Unlocking the Potential of Groundwater for the Poor

LONG LIVE THE HUMBLE HANDPUMP

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HYDROGEOLOGY: BACK TO THE FUTURE!

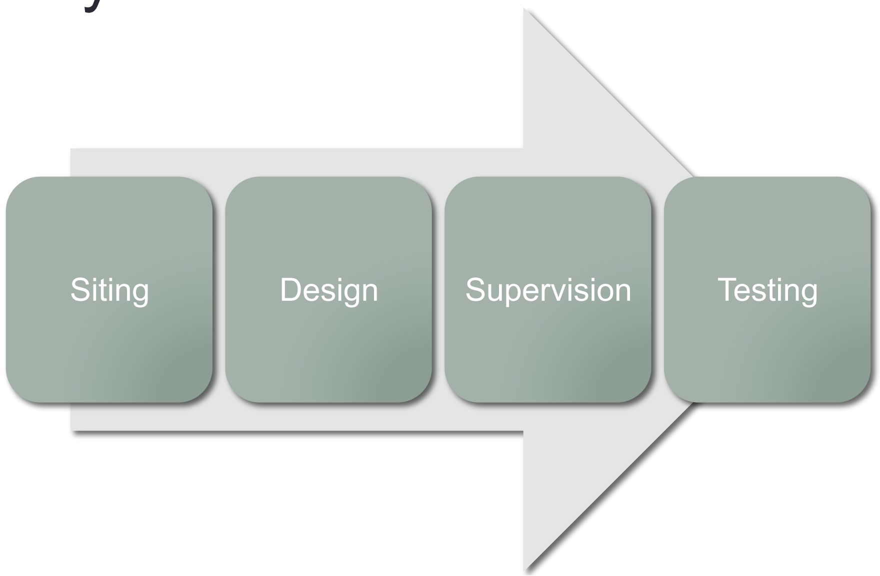
Richard Carter and Associates Ltd.

Some say …

… the handpump in rural Africa has had its day; handpumps are too difficult to manage; our ambition should be piped water for all.

I will say …

- … dispersed and low density populations will continue to need point sources, well beyond 2030; many of these point sources will be wells and boreholes with handpumps;
- … the performance of such point sources needs much improvement;
- … a few simple measures by hydrogeologists and engineers (together with decision-makers and managers) could improve handpump performance significantly.



