Groundwater Data in Africa

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with many thanks to

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Why talk about groundwater data in Africa?

- In most of Africa, groundwater is the best* solution for water supplies

BUT

- Accumulation of groundwater data isn't keeping up with groundwater resource development

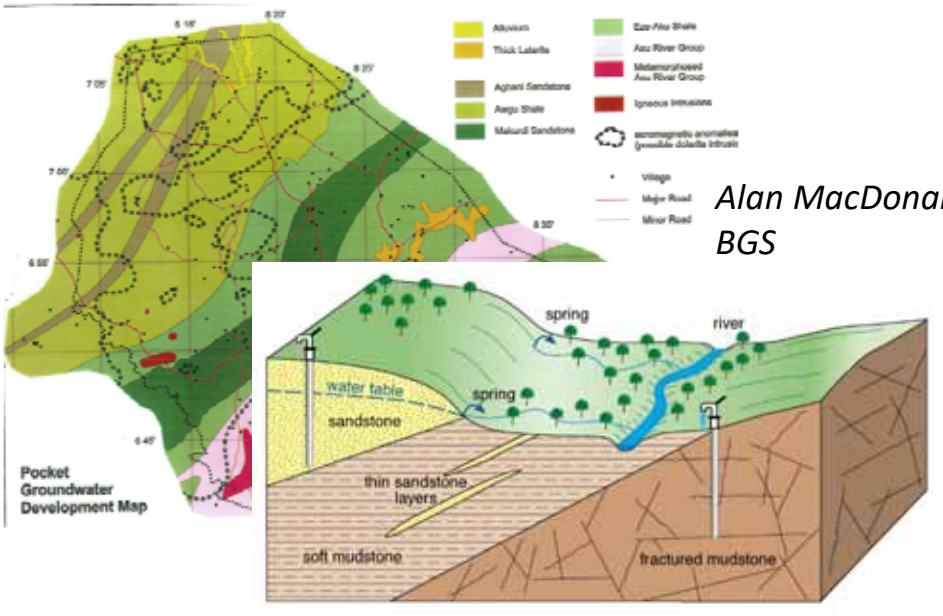
Why is this a problem?

- Because not enough information to:
  - understand the groundwater resource
  - plan & manage effective groundwater development
  - understand and manage trends in groundwater depletion, contamination & flooding

* best = most appropriate hydrologically / logistically / financially / technically / environmentally, etc

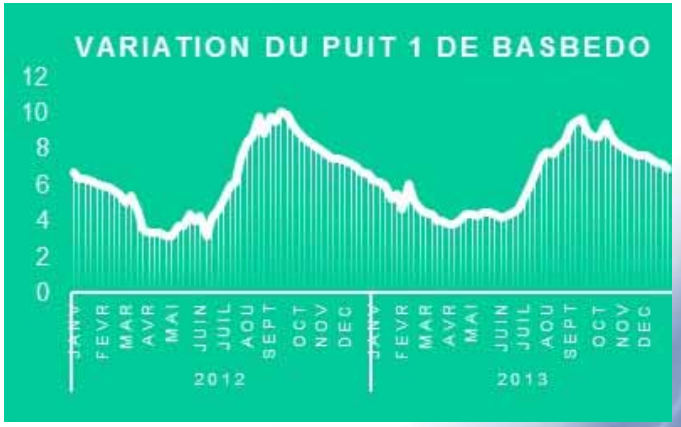
What do we really need to know about groundwater?

- Where and how deep to drill?
- Is the groundwater quality suitable?
- Where is the groundwater level over time?



Alan MacDonald, BGS

Jade Ward, BGS, Malawi



Djibreel Barry, WaterAid, Burkina Faso

What key groundwater data do we need?

Groundwater data	*What exactly?*	*How do we get it?*
Aquifer location & characteristics	Aquifer geology Aquifer properties - permeability/transmissivity, storage capacity, typical borehole yields	Detailed lithology, fractures, etc from drilling logs Aquifer & borehole properties from test pumping.
Groundwater quality	Essential chemical and microbiological parameters for drinking/health (human & livestock); irrigation; industry	Field sampling and lab analysis Ongoing monitoring
How groundwater levels fluctuate in response to seasonal & inter-annual recharge and long-term pumping	Groundwater levels in individual boreholes, at representative locations & depths	Ongoing groundwater level monitoring; at least monthly

