Unlocking the Potential of Groundwater for the Poor

UNLOCKING THE POTENTIAL OF GROUNDWATER FOR THE POOR (UPGRO)

An overview of an on-going research initiative

Richard Carter

Session summary

- Overview of the UPGro programme
- “Sampler” of the Catalyst Projects
  - Fabio/Cheikh – Mapping Manual Drilling Potential
  - Helen Bonsor – Hidden Crisis
  - Lisa Bunclark - AMGRAF
- Keynote Interview – Prof Richard Taylor, interviewed by Prof Richard Carter
- Panel discussion – Helen, Fabio, Cheikh, Lisa, and the two Richards.

The UPGro Programme

- A 7-year research programme bringing together natural science and engineering, social science and development, focusing on groundwater in Africa.
- Four components
  - The Africa Groundwater Atlas and Literature Archive
  - The 15 Catalyst Projects
  - The 5 Consortium Projects
  - The Knowledge Broker

The Catalyst Projects

- 15 short (one-year) proje… …ering … …ange groundwater research iss… …elating … …quality, quantity, trends, threats, and uses in domestic water supply and agriculture.
- Work… …d out in 12 countries, and some projects had … …e focus.
- The f… …ults have been synthesised in an easy-to-re… …ment.

ET — **Optimizing Road Development for Groundwater Recharge and Retention** — wr, inf, gov

KE — **Groundwater Risks and Institutional Responses for Poverty Reduction in Rural Africa** — wr, gov, ag, inf, min

KE — **Assessing Risks of Investment in Groundwater Resources in Sub-Saharan Africa (ARIGA)** — wr, gov

MW, ZW — **Resource limitations to sustainability of groundwater well-points in basement complex regions of sub-Saharan Africa** — wr

Africa-wide — **Groundwater recharge in Africa: identifying critical thresholds** — wr, inf

ET, ZA, GH — **Adaptive management of groundwater resources for small-scale irrigation in sub-Saharan Africa (AMGRAF)** — wr, ag, gov

KE, KM, TZ — **Towards groundwater security in coastal East Africa** — wr, cc

TZ — **IN-GROUND: Inexpensive monitoring of Groundwater pollution in Urban African Districts** — pol, urb

UG — **A hidden crisis? Strengthening the evidence base on the sustainability of rural groundwater services** — ws, inf

NG, ZM — **Mapping groundwater quality degradation beneath growing rural towns in sub-Saharan Africa** — pol, urb

KE — **Sustaining groundwater safety in peri-urban areas** — pol, urb

BF, GH — **Building understanding of climate variability into planning of groundwater supplies from low storage aquifers in Africa (BRAVE)** — wr, cc

GN, SN — **Use of remote sensing and terrain modelling to identify suitable zones for manual drilling in Africa and support low cost water supply** — wr, inf

ET — **Improving access to safe drinking water: prospection for low-fluoride sources** — pol, wr, gov

ET, TZ, GH — **Groundwater Futures in Sub-Saharan Africa (GroFutures)** — wr, ag, inf, gov, cc

Awarded a Consortium Grant to continue work (2015-2019)

RESEARCH THEMES

- ag — agriculture
- gov — water governance & risk
- min — mining
- urb — urban groundwater
- cc — climate change
- inf — infrastructure planning and performance
- pol — groundwater quality and pollution
- wr — water resources and aquifer properties

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

The Consortium Projects

Five bigger projects, of four year duration, involving consortia of research organisations and an even more inter-disciplinary focus.

Hidden Crisis – examining causes of failure of borehole / handpump water sources – Ethiopia, Malawi, Uganda

Gro for Good – developing approaches to management of groundwater for social and economic good - Kenya

GroFutures – understanding and managing groundwater resources in context of environmental change – Africa-wide, Benin, Burkina Faso, Ethiopia, Niger, South Africa, Tanzania, Uganda

BRAVE – building understanding of climate variability and change into groundwater management – Burkina Faso & Ghana

T-GroUP – bringing about sustainable groundwater management in urban Africa – Ghana, Tanzania, Uganda

A bit more on the Catalyst Projects …

Synthesis: methods and tools

- Two projects (Lapworth, Velasquez-Orta) explored the use of **novel water quality testing methods**, with the latter designing a new biosensor to do so.
- Four projects (David MacDonald, van der Leeuw, Gowing, Colombo) developed **modelling frameworks** for resource development and management.
- One project (Gowing) used **community-level monitoring** of water resources.