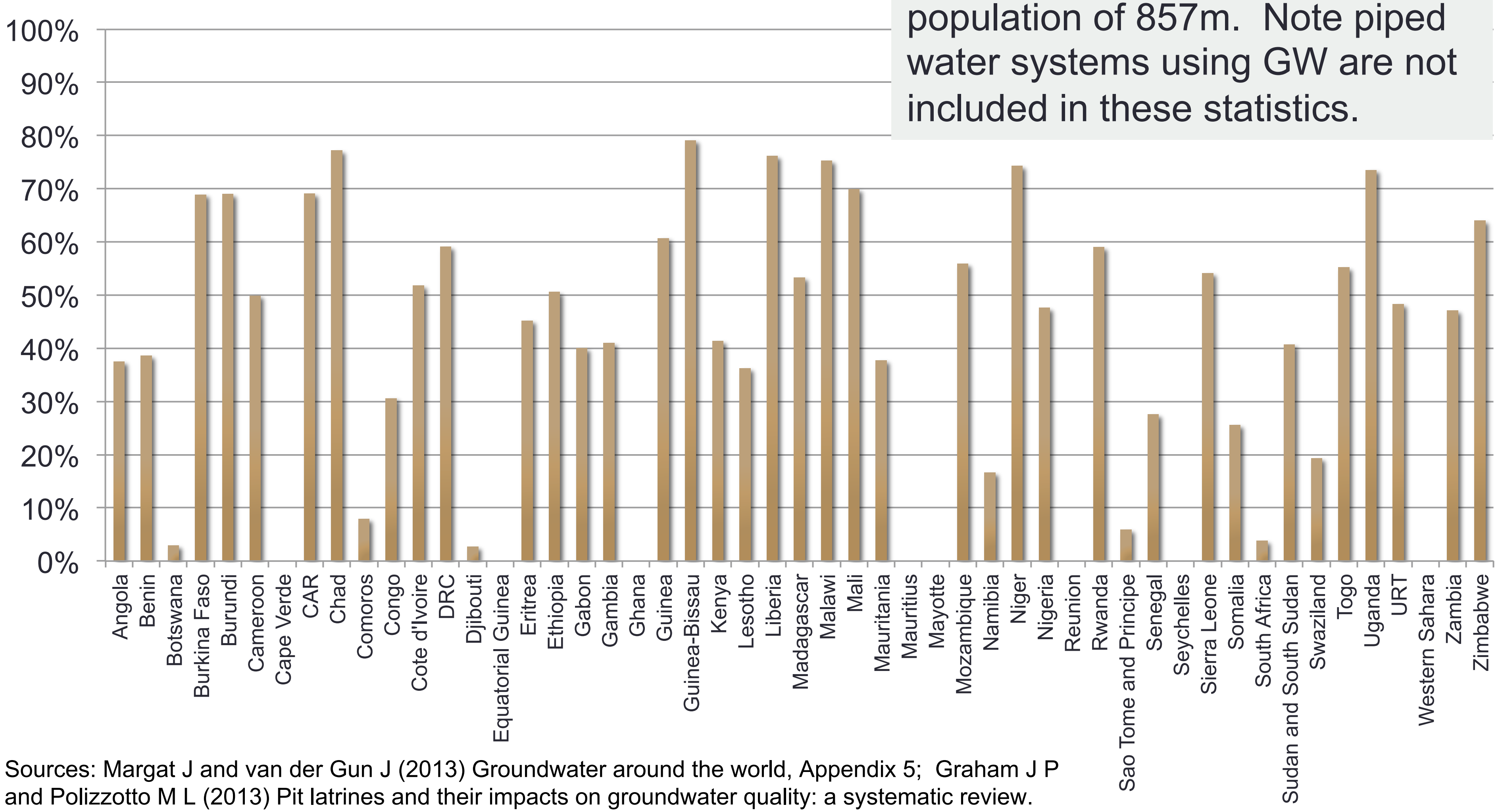
A focus on sub-Saharan Africa …

- Heavy dependence on groundwater for domestic water supply
- The key technologies – wells and boreholes with handpumps
- The statistics of under-performance
- What we can do as hydrogeologists and engineers

Graph 1a – groundwater dependence, SSA

Percentages of national populations using groundwater directly for drinking

Overall population-weighted average 47%, 407m out of a total population of 857m. Note piped water systems using GW are not included in these statistics.



Sources: Margat J and van der Gun J (2013) Groundwater around the world, Appendix 5; Graham J P and Polizzotto M L (2013) Pit latrines and their impacts on groundwater quality: a systematic review.

47% of the population of the region use groundwater directly from springs, wells and boreholes, the vast majority of these using handpumps.

An unknown additional number use groundwater supplied via piped systems.

Overall it is likely that **around two-thirds of the population of sub-Saharan Africa depend on groundwater.**

The problem with handpumps lies in …

… groundwater resources …

… siting and drilling …

… community engagement and participation …

… post-construction support to community management …

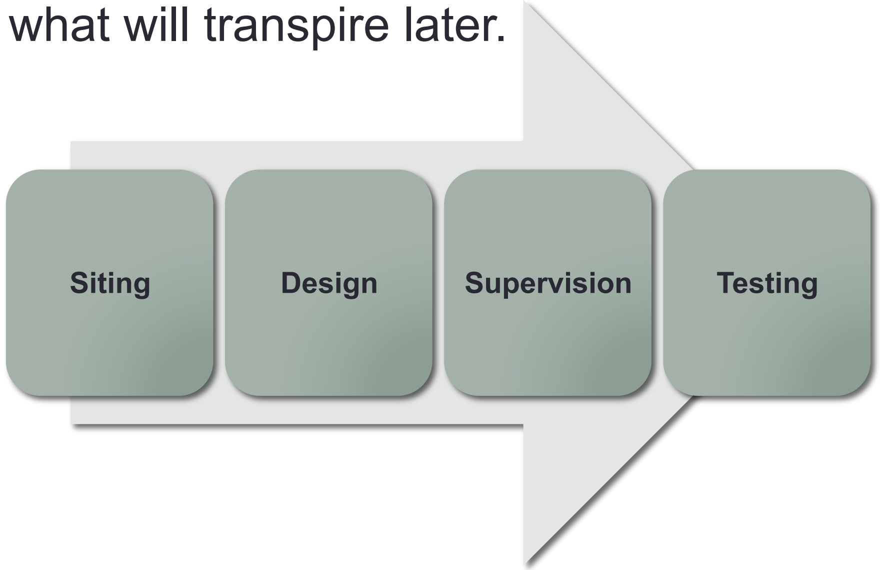
… post-construction financing …

… broader sector 'governance' issues …

I say …

- … all of these are important, but
- … the single most important area of improvement should be on **the pre-construction and implementation period.**

