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UPGro Unlocking the Potential of Groundwater for the Poor

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A Hidden Crisis: unravelling current failures for future success in rural groundwater supply

Introduction and background

Anecdotal evidence suggests that more than thirty percent of hand pumped borehole (HPB) supplies are non-functional in Sub-Saharan Africa and many more are unreliable. Extending and sustaining access to safe and reliable water services remains central to improving the health and livelihoods of many rural communities in Africa. The aims of the Hidden Crisis project are to understand the multi-faceted and nuanced reasons (summarised in **figure 1**) underlying poor HPB functionality. This will be achieved by:

1. **Developing a nuanced definition of functionality.**
2. **Applying this definition to a sample of HPBs in Uganda, Ethiopia and Malawi (Survey 1, locations shown in figure 2).**
3. **Detailed interdisciplinary investigations of subset of original HPBs in each country (Survey 2).**
4. Trends and forecasts – longitudinal studies and modelling.
5. Analysis – interdisciplinary approaches.

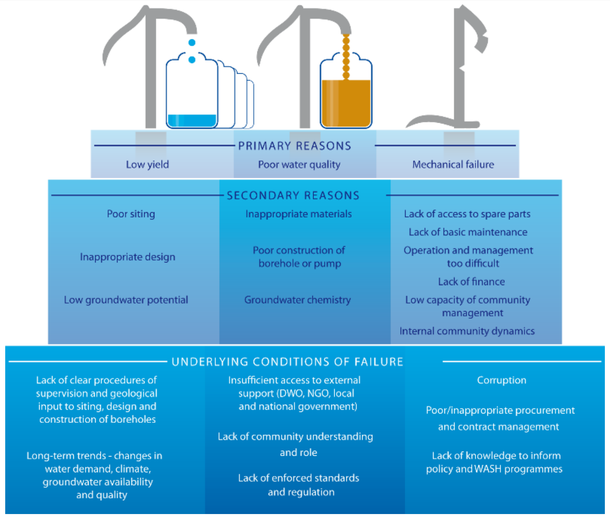

Figure 1 – summary of factors influencing borehole functionality.

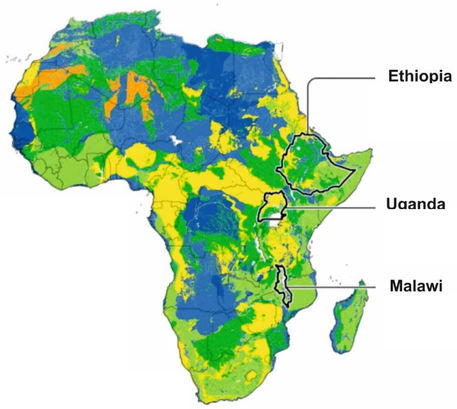

Figure 2 – Aquifer productivity map of Africa and location of three study countries.

Definition of functionality

Functionality was defined prior to the field work phase of the project, the definition adopted the following criteria:

- Measure functionality against an explicitly stated standard and population of HPBs;
- Measure functionality separately from the users' experience of the service provided by HPBs;
- Tiered assessment of functionality, providing different levels of information.
- Distinguish between snapshot of functionality (e.g. for national metrics) and monitoring HPB reliability over time.

The flow chart below (**figure 3**) explains the functionality assessment developed. Answering the first question on the top left gives a basic binary assessment of functionality; and the second question gives a snapshot of yield. Answering all the questions gives an assessment of the functionality which includes yield and reliability.

Application of functionality definition – Survey 1

Survey 1 consisted of a stroke test, water point committee interviews and water quality sampling. The results, obtained using the new definition of functionality, are shown below (**figure 4**).

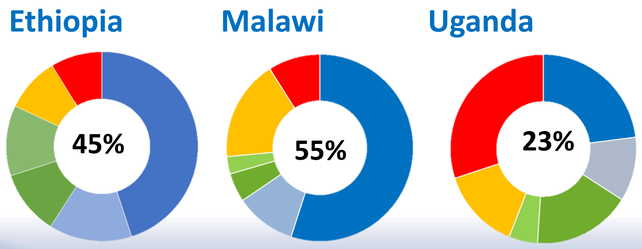

Figure 4 – Results of survey 1 using the definition (and colour scheme) shown in figure 2.