Synthesis: data and information

All projects generated data, but of particular note,

- One project (Taylor) identified 25 continuous or near-continuous long-term **groundwater level data-sets** from around Africa.
- One project (Chilton) generated **down-hole and social / management data** on abandoned boreholes-with-handpumps.
- One project (Alan MacDonald) assembled and reviewed more than 200 **groundwater recharge studies**.
- Three projects (Lapworth, Wright, Smedley) generated **groundwater quality data-sets**.
- Two projects (Hope, Obando) generated data on **water demand, use and welfare indicators**.
- One project (Colombo) generated **structured and codified datasets** of stratigraphic borehole logs, allowing an automatic analysis of hydrogeological parameters.
- The Africa Groundwater Atlas / Groundwater Literature Archive project indexed **more than 5000 documents**, many with links to full text documents or abstracts.

Synthesis: subject matter

- Most projects focused on groundwater resources or quality in the context of **domestic water use by the poor**.
- Six projects (Obando, Hope, A. MacDonald, D. MacDonald, Wright, Taylor) explicitly considered **future threats** from environmental degradation, population growth, increasing demands and climate change.
- Only one project (Gowing) explicitly focused on **shallow groundwater for productive use**.
- One project (van Steenbergen) examined the interaction of **roads and groundwater**.

Findings: groundwater resources

- Information on groundwater resources is patchy in Africa, but **some good data-sets, maps and other materials do exist** (Taylor, A. MacDonald, Lapworth, Wright, Smedley, Colombo).
- It is evident that renewable groundwater resources are limited by rainfall amounts and their distribution over time (A. MacDonald, Taylor). In relatively dry climates it is more appropriate to **report recharge on a decadal basis** than as an annual average.
- Groundwater resources in the Basement Complex may be limited and scarce locally, but this is not always the case (Burgess).
- Competent borehole **site selection and evaluation of groundwater resources** are both important in order to deliver sustainable yields (Chilton, Burgess). Systematic analysis of hydrogeological context is essential for identification of suitable drilling locations (Colombo).
- **Climate change** will alter the local water balance, but its impact on groundwater recharge is likely to be very location-specific (A. MacDonald, Taylor).

Findings: groundwater quality

- **Groundwater is often highly corrosive**, and so the careful selection of suitable borehole lining and water pumping materials is very important (Chilton).
- Peri-urban groundwater quality is compromised, and the situation is likely to worsen. Nevertheless **many consumers are dependent on such unsafe waters** (Lapworth).
- **Novel water quality techniques** hold some promise for easier and more cost-effective measurement and monitoring (Lapworth)
- **Geogenic contaminants** (such as fluoride) pose difficulties for water supply. None of the available mitigation options is without disadvantages (Smedley).

Findings: developing groundwater

- **Weaknesses in siting, design and construction** (made worse because of poor supervision of contractors) result in many boreholes coming into service which should never have been commissioned (Chilton). This results in high rates of abandonment.
- **Novel ways of thinking** such as combined roads / water planning and design (van Steenbergen) still remain to be explored.
- **Combining data sources** such as indigenous and “scientific” knowledge (Gowing); and remotely sensed and down-hole data (Colombo) offers real synergies.

Findings: risk, uncertainty and change

- Modelling the future is only as good as modelling of the past. **There are still significant uncertainties** inherent in combining land, water and climate modelling (D. MacDonald).
- **Groundwater resources are at risk** from environmental and demographic change. The services they provide are therefore also at risk (Obando, Hope, D. MacDonald).

Findings: groundwater governance

- **Water users** are enthusiastic and competent participants in groundwater management (Obando, Gowing).
- **Information and participation** hold the promise of better water management (van der Leeuw).
- Sustainable groundwater management requires the **collaboration** of domestic water users, agro-industry, mining and other large-scale users, and public authorities (Hope).
- **There is willingness for Africa-wide collaboration** among groundwater scientists and civil servants (Taylor).