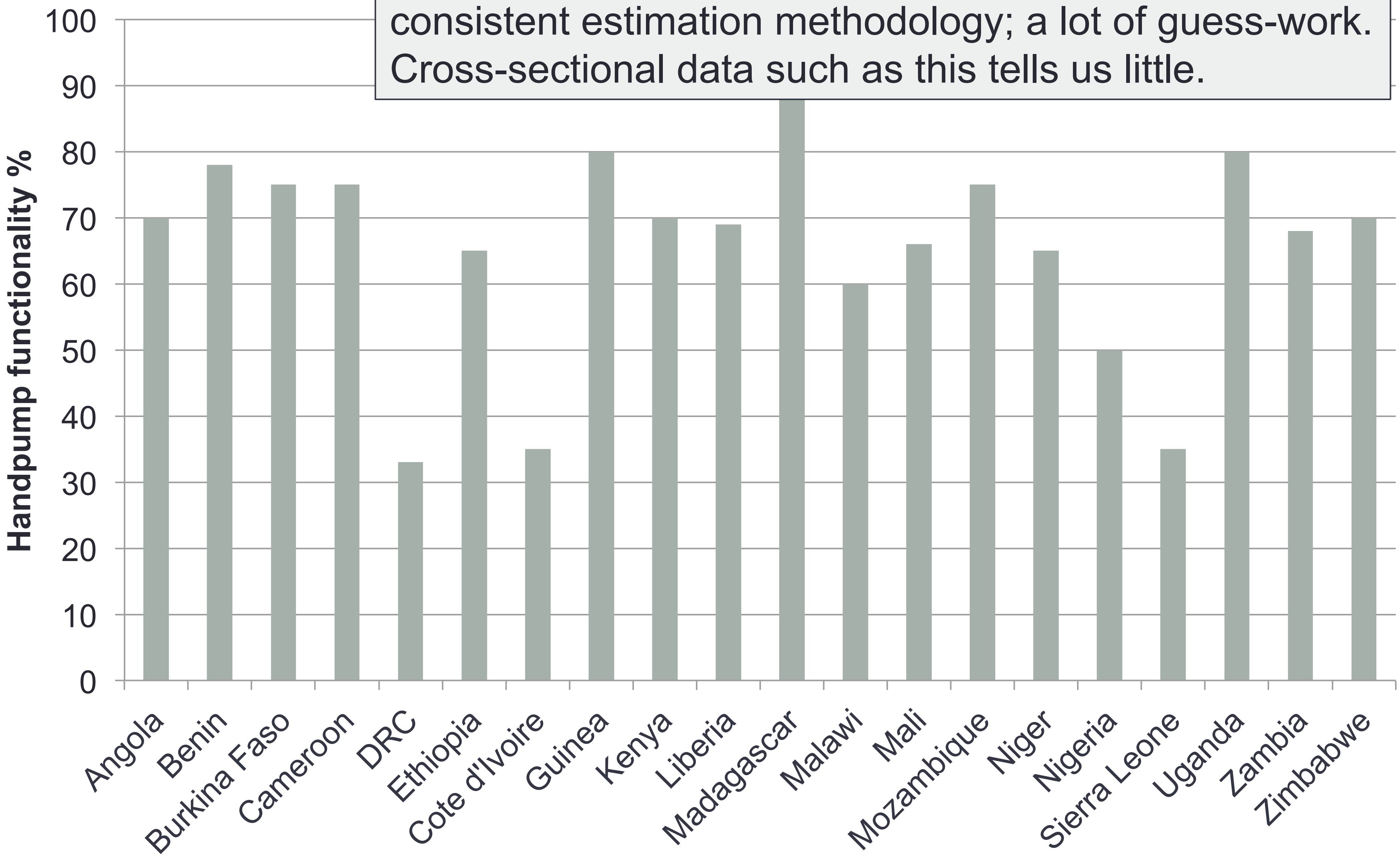
What happens in the implementation period determines to a great extent what will transpire later.



