Groundwater and data – an African experience

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The failure of borewell drilling can often be avoided if data on rural water sources are collected and kept in an accessible format. A landmark project in Malawi demonstrates the value of data gathering and is doing this through involvement with local communities, technical consultants, contractors and the ministry.

The importance of data collection and data access cannot be over emphasized within the context of rural water supply development in sub-Saharan Africa. Although thousands of boreholes are drilled each year in the region, established systems for gathering and collating the information produced have failed in several countries. There are a variety of reasons for this, not least lack of resources, but also decentralization of effort, transfer of responsibilities away from institutions such as geological surveys to more utility-based departments of water, and loss of trained and key staff due to the HIV/Aids pandemic. It is not, however, a failing just of the poorer countries. For example, Botswana, a relatively affluent and well-governed state, has ceased to collect borehole records centrally and now relies largely on consultant activities to create individual databases. However, the situation is more extreme in countries such as Malawi, Zambia, Tanzania, and Ghana.

The first sign of a deteriorating establishment is usually the abandonment of data collection and data management. In Malawi the national well record archive began to fail as early as 1986. The situation was exacerbated with the refugee crisis during civil unrest in neighbouring Mozambique, and during an emergency drilling programme of 3000 boreholes, the government was forced to permit drilling to proceed without any formal data gathering.

A landmark project in Malawi is attempting to reverse this trend. The Mangochi Rural Water Supply and Sanitation Project, funded by the German government through KfW, and being carried out by GITEC Consult GmbH, is designed to involve local communities and government departments. The project provides the technical advisory consultants, technical and teaching staff as well as contractors. Most important is a direct link to the Ministry of Water Development, to inform the government of current activities and to transfer the data that have been gathered. The project shows that adequate data gathering can be carried out at reasonable cost. It also demonstrates the importance of monitoring field systems after installation.

The data trap

There are a number of questions that are commonly asked about data gathering:

- What information is useful, affordable and beneficially usable at a future date?
- What information is perceived to be of minimal short-term value although of benefit in the long term?
- Once the data are collected, how should they be managed and how can access to the data be facilitated to ensure that the information is interrogated and used as a resource?

The answer to the first question is straightforward; the second question relates to sustainability; and the third depends on education and need. It is the failure of the third that creates the data trap.

The information that is usable and affordable derives from seven phases of groundwater development:

1) Preliminary survey of water availability, e.g. protected springs, small dams, hand-dug wells, existing boreholes, rainwater harvesting.
2) Base-line surveys to assess demand and likely occurrence of groundwater, using surveys of user groups and inspection of any existing geological and hydrogeological data and regional summaries.
3) Surveys to site new boreholes or hand-dug wells, using remote sensing, geophysics and local knowledge.
4) Borehole drilling or well digging construction; this involves technical choice of design and optimum depth.
5) Test pumping and water quality assessment: the physical and chemical assay of the source.
6) Choice of pump: the most effective method of getting water to the people.
7) Long-term monitoring: this ensures the water point remains adequate for the community.

Each phase offers a unique opportunity for the collection of usable data that may enhance the execution of other development projects.

What data? The key information required for all water sources with which to base any future planning and development is:

- type of source
- place name and precise location, using global positioning system (GPS)
- water use – how many people does it supply?

- type of pump or lifting device
- water quality.

The key additional information on boreholes and wells to assist with any additional drilling and development is:

- depth, diameter and casing
- depth to water, yield and drawdown (aquifer characteristics)
- geology
- siting criteria.

Operational information is also required in order to predict when supply problems are likely to occur so that coping strategies can be implemented. Monitoring should include the operational status of the pump, approximate yield (is it declining?) and any change in demand. Note that water levels cannot be measured in boreholes under pump headworks such as the Afridev.

The third question is the problem of data accessibility and encouragement to field workers to use data. The data have to be readily accessible, and this is best facilitated with digital databases maintained at regional or district level and transferred periodically to a central database. The output must be in a usable form and should be aimed at the community, including maps, graphics and simple tables that will help in the search for new sources and resources. Using the data requires both education and a realization of the data's value in relation to water supply. Both of these factors have been extremely difficult to sustain in recent decades, and although some data may have been coming in to the databases, little have been going back out again. The data are trapped.

The economic benefits that accrue from collecting usable and useful data are compelling. Project auditing, and the evaluation of targets, objectives and promises can only be carried out using data. The data are only available to the auditors if they have been collected and collated during the project. The cost of data gathering is marginal to the cost of the project as staff are available to make the necessary records which can then be put on a computer at the project office at little additional expense. In reality, over the longer term, it is too expensive not to collect the project information.

The Mangochi Project

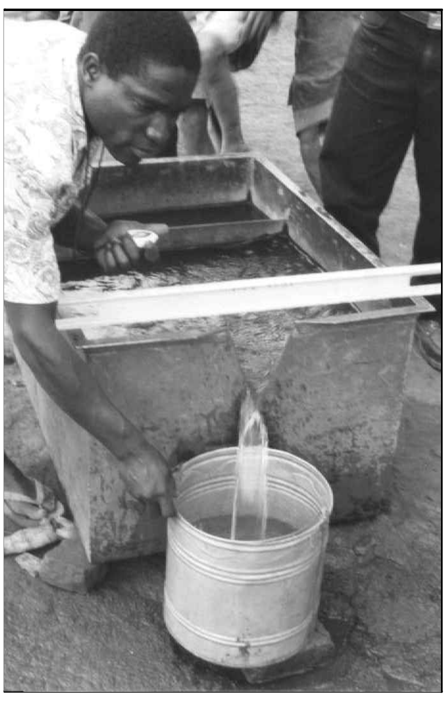
Mangochi is situated in the bottom of the rift valley in south-east Malawi, not far from the border with Mozambique. The area occupies gently undulating land situated over precambrian basement complex gneisses and schists, with subsidiary igneous intrusions, and is weathered to form a shallow regolith aquifer. The rural community is dispersed across the land although there are a number of village centres.

