Case Study Water Point Failure Uganda

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A local-level study of water boreholes failure in Uganda

This case study describes work by the **Hidden Crisis** project, part of the **UPGro** research programme, to develop a toolbox to assess why water boreholes fail.

The problem

Rural water supply boreholes with hand pumps suffer high failure rates. Although it's difficult to measure and assess, the available evidence suggests that 30% or more of groundwater-based water points in Sub-Saharan Africa are non-functional at the time of monitoring, and that even more experience seasonal problems. Understanding why this happens is essential if service provision is to improve.

There are complex and multifaceted reasons for why groundwater-based water points fail. These may include one or more of:

- hydrogeological reasons – both groundwater quality and quantity;

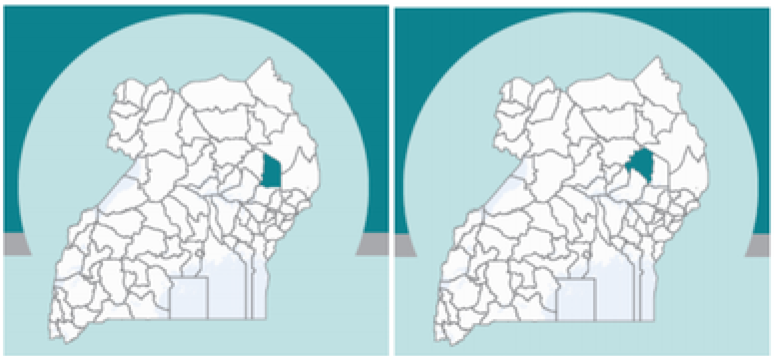
- mechanical reasons;
- design and/or management reasons;
- wider economic reasons; and
- social reasons.

But in spite of the big scale of the problem, there is little evidence for exactly why groundwater-based supplies continue to fail in Africa.

Water supply in Amuria and Katakwi districts, Uganda

The Hidden Crisis project is investigating this big problem, with field studies in Uganda, Ethiopia and Malawi. This project was part of the UPGro research programme – Unlocking the Potential of Groundwater for the Poor.

The project carried out a pilot study in the districts of Amuria and Katakwi in northeast Uganda.



Location of Amuria (left) and Katakwi (right districts of Uganda. Image credit: Bonsor et al. 2013

In both districts, most water points are deep boreholes (ranging from 15 to 100 m deep overall, but most are 40 to 60 m deep) fitted with hand pumps, of which 90% are community managed. These boreholes abstract groundwater from a Precambrian basement aquifer, which consists of a weathered regolith (overburden), usually 5 to 20 m thick, and underlying this a zone of fractured bedrock. The groundwater level is usually between 1 and 5 m below ground. The thickness and degree of weathering in the regolith, and the permeability of the deeper fractured zone, are the main controls on the size and sustainability of borehole yield.

Most of the boreholes are fitted with India Mark II, India Mark II Extra Deep Well or U2 hand pumps. In a Ugandan government Ministry of Water and Environment (MWE) survey in 2010, about 15% of the groundwater points were found to be non-functional. These water points were throughout the districts, with no obvious spatial clustering. The reasons for non-functionality given by the MWE were largely technical failure or low yields.

What is 'failure'?

The first thing the Hidden Crisis project did was develop a working definition of what 'failure' means for a borehole with a hand pump. One of the key difficulties when examining water point functionality data is that different studies use different definitions of functionality and failure. The Hidden Crisis project defined failure of a rural water supply borehole as:

the inability of a water point to supply sufficient quantity or quality of water for domestic drinking needs, year-round

Toolbox methods

The Hidden Crisis project investigated failed boreholes in three stages:

- (1) **Reconnaissance surveys** to identify failed water points across the districts, carried out by NGOs and government District water staff.

- (2) **Detailed community surveys** in a selection of communities with failed water points, to collect data on local water point governance procedures

- (3) **Technical investigations** of a smaller selection of failed water points, to collect engineering and hydrogeological data

For more details on the toolbox and survey methods used by the project, see the **Hidden Crisis project report**.

Community survey being carried out during the Hidden Crisis project. Image credit: Bonsor et al. 2013

Field surveys

In Amuria and Katakwi districts:

- The reconnaissance survey identified 37 long-term failed water points

- Detailed community surveys were carried out at 24 of these failed water points

- Technical investigations were also carried out at 10 of the failed water points

Example - Water point, Amuria District

- The main observed problem was insufficient yield.

- Pumping tests carried out during the technical survey showed that the aquifer had low transmissivity.

- CCTV borehole inspection showed inflows of shallow groundwater through borehole casing joints from the weathered regolith aquifer, but the borehole had not been designed to include a screen within the weathered regolith, so most shallow groundwater wasn’t reaching the borehole.

- It was unclear from community discussions how the pump had been sited, and by who.