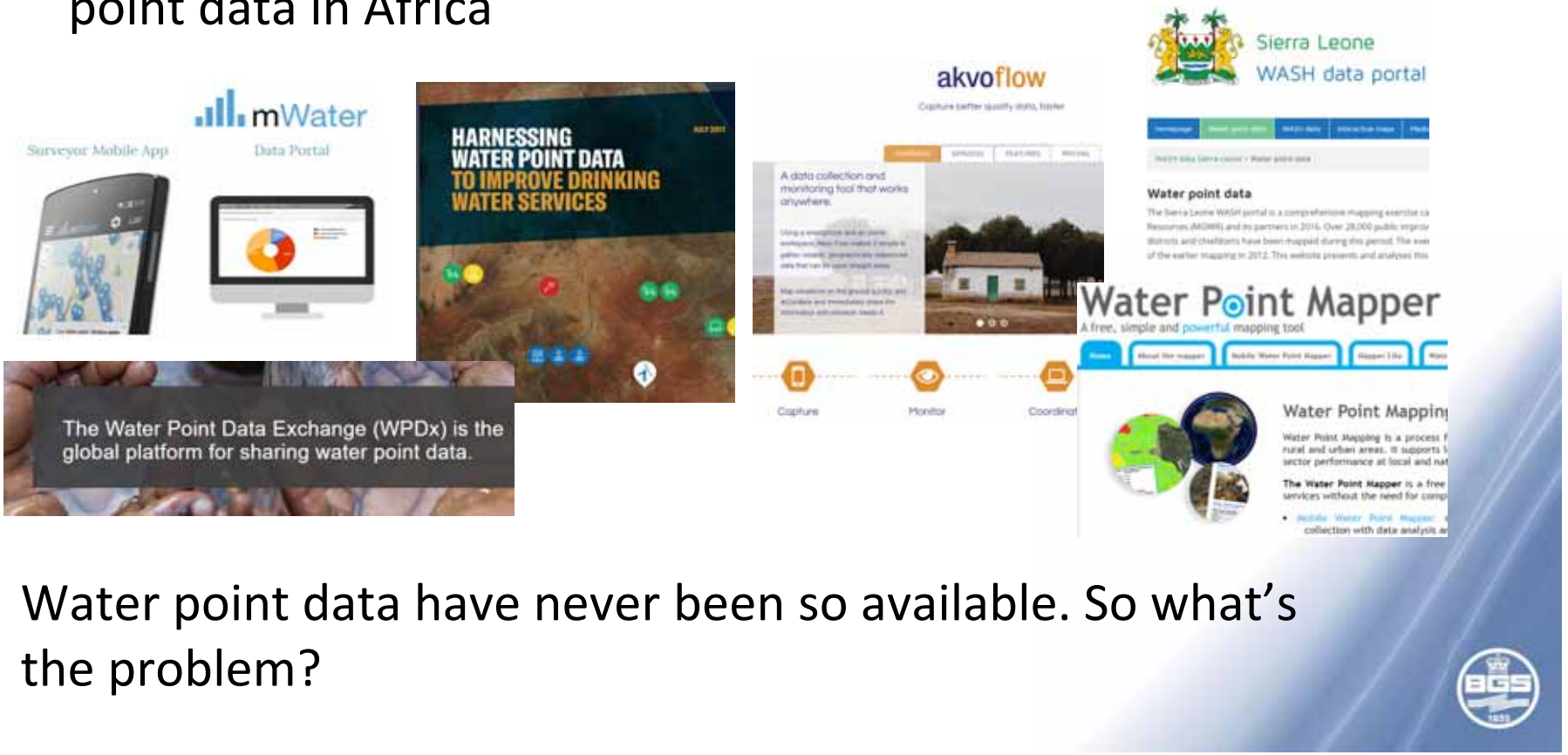
- Fundamentally = data from boreholes (and secondarily from wells & springs) – one-off & monitoring through time

A data flow for groundwater

- Many issues are involved in this data flow – not only in Africa
- This talk focuses on:
  - What groundwater data are currently collected & stored?
  - The difference between groundwater and water point data
  - Key issues with one-off and monitoring groundwater data

Water point data

- Most water points in Africa are groundwater sources – usually boreholes or hand dug wells
- Recent proliferation of procedures, databases & apps for more efficient collection, storage and availability of water point data in Africa



- Water point data have never been so available. So what's the problem?