Synthesis: catalyst projects overview

Major achievements so far:

1. Data-sets on groundwater quantity and quality and a substantial body of documentary data and maps have been assembled.
2. New tools and methods have been developed and trialled.
3. There is clearer understanding of the need for multi-stakeholder collaboration in groundwater governance.
4. Professional networks have been built and strengthened.
5. Links between hydrogeology and other natural sciences, the social sciences, and the key issues pertaining to groundwater governance have been forged.

INDIVIDUAL PROJECT SUMMARIES

The Africa Groundwater Atlas and Literature Archive

The problem Much of the data and information that already exists about groundwater in Africa is not available to the people who could make use of it. This project aims to address that problem.

Key findings The Atlas and Archive will be of use to practitioners, researchers, policy makers and decision makers. The development and publication of the atlas will also involve many African groundwater scientists and be a platform to both publicise their knowledge and to deposit and secure their research and data.

Being web-based means the Atlas and the Literature Archive can be quickly updated and grow as more information becomes available. However, to maximise accessibility where internet connections are poor, the first edition of the Atlas will be supported by a hard copy version.

The approach Development of a literature archive and an Atlas of groundwater maps.

www.bgs.ac.uk/africagroundwateratlas

Where? Africa-wide.

Contact: Brighid O'Dochartaigh, BGS, beod@bgs.ac.uk

Africa Groundwater Literature Archive

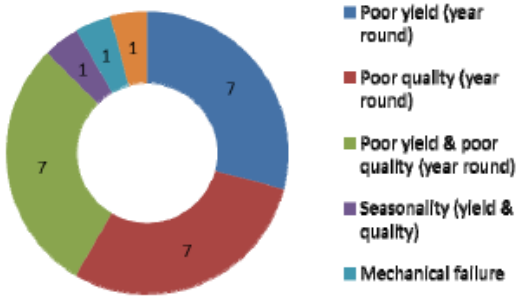
Hidden crisis: the causes of failure in rural groundwater supply

The problem Rural water boreholes with handpumps suffer high failure rates. Understanding the causes of these failures is necessary to carry out more effective service provision

The approach A conceptual framework involving symptoms, causal factors and underlying conditions. Field studies including community meetings and detailed borehole / handpump inspections.

Key findings Low yield and poor water quality are symptomatic of poor siting, construction and materials selection. Underlying causes lie in poor practices of implementing agencies, and especially the lack of competent construction supervision.

Dominant symptoms of failure



Where? Uganda

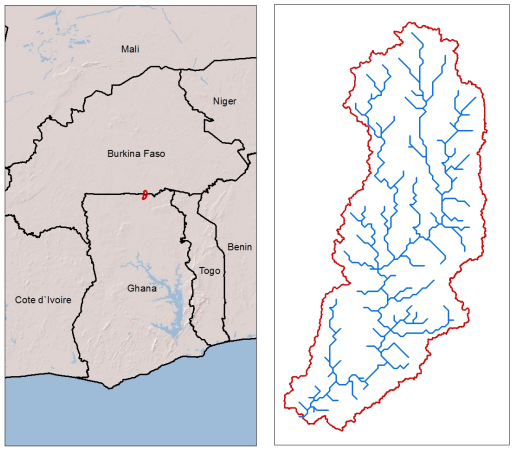
Awarded consortium follow-on grant

PI: John Chilton, IAH, jchilton@iah.org

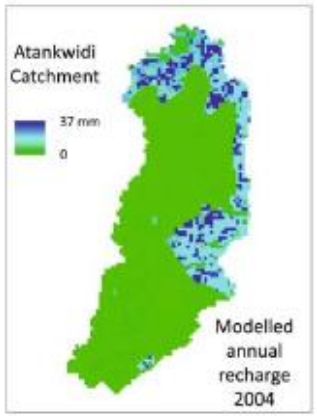
Building understanding of climate variability into the planning of groundwater supplies from low storage aquifers in Africa (BRAVE)

The problem Increasing water demands set in a context of variable climate and changing land use, together with dependence on low-storage, low-yield aquifers.