The conclusion is that this borehole was not designed or constructed in an optimum way. If it had been sited in a more productive part of the aquifer, and/or the borehole screen had been installed to allow inflow from the weathered regolith zone of the aquifer, the water point may not have failed.

Carrying out a pumping test on a failed borehole in Amuria District. Image credit: Bonsor et al. 2013

Example - Water point, Katakwi District

- The main observed problem was mechanical failure of the pump - downhole parts of the pump were mechanically corroded

- This mechanical failure was caused by high demand and intensive use in a school placed pressure on the pump components.

- The water user committee had little capacity to access spare parts or higher-level support in order to fix or replace the corroded parts of the pump, and they could not convince community members to pay for maintenance and repair.

- Other water sources were available in the community, which made the community less willing to pay to repair the failed water point.

High demand on water points in Amuria District is just one of the complex set of interlinked factors that can lead to water point failure. Image credit: Bonsor et al. 2013

Analysing the results

Understanding why water supply services fail requires a systems approach, which recognises the many different components of the service delivery chain, and the variety of interlinked factors (technical, social, institutional) that can contribute to failure.

The Hidden Crisis project used 'Root Cause Analysis' (RCA) approaches to investigate the causes of water point failure. The first way they did this was the '5 whys' approach – a problem is stated and then five 'why' questions are asked, in order to delve into the underlying causes of the problem.

For example: **Problem: borehole hand pump failed due to inadequate water quality.**

1 Why is water quality poor? *Water chemistry doesn't meet WHO drinking water standards*

2 Why doesn't water quality meet WHO standards? *Hand pump material corrosion led to high dissolved iron in the groundwater*

3 Why have hand pump materials corroded? *Low pH and Eh in the groundwater and use of inappropriate materials for this*

4 Why have inappropriate materials been used? *Lack of knowledge in design and construction of supply, and cost and availability of alternatives*

5 Why lack of knowledge in design of supply? *No supervision by hydrogeologist or trained engineer in the design-siting-construction process.*

Another RCA approach is a causal link diagram, which can begin to examine how different causal factors of a problem might interlink. This was very useful in identifying the number and the complexity of interlinked reasons for groundwater point failure.

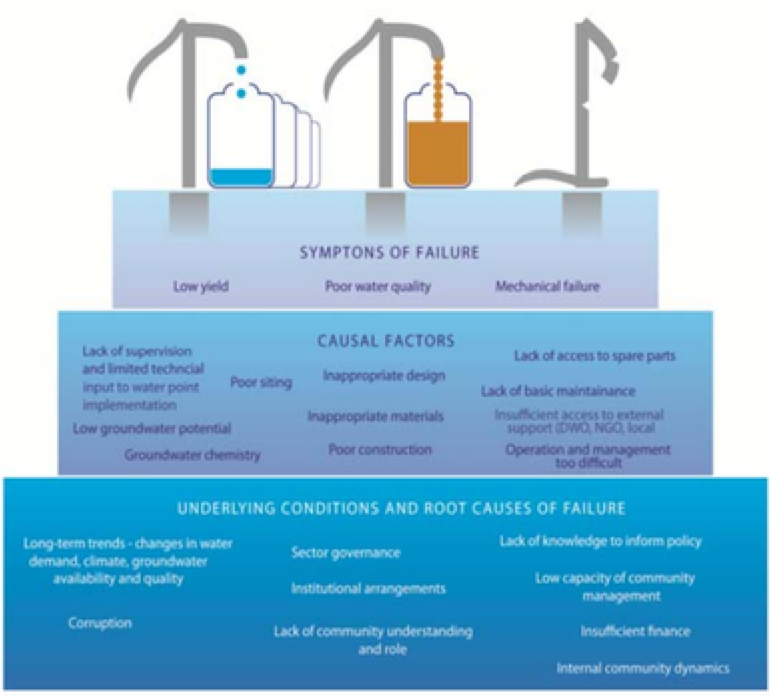
A schematic causal link diagram of water point failure. Factors which can contribute to water point failure are shown in concentric rings around a failed water point in the centre. The arrows indicate linkages between different causal factors. Underlying conditions and root causes, which underpin these causal factors, and ultimately lead to water point failure, are shown by the outer circle of red text. Image credit: Bonsor et al. 2013

Conclusions

By analysing the results of the surveys, the Hidden Crisis project identified three overarching reasons for groundwater point failure in Amuria and Katakwi districts:

- **Water point construction practices**
- **Community management models**
- **Lack of knowledge of why water points fail**

The figure below shows more detail of the hierarchy of symptoms, causal factors and underlying causes of groundwater source failure.



Hierarchy of symptoms, causal factors and underlying causes of groundwater source failure. Image credit: Figure source: Bonsor et al. 2013

Source

Bonsor HC , Oates N, Chilton P , Carter RC and Casey V . 2015. A Hidden Crisis: strengthening the evidence base on the sustainability of rural groundwater supplies – results from a pilot study in Uganda. UPGro Catalyst Grant Report NE/L001969/1

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