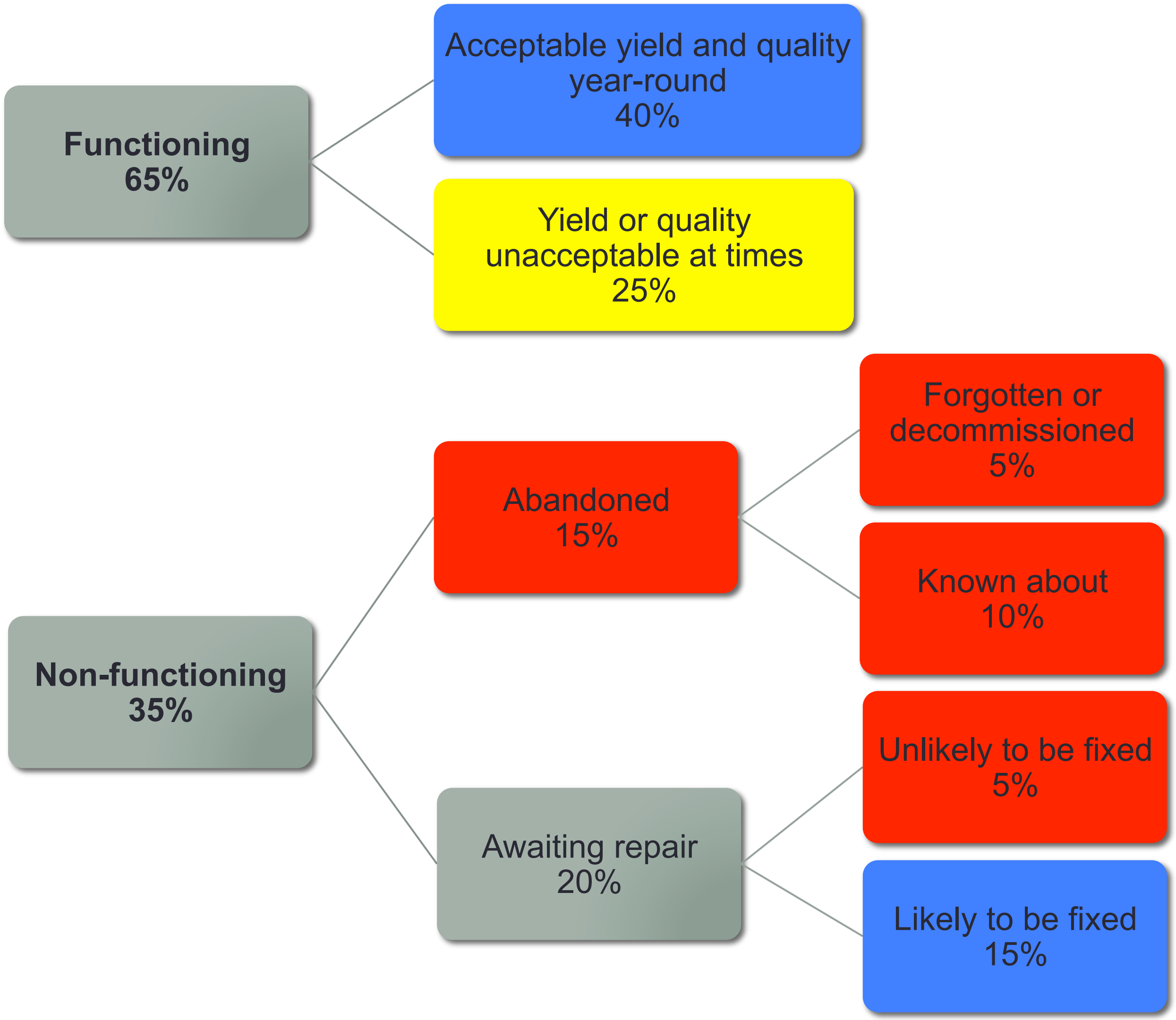
Graph 1 – handpump functionality

[RWSN, 2009]

Average estimated snapshot functionality 60-65%; no consistent estimation methodology; a lot of guess-work. Cross-sectional data such as this tells us little.



However … on any given day approximately one third of handpumps are thought to be not working.



Both **blue** categories are good.

Yellow water points may provide a partial service.

The **red** boxes must be made **blue**.

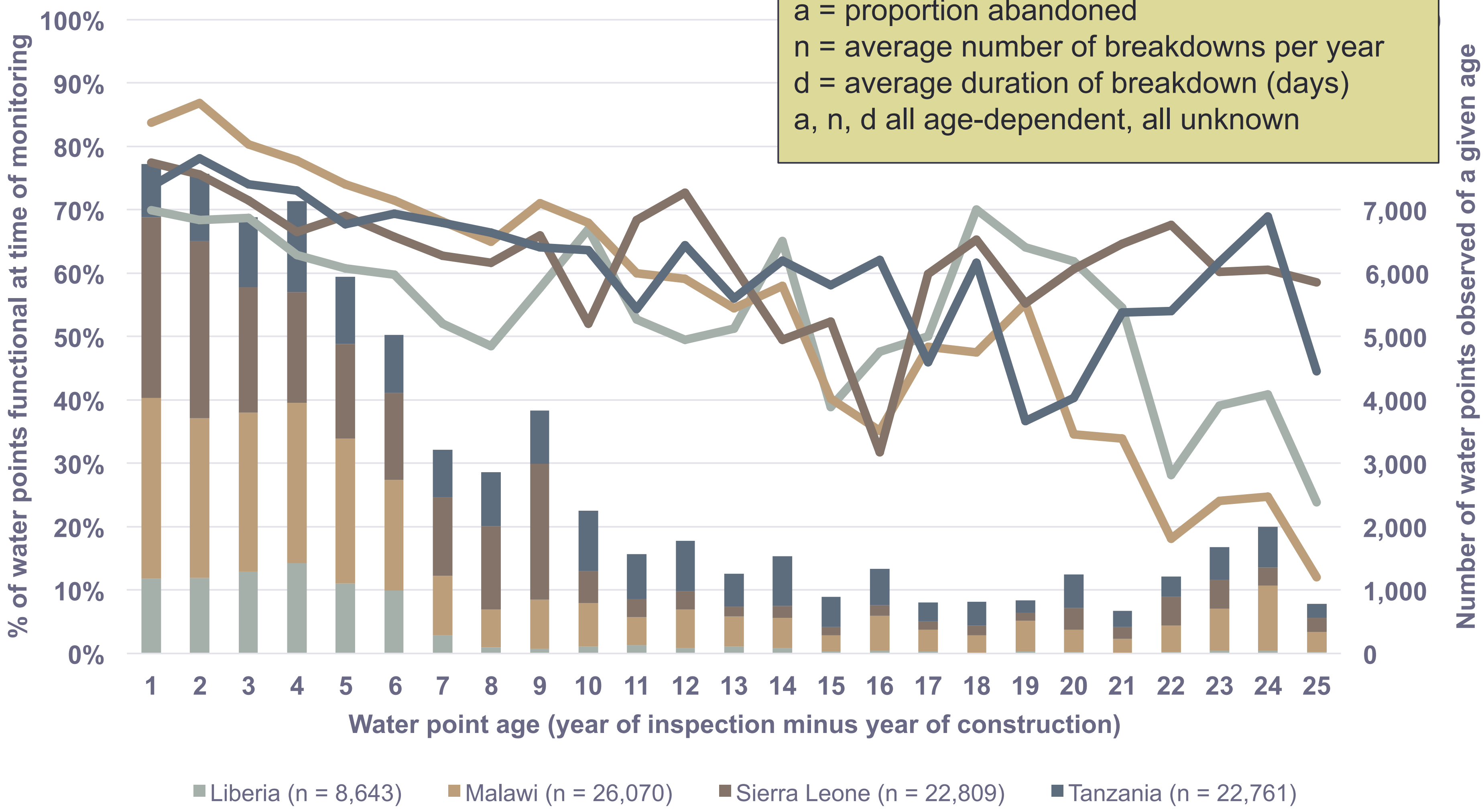
A binary F/NF distinction tells us very little.