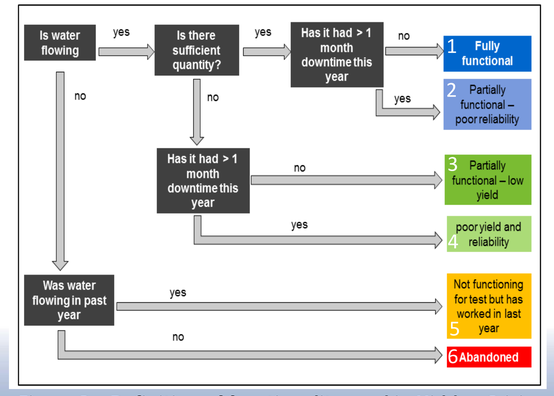

Figure 3 – Definition of functionality used in Hidden Crisis.

Survey 2 Field methods

Survey 2 used a subset of survey 1 HPBs to develop as detailed understanding of the factors underlying functionality (**figure 1**). The methods used in survey 2 are shown below (**figure 5**).

- HPB was dismantled and thoroughly inspected.
- Three hour pumping and recovery test.
- Water quality and residence time sampling.
- Downhole CCTV surveys.
- Discussion of communities experience of HPB.

Figure 5 – Field methods, from left to right; pump inspections; pumping test; field chemistry; borehole inspections. Bottom; discussions with communities.

Survey 2 Initial results

- The relationship between the tiered functionality categories (**figure 2**) and selected physical controls on functionality are shown in the plots to the right (**figure 6**).
- Pumping tests (top-left) revealed distinctive patterns of transmissivity between countries, due to different geological environments. In Ethiopia and Malawi there appears to be a distinct relationship between transmissivity and functionality.
- Ethiopia has deep water levels (top-right) and there appears to be a strong influence on functionality.
- Pump position(bottom-left), appears to affect HPB reliability in Ethiopia and Uganda.
- The Larson-Skold index (bottom-right), a corrosion risk indicator, shows that there is a significant risk of corrosion in Uganda and very low risk in Malawi.

Conclusions and future work

- The initial analysis suggests important, but geographically distinct, relationships between functionality and transmissivity, water table depth, corrosion risk and borehole construction.
- Future work will:
- Continue to derive functionality indicators, based on the available observations and measurements.
- Conduct multivariate regression and other techniques to investigate causal and inter-related factors.
- Examine the influence of, and relationships between, physical and socio-economic factors on HPB functionality.

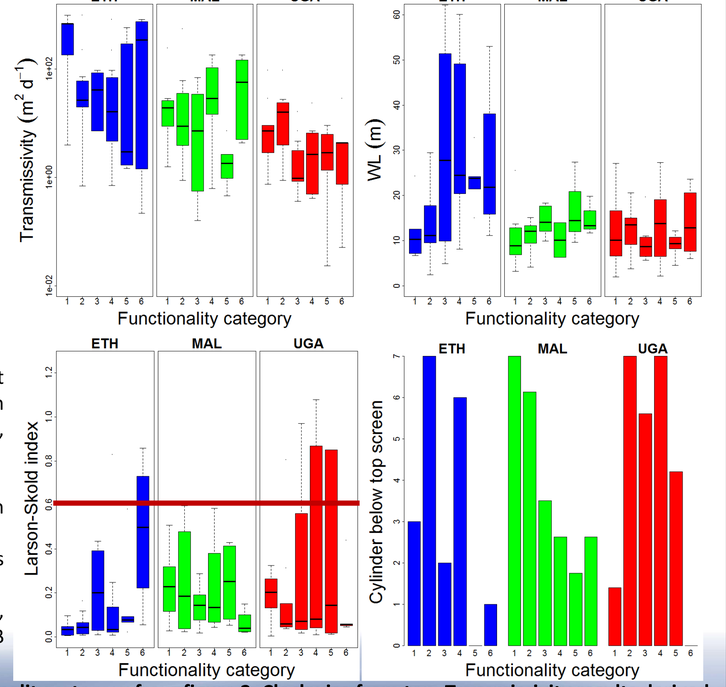

Figure 6 – Initial analysis results mapped against functionality category from figure 2. Clockwise from top; Transmissivity results derived from pumping tests; water level below ground (WL); Larson index, values above the red line index corrosion risk; pump cylinder depths.

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