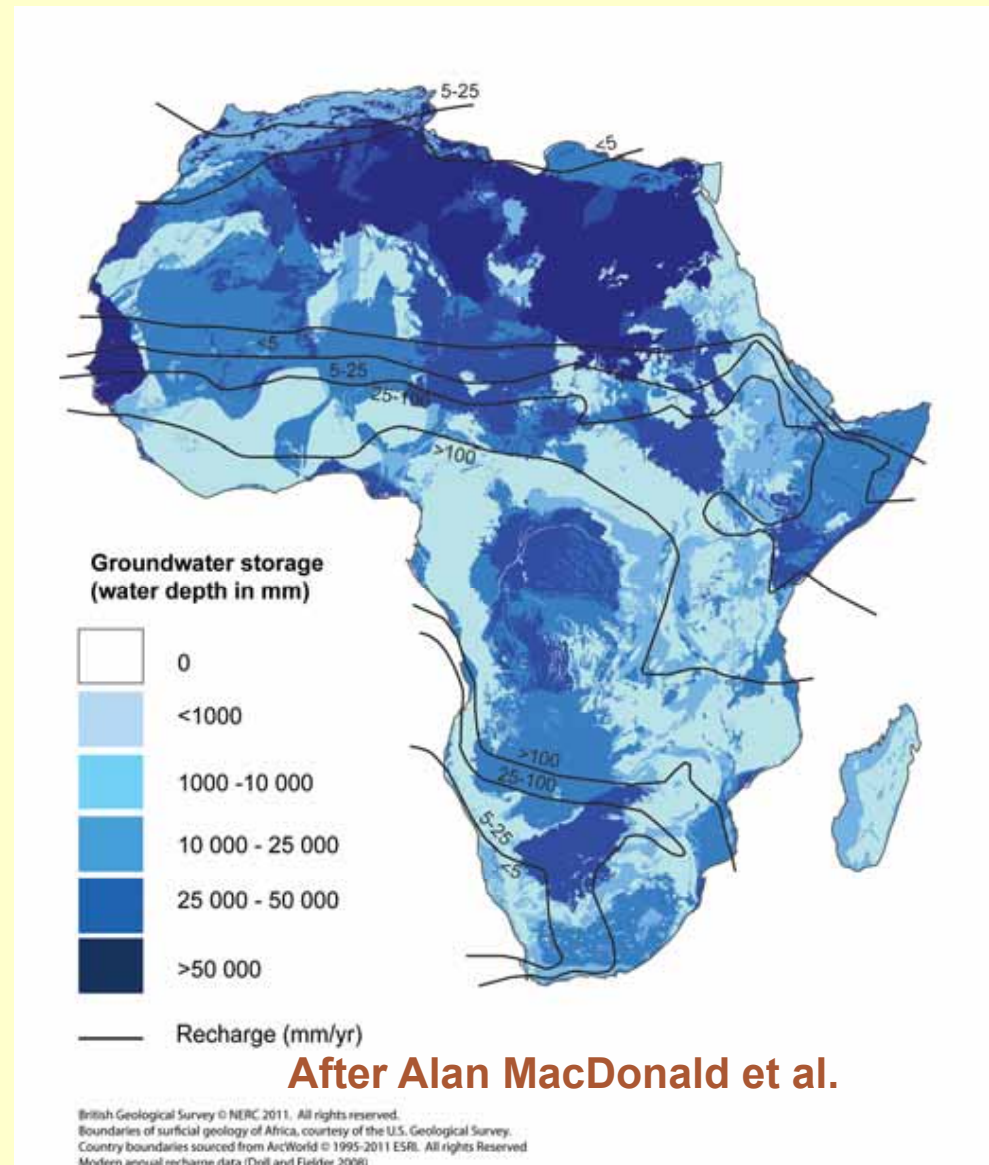
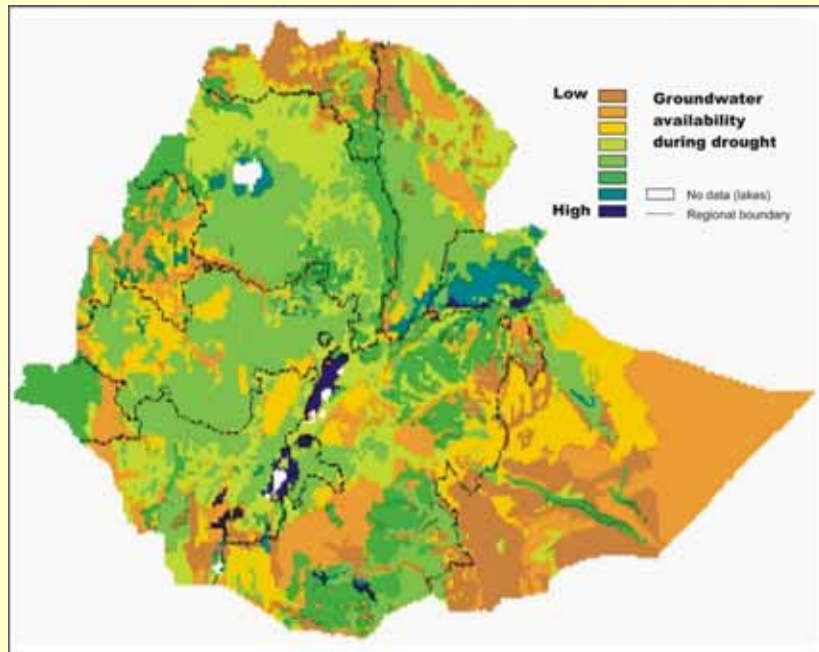