Water point datasets usually include little groundwater data

- E.g. WPDx – Water Point Data Exchange – 'largest global collection of water point data' from many sources
- Tens of attribute fields with water point data
- But in a sample of 34 water point datasets = very little groundwater data

Groundwater data	*Number of datasets with any info (/ 34)*
Borehole / well depth	3
Rest water level	2
Borehole / well yield	1
Qualitative water quantity	2
Quantitative water quality	1 (pH & EC only)
Qualitative water quality	6

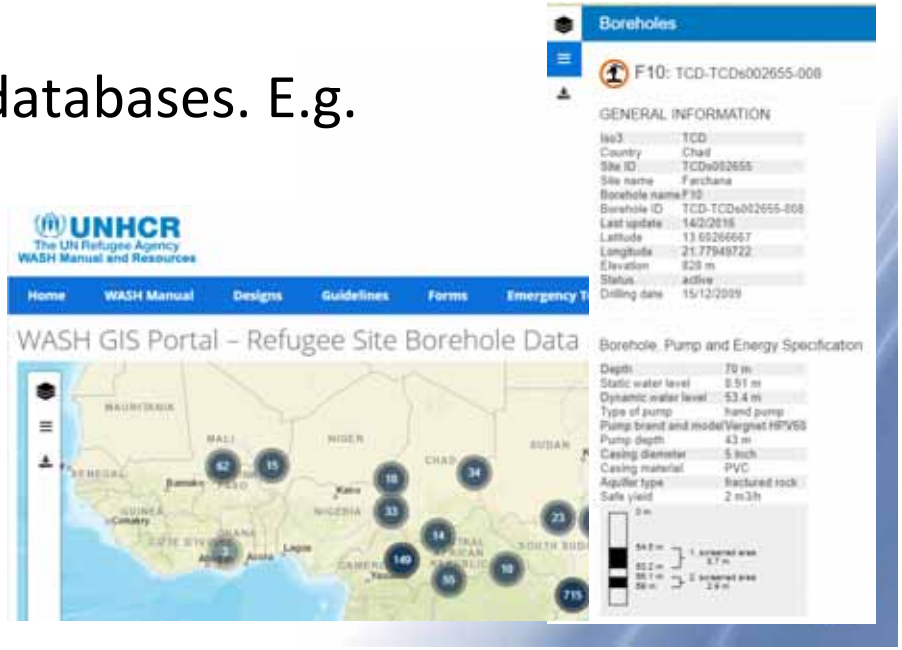
Water point data usually tell us little about groundwater

E.g. of data field	*Groundwater insight?*
Location: Geographic coordinates, name of village/district	Can locate water point on a geology / hydrogeology map – so a hydrogeologist can infer basic aquifer characteristics
Source type: e.g. Hand dug well / spring / drilled borehole	May be able to infer approximate depth to groundwater level
Number of people served	Can assume a minimum borehole/well/spring flow rate, and from this a minimum aquifer productivity
Functional/Not functional	Not much – too many reasons for non-functionality
Water quantity: Almost always qualitative: e.g. *Enough, Insufficient*	Very little – too subjective. May be able to infer minimum yield
Water quality: Almost always qualitative: e.g. *Soft*, *Milky*, *Salty*, *Good*, *Fair*	Very little – subjective and not reliable.

What one-off groundwater data are there?

- Most countries have a national borehole inventory - usually information from time of drilling. E.g.
  - Uganda: drilled boreholes >30m recorded; drillers return borehole completion forms with drilling & test data to ministry for digital database entry
  - Botswana: drillers return borehole completion certificates with drilling, any test & water chemistry data to ministry

- Donors / international borehole databases. E.g.
  - UNHCR: online borehole inventory
  - Eawag / GAP: some GW quality data from various organisations



National borehole inventories aren't perfect

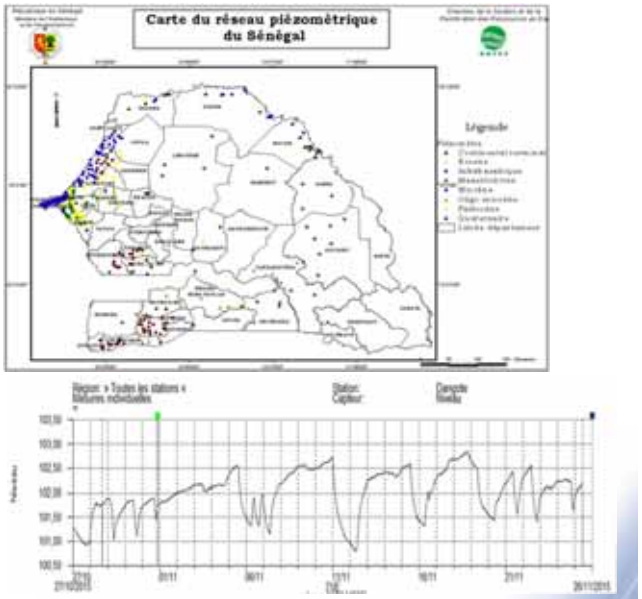
- Issues can include:
  - Not all countries have strong procedures for data collection & management
  - Not recording boreholes < a certain depth
  - Hand dug / manually drilled wells/boreholes not recorded
  - Not (fully) digital – e.g. hard copy data collected but not digitally databased
  - Missing data – e.g. RWL, geological logs, water quality, test pumping
  - Errors – can be missing quality control
  - May not be regularly updated
  - Fragmented – data held in different departments