Graph 2 Functionality of water points by age in 4 African countries

(analysis by OPM, data from RWSN WPM group)

$$F = (1-a) - (1-a).nd/365$$

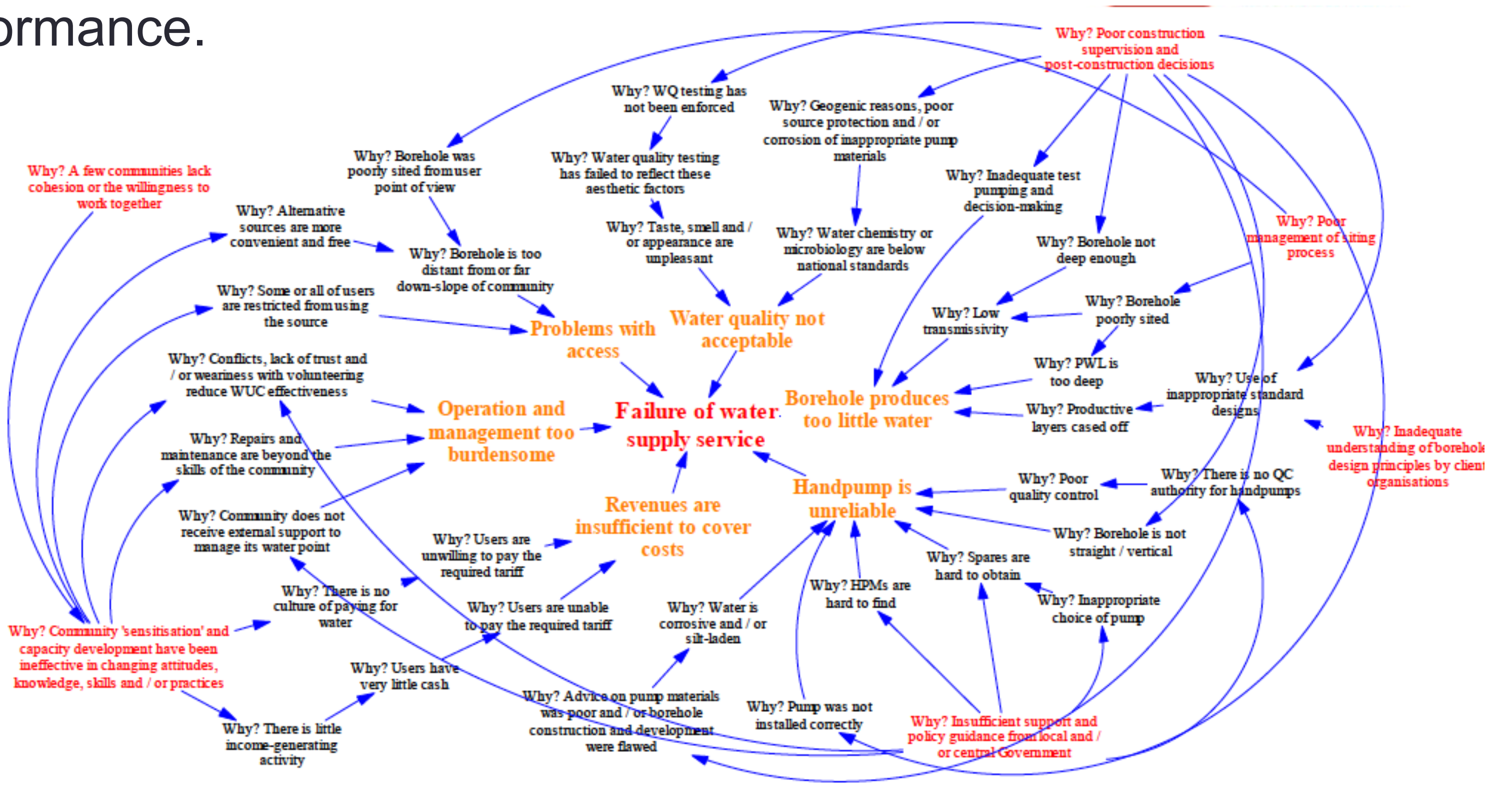
F = proportion working
a = proportion abandoned
n = average number of breakdowns per year
d = average duration of breakdown (days)
a, n, d all age-dependent, all unknown



1. Assuming 100% functionality at the time of commissioning, the fall in functionality after one year is **20 times** the rate of decline in subsequent years.
2. The curves can be modeled using three parameters which are each age-dependent (and for which we have no data!)