The approach
Application of linked land surface and groundwater models to assess impact on groundwater supplies of periods of reduced recharge; investigation of sensitivity of groundwater recharge to key climate and land use controls; development of stakeholder networks to examine planning needs and support decisions on groundwater development.



the study catchment



modeled annual recharge

Key findings Although the study shows that the land surface model used needs development to incorporate all the key processes, initial findings confirm that annual groundwater recharge can be highly variable. The impact of this variability on the continuity of supply during drought depends on how non-pumped water discharges from these low storage aquifers.'

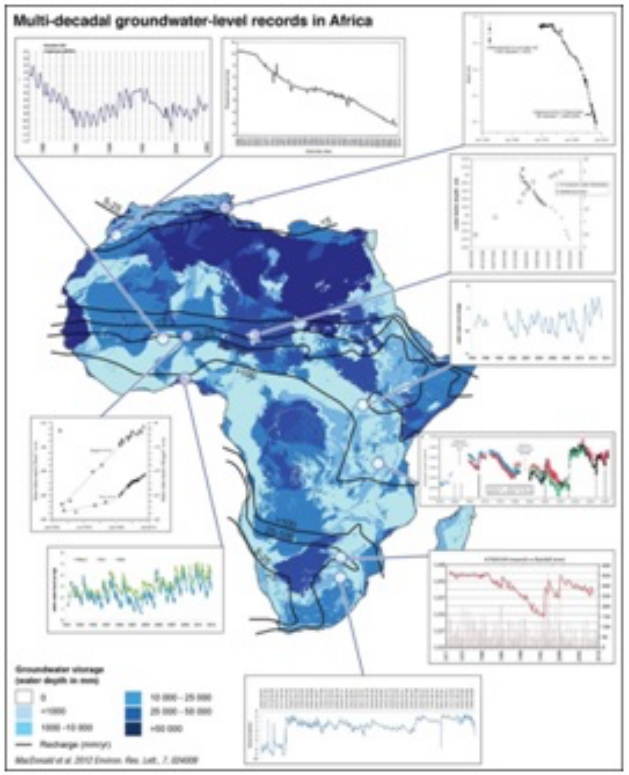
Where? Burkina Faso, Ghana

Awarded consortium follow-on grant

PI: David Macdonald, BGS, dmjm@bgs.ac.uk

GroFutures: Groundwater Futures in Sub-Saharan Africa

The problem Despite the importance of groundwater for growth and development, substantial uncertainty concerning the renewability, accessibility and management of groundwater resources remains.



Above: location of ten long-term groundwater level data-sets.
Right: monitoring water levels in the Makutopora wellfield, Tanzania.

The approach Quantifying changes in groundwater demand and supply. Development of an interdisciplinary, pan-African consortium to prepare a consortium research proposal for more in-depth research. Identifying long-term groundwater data-sets.

Key findings Multi-decadal groundwater level time series have been compiled. A strong collaborative network has been established to take the consortium research forward.

Where? Ethiopia, Ghana, Tanzania, Uganda, Africa-wide

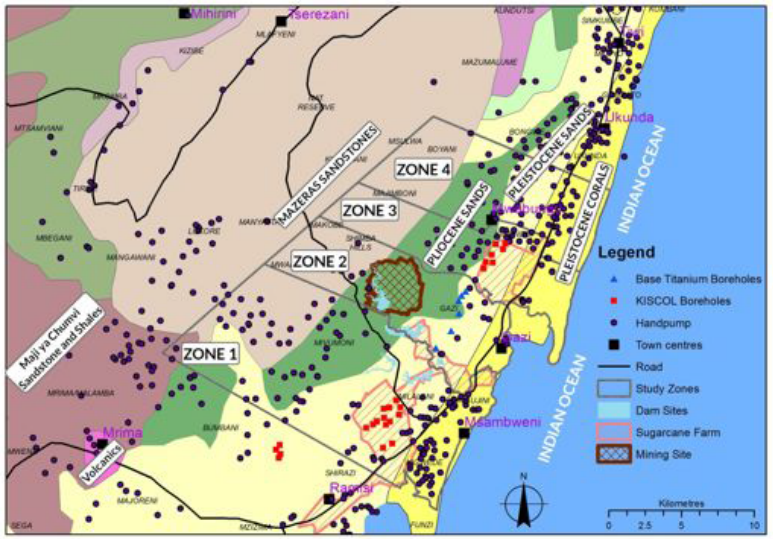
Awarded consortium follow-on grant

PI: Richard Taylor, UCL, richard.taylor@ucl.ac.uk

Groundwater risks and institutional response in rural Africa

The problem In locations with limited groundwater resources, but where large-scale demands are increasing, the question arises as to how groundwater can be sustainably managed to the benefit of both the wider economy and the rural poor. Can water risks be managed for both growth and development?