COUNTRY	Total Water Points	Boreholes	Stratigraphic logs
BENIN	15692	10810	no records
BURUNDI	limited	undefined	no records
CENTRAL AFRICAN REPUBLIC	2602	undefined	no records
CHAD	10844	5418	no records
GUINEA	16000	16000	More than 1000, country
IVORY COAST	13383	9912	no records
LIBERIA	5474	625	no records
MADAGASCAR	3000	undefined	no records
MALI	29064	18954	no records
MAURITANIE	13911	4020	no records
NIGER	19865	undefined	no records
SENEGAL	7144	2846	1419
SIERRA LEONE	limited	undefined	no records
TOGO	7500	undefined	no records
ZAMBIA	18236	3716	1089

E.g. 15 country databases, 2008-12: most don't hold geological logs (Fabio Fussi, University of Milano Bicocca, Italy / UNICEF)

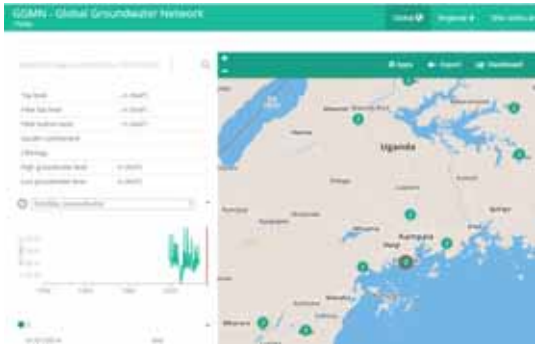
What groundwater monitoring data are there?

- National: many countries have strategic groundwater level monitoring networks; fewer for groundwater quality. E.g.
  - Senegal: GWLs & key quality parameters from network of 170-500 piezos across different aquifers. Most measured 2- 4 / year; some automatic GWL loggers.
  - Kenya: GWL & key quality data collected 4-12 / year from ~90 boreholes (often abstraction), of which 11 dedicated for monitoring (automatic GWL loggers).



Moustapha Diene, Cheikh Anta Diop University, Dakar, Senegal

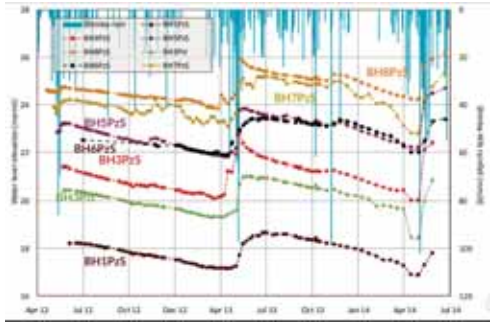
- International: E.g.
  - UN-IGRAC: GGMN - some GWL & quality data from various organisations

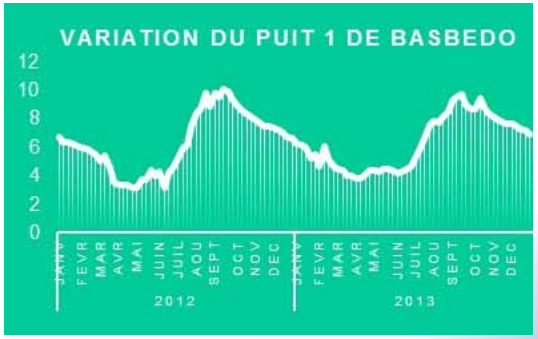


Project-based & private sector groundwater monitoring

- Pros – detailed data
- Cons – restricted areas / time scales; may not be linked with national datasets; IPR – who owns the data? E.g.
  - Network of African Groundwater Observatories – collating long term groundwater level records across Africa (GroFutures/UPGro)
  - WaterAid, Burkina Faso – voluntary community GWL monitoring in 2 villages; incorporated in government database
  - Large private industrial or agricultural operations – e.g. Kwale, Kenya (Gro for Good/UPGro)