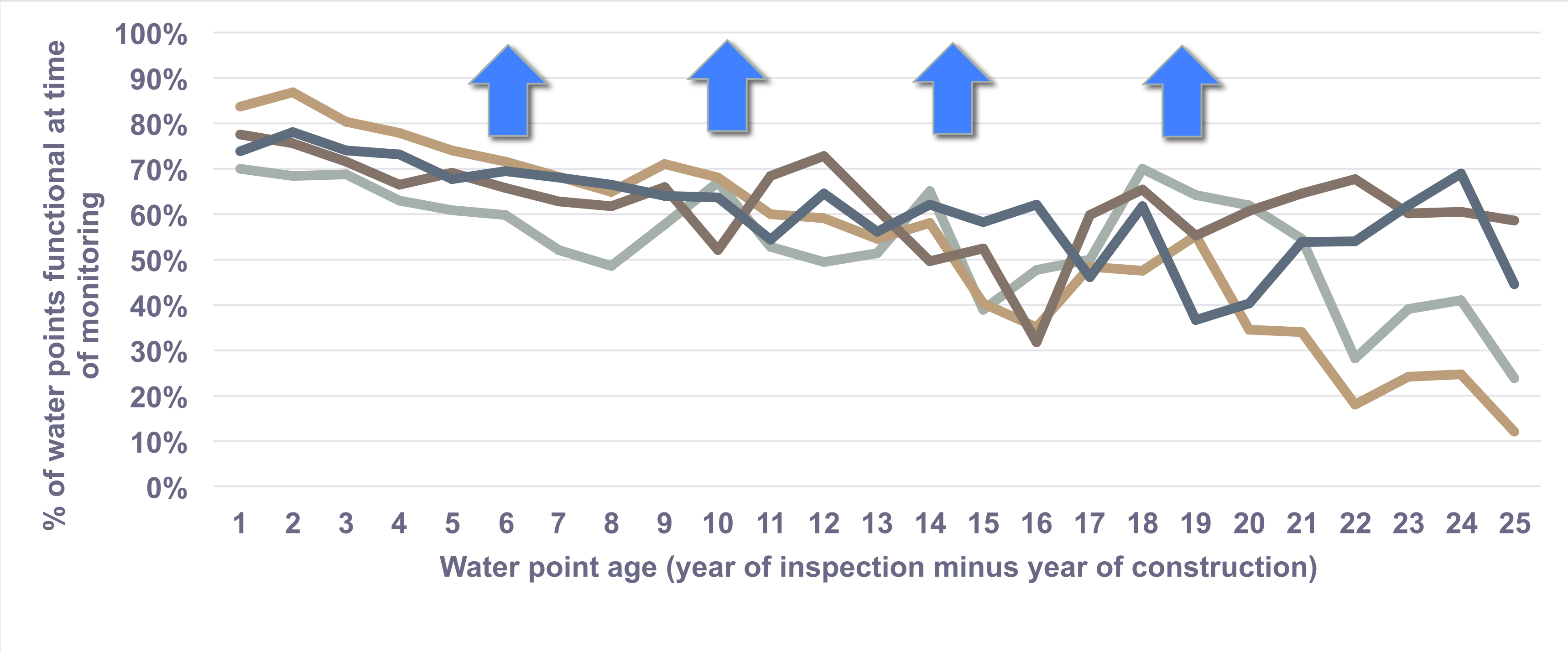
What don’t these graphs tell us?

1. Reasonable **benchmarks** for functionality – 65%? 85% 100%?
2. The **causes** of the steep decline between commissioning and year one.
3. The **causes** of the steady attrition after year one.
4. The **relative importance and context-dependence** of hydrogeological, engineering, governance, management and financing aspects as causes of under-performance.



Plausible hypotheses

1. The large drop in functionality between commissioning and the end of year one is due to abandonment of boreholes **which should never have been commissioned**.
2. If these abandoned boreholes were in use, the entire functionality-age graph would rise by 25% leading to an average **functionality for a mixed-age sample of 85-90%**.