The approach A case study in Kenya, involving hydrogeological assessments, handpump monitoring, a household survey to inform understanding of water poverty, and key informant interviews and focus group discussions to understand groundwater governance.



Key findings A great deal of data regarding ground-water level and quality, water use, health and indicators of welfare has been generated. An inter-disciplinary Groundwater Risk Management Tool has been proposed for development in the consortium phase.

Where? Kenya

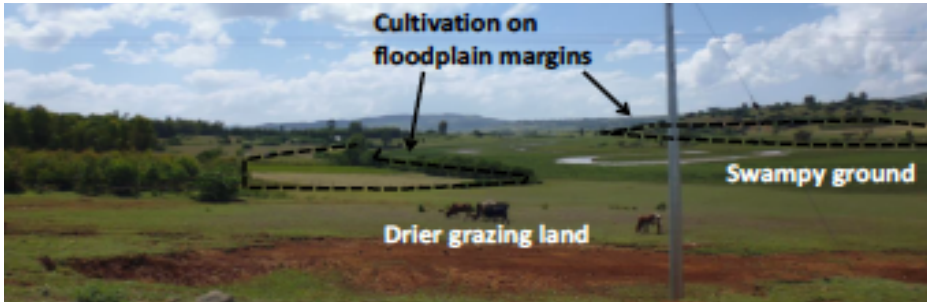
Awarded consortium follow-on grant

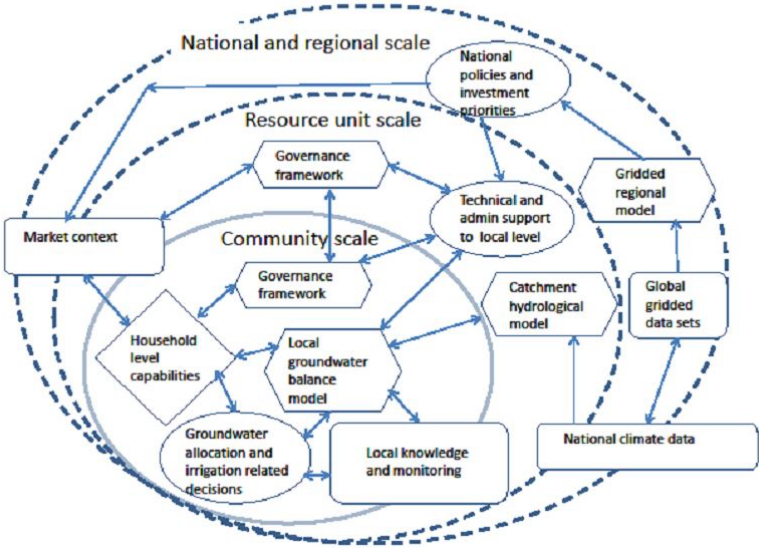
PI: Rob Hope, Oxford University, robert.hope@ouce.ox.ac.uk

Adaptive management of groundwater in Africa (AMGRAF)

The problem Productive use of groundwater in Africa offers many opportunities. Much information on groundwater exists in the form of global remote sensing products, while local indigenous knowledge also has much to offer. These two information sources need to be combined with hydrological modelling and appropriate social and governance systems to achieve sustainable development and to assure equitable access to the resource by the poor.

The approach A multi-scale, multi-disciplinary approach was taken, including water resource monitoring by community members, modelling and social science studies.





Key findings Potential exists for shallow groundwater irrigation. Simple water balance models and community monitoring can be used with appropriate governance systems for local adaptive resource management.