Groundwater recharge mechanisms and rates using several methods



After Mike Edmunds

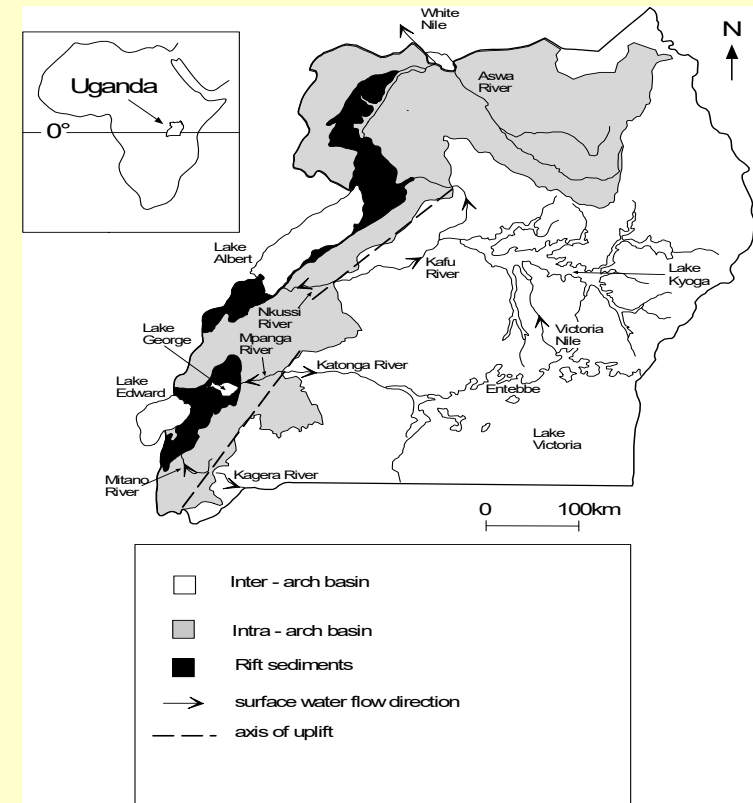
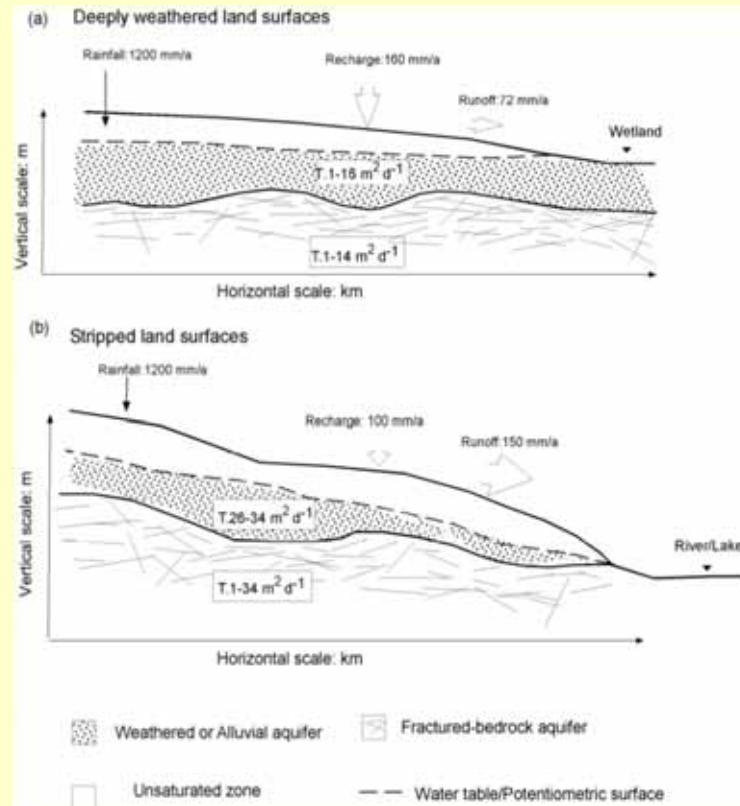
Groundwater availability during drought, storage and yields in Africa



After Alan MacDonald et al.

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Boundaries of surficial geology of Africa, courtesy of the U.S. Geological Survey.
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Modern annual recharge data (Doll and Fielder 2008)

Conceptual cross-sectional models of surfaces of deep weathering and stripping



After Richard Taylor

SUMMING IT UP

- ❑ Groundwater is poised to play a key role in Africa's transformation.
- ❑ The impending groundwater management challenges are however enormous
- ❑ The ongoing groundwater management related programs and existing institutional frameworks offer great hope for addressing the challenges
- ❑ A pending issue is on effective coordination of the groundwater agenda on the continent