Plausible hypotheses

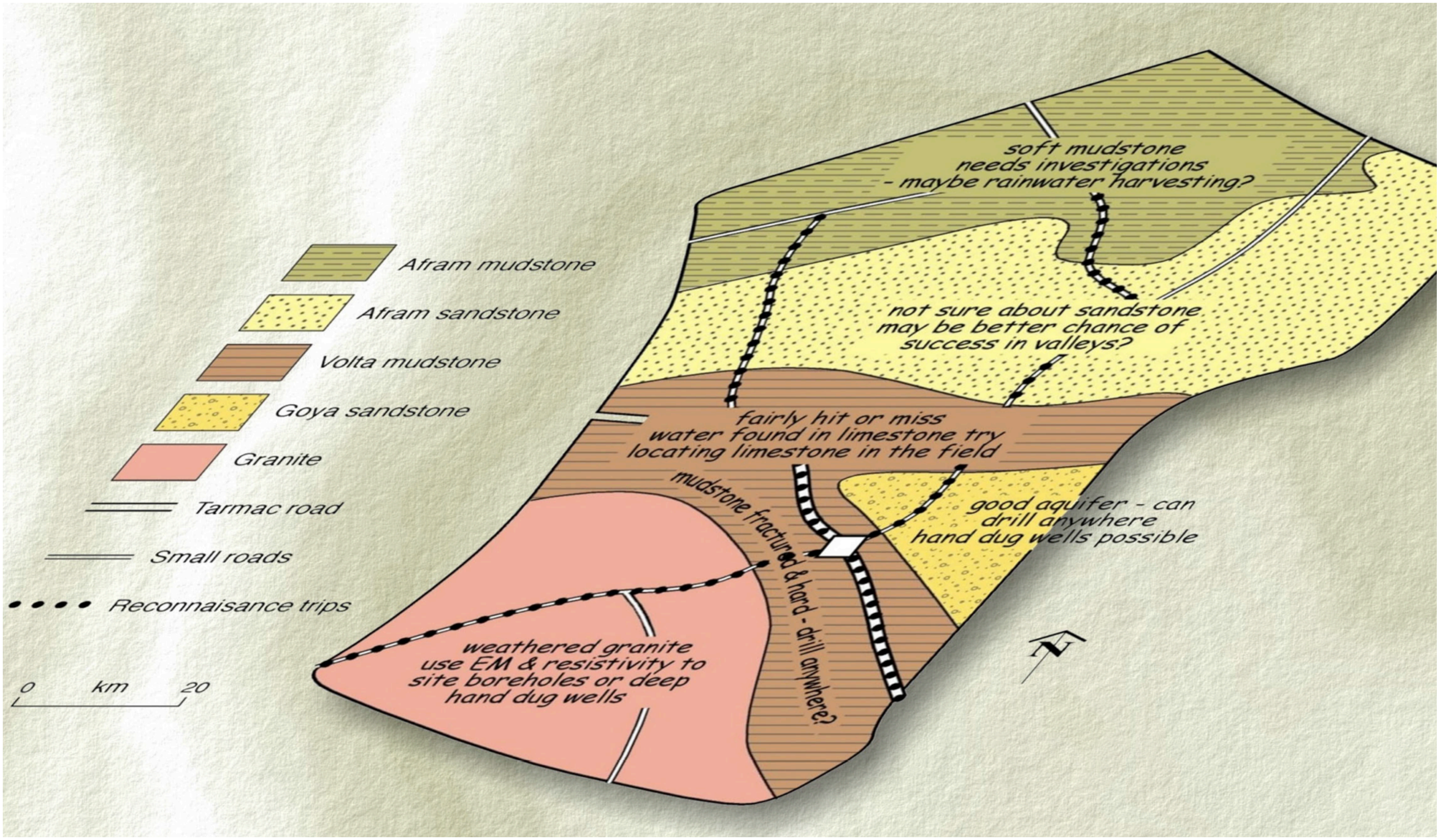
3. The high rate of abandonment in year one is due to user dissatisfaction with yield (including seasonality) and / or water quality (especially turbidity, iron and rapid corrosion).

4. Those factors have their roots in poor siting, poor design and inadequate supervision of construction and post-construction tasks – these are to do with sector governance.

5. The continuous post-year-one attrition is due to slower deterioration of handpumps (eg slower corrosion, general wear and tear), and difficulties faced by service users in managing and financing ever more difficult repairs (especially in the absence of external support).

Support for these assertions

Siting is often carried out by inexperienced hydrogeologists, ‘moonlighting’. Clients do not understand siting reports. **Consequently siting tends to be more random than scientific**.



Support for the assertions

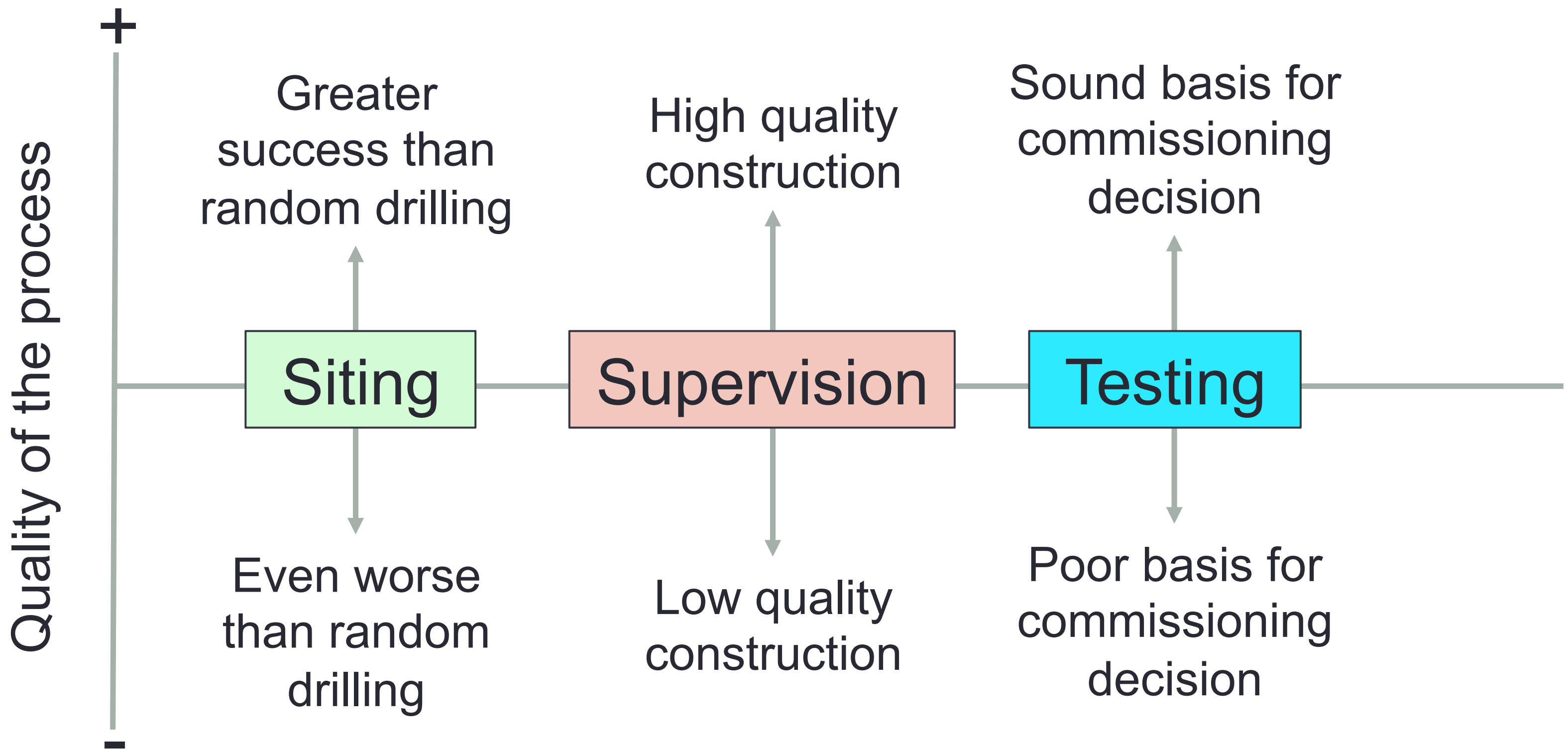
Drilling contracts are commonly of the ‘no-water-no-pay’ type. Supervision is inadequate or non-existent. Standard borehole designs are used without modification. **Consequently construction is often of poor quality**.