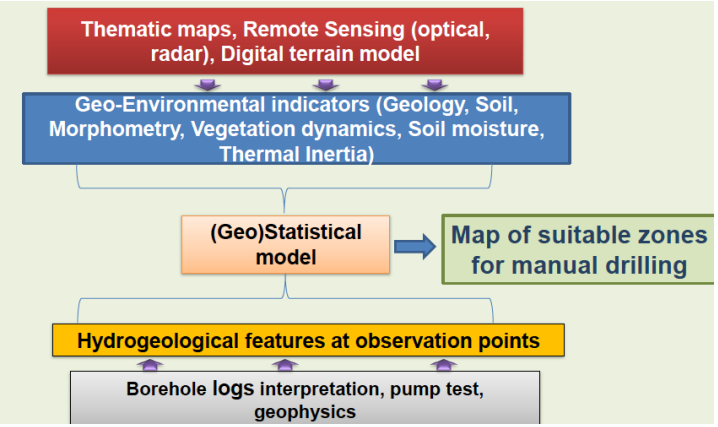
Where? Ethiopia

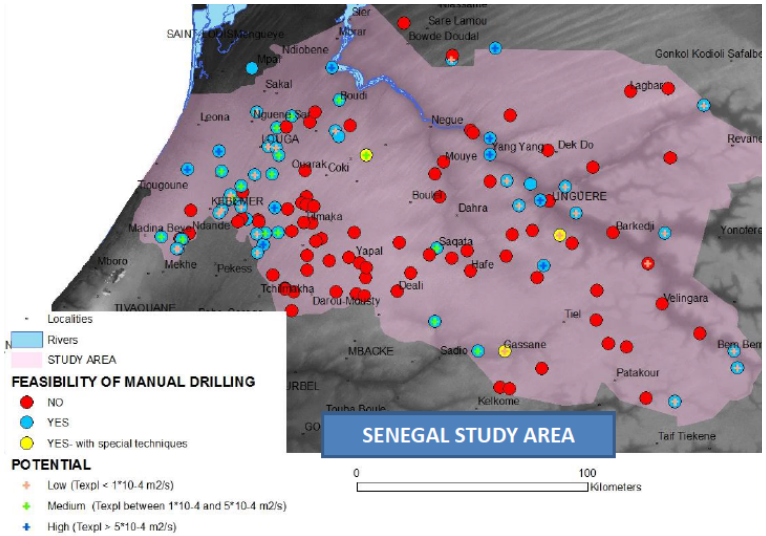
PI: John Gowing, Newcastle University
john.gowing@newcastle.ac.uk

Use of remote sensing and terrain modelling to map manual drilling potential in Senegal and Guinea

The problem Extending groundwater supply to more people is expensive using conventional technologies. Manual well drilling offers cost-saving opportunities, but the techniques involved can only be used in specific ground conditions.

The approach Development of a systematic methodology for combining remotely sensed data with direct data from drilling records, to map the potential for manual drilling.





Key findings Software has been developed to integrate drilling data and remotely-sensed data to map manual drilling potential in Senegal. Further validation of the approach is still needed.

Where? Guinea, Senegal

PI: Roberto Colombo, University of Milano-Bicocca,
Contact: Fabio Fussi, fabio.fussi@usa.net

Recordings of Rural Water Supply Network (RWSN) webinars featuring UPGro research can be found at: http://upgro.org/webinars-and-films/

- **Groundwater Governance**
  10th March 2015 (vimeo.com/121992412)
  Jacob Katuva (University of Oxford) / Tom Armstrong (JB Drilling)

- **Groundwater Resources and Supplies in Africa**
  24th February 2015 (vimeo.com/120571030)
  Joy Obando (Kenyatta University) / Dan Lapworth (BGS)

- **Groundwater Research**
  9th December 2014 (vimeo.com/114133055)
  Jan de Leeuw, (World Forestry Centre - ICRAF) / John Chilton, (IAH) / John Gowing (Newcastle University)

- **Mapping Groundwater Quality for Decision-Makers**
  25 November 2014 (vimeo.com/112900426)
  Pauline Smedley (BGS) / Jim Wright (University of Southampton) / Rob Hope (University of Oxford)

- **Groundwater Recharge**
  21 October 2014 (vimeo.com/109696443)
  Kifle Woldearegay (Mekelle University) / Alan MacDonald (BGS) / Richard Taylor (UCL)

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