Jacob Katuva, Oxford University; Base Titanium, Kenya

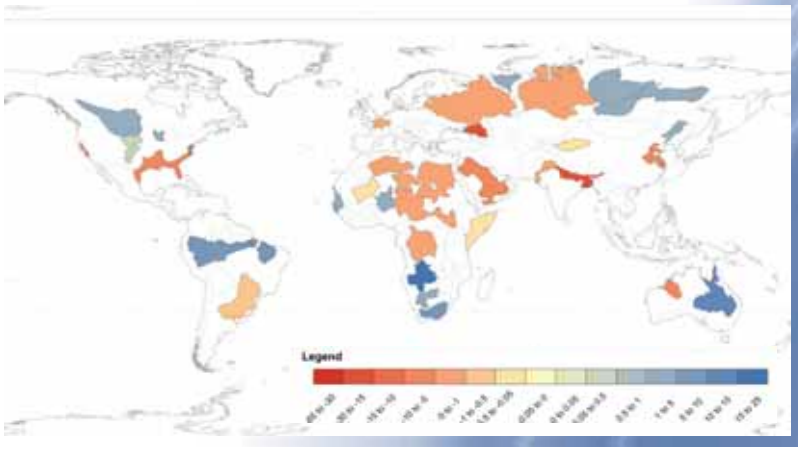




Djibreel Barry, WaterAid, Burkina Faso

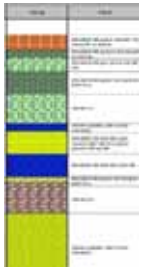
What about remote sensing?

- Recently, remote sensing – in particular GRACE – promoted as tool for groundwater level monitoring
- GRACE:
  - Measures gravity variations caused by mass changes attributed to total water storage
  - Doesn't distinguish between groundwater & soil moisture
  - Doesn't measure groundwater levels
  - Mass changes modelled to estimate groundwater storage changes
  - Needs measured GWL data for validation
  - Low spatial resolution – not appropriate for many African aquifers
  - Doesn't address water quality

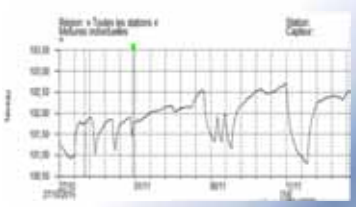
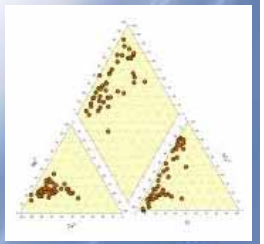


Summary

- Recent success improving water point data collection & management in Africa – & most water points are groundwater sources – but little groundwater data included.
- Strategic groundwater data collection in most countries, but:
  - Key borehole data not always recorded or databased collected (RWLs, logs etc)
  - Groundwater monitoring, especially quality, not always representative coverage
  - Limited frequency of monitoring data
- Management of water points is often disconnected from management of the groundwater resource they rely on

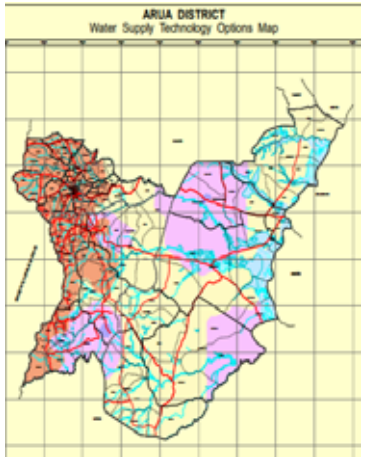


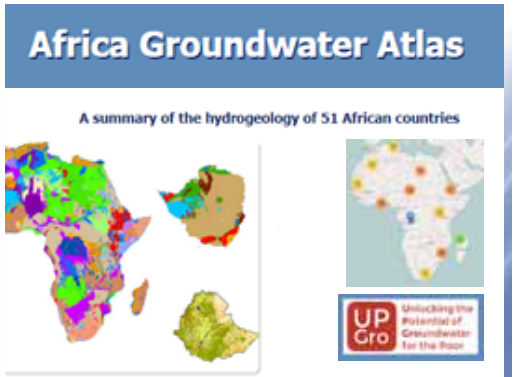
How to move forward?

What's needed for an effective groundwater data flow to support IWRM?

- No easy solutions!
- Promote strong institutional & legislative framework
- Persuade donors, governments & private sector of the value of collecting – & sharing – groundwater data. E.g.



- Promote examples of groundwater data used to produce maps / tools that improve success – e.g. Uganda
- Africa Groundwater Atlas (UPGro) – increasing visibility of groundwater information (interpreted from data)



- Can / should water point & groundwater data collection & management be more closely linked?