Support for the assertions

Development, test pumping and water quality testing are rushed and inadequate. On-site water quality testing is almost never done.

Consequently low-yielding boreholes or boreholes with poor water quality are commissioned. Pumps with GI components are installed in aggressive waters.

The quality of siting, supervision and testing determine decisions over commissioning, and these affect subsequent manageability



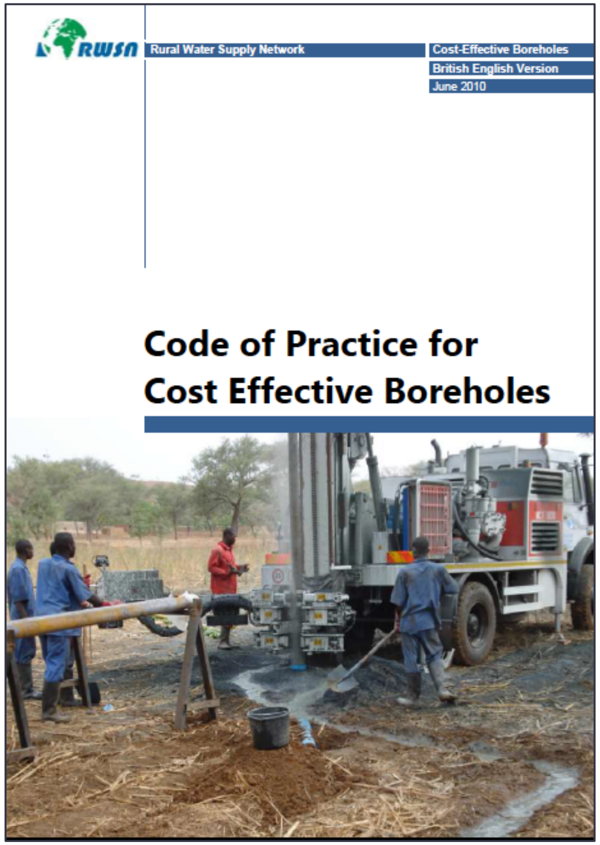
So what can we do?

1. Raise standards of **siting** work, whether undertaken by the client, the driller or an independent consultant.
2. Undertake **supervision** of drilling and borehole completion full-time, using experienced personnel.
3. [illegible] according to lithological log findings.

In short, good professional hydrogeological practice

4. Undertake adequate well **development**, post-completion.
5. Install effective **sanitary seals**.
6. Carry out necessary **on-site water quality testing** at time of completion and test pumping.
7. Undertake adequate **test pumping** and analysis.
8. **Only commission boreholes which meet minimum standards**.

Not rocket science, but a need for a step-change in hydrogeological practice in low-income countries



Thank you for listening.

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Benchmark costs

[Source: WASHCost Working Paper 8, 2013]

Cost component	Primary formal water source in area of intervention	Cost ranges* [min-max] in US$ 2011
Total capital expenditure (per person)	Borehole and handpump	20-61
	Small schemes (serving less than 500 people) or medium schemes (serving 500-5,000 people) including mechanised boreholes, single-town schemes, multi-town schemes and mixed piped supply	30-131
	Intermediate (5,001-15,000) or larger (more than 15,000 people)	20-152

Breakdown of recurrent expenditure*	Cost ranges [min-max] in US$ 2011 per person, per year	
	Borehole and handpump	All piped schemes
Operational and minor maintenance expenditure	0.5-1	0.5-5
Capital maintenance expenditure	1.5-2	1.5-7
Expenditure on direct support	1-3	1-3
Total recurrent expenditure	**3-6**	**3-15**

In round figures, borehole and handpump **capital** cost is USD40 per person (say USD1.50 per person per year); **recurrent** costs are USD4.50 per person per year; **total** USD6.00