The Mangochi Rural Water Supply Project places heavy reliance on primary data collection using conventional survey work, geophysics and careful recording of drilling activities. The project borehole success rate (yield >0.2 l/s) has increased from just 40 to 85 per cent, and the project is producing a wealth of data that can be used for future development work.

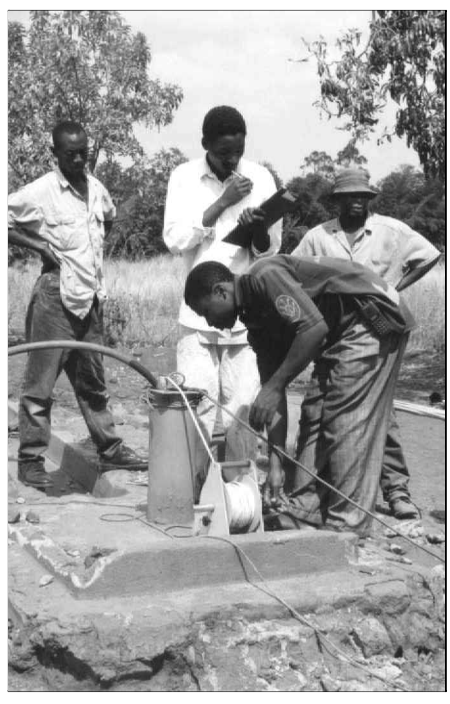
GITEC Consult GmbH of Düsseldorf, Germany was appointed consulting engineers to the Ministry of Water Development, Malawi, to install hand-pumped boreholes for domestic water supply to 104 villages (70 000 population) in the Jalasi Traditional Authority in Mangochi District, Malawi. This project was initiated in 1999 with the aim of organizing communities to accept, use and maintain boreholes for domestic water supply. A key objective was to maintain dialogues both with the rural communities and with central government, and to utilize all available data both local and regional.

The project was established to install up to 250 boreholes equipped with Afridev hand pumps each capable of producing water at 0.2 l/s to serve 250 persons within a 500 m radius. Each borehole is located away from sources of pollution. The project target drilling success rate is 75 per cent. By the end of 2001 some 242 boreholes had been drilled and of these only 33 were dry.

The project undertook baseline surveys to locate communities accurately using a GPS, and to assess potential water demand. The occurrence of groundwater was assessed using basic data obtained from the few existing borehole records. These indicated that the weathered regolith was between 20 and 50 m thick and that the better yielding boreholes drew from the deeper zones of weathering. Some 110 existing boreholes, 20 to 50 m deep, were located in the area. Depth and yield-drawdown data (the amount that the water level in a borehole or well is pulled down during pumping) where available from the existing borehole records were put together with information on the distribution of geological units, fracture zones and topography derived from analysis of digitized 1:50 000 scale topographic maps and



Test-pumping an old borehole in Mangochi



Measuring yield with a 20 litre bucket

1:25 000 scale aerial photographs, geological maps and satellite imagery for the area. Together these information fields highlighted those areas where groundwater was probably best available to supply boreholes, and suggested likely drilling depths to access the groundwater.

Geophysical logs were run on all existing production boreholes to provide base data. Surface electro-magnetic and follow-up electrical resistivity geophysical surveying methods were used to traverse the areas occupied by the villages in order to define potential drilling sites to exploit the greatest depths of weathering. The geophysical survey data were used to define 481 potential drilling sites. The field data generated were recorded in a GIS-style database with the survey report in digital format on CD as well as hard paper copy.

Project boreholes are being constructed to a design using 110 mm diameter PVC pipe and screen (0.75 mm slots), installed with a 1–2 mm formation stabilizer in a 200 mm-diameter borehole. The design is customized for each site to optimize access to the groundwater resource.

Water-struck levels and the thickness and nature of the upper weathered zone are recorded (Figure 1). Yields are measured using a 'V' notch weir, and by timing a known volume. A three-step, step-drawdown test (designed to measure the relationship between yield and the amount the water level in the well or borehole is pulled down) is performed at 0.2, 0.5 and 1.0 l/s. Then a constant discharge test is run for three hours followed by a water-level recovery test to within 10 per cent of the rest water level. These tests indicate the performance capability of the borehole and enable appropriate pumping regimes to be devised to suit both the groundwater availability and the community demand.

The drilling success rate surpassed its 75 per cent target

Groundwater temperature, pH and specific electrical conductance are measured at the well head. Samples for hydrochemical analysis are taken to a competent laboratory to determine if the water quality meets WHO guidelines (total dissolved solids content of less than 1000mg/l). Following installation of a sanitary seal around its upper part, the borehole is chlorinated, and the surface headworks and production hand-pump are installed.

The project staff collects data on siting, construction, testing and equipping. Thereafter the communities monitor the sources and reports are submitted periodically to project officers. The data are collated in spreadsheet form and tied to the GIS. This is done by the project and is used to provide output in easily understood graphical form to assist in decision making for the ongoing process of groundwater development and maintenance of existing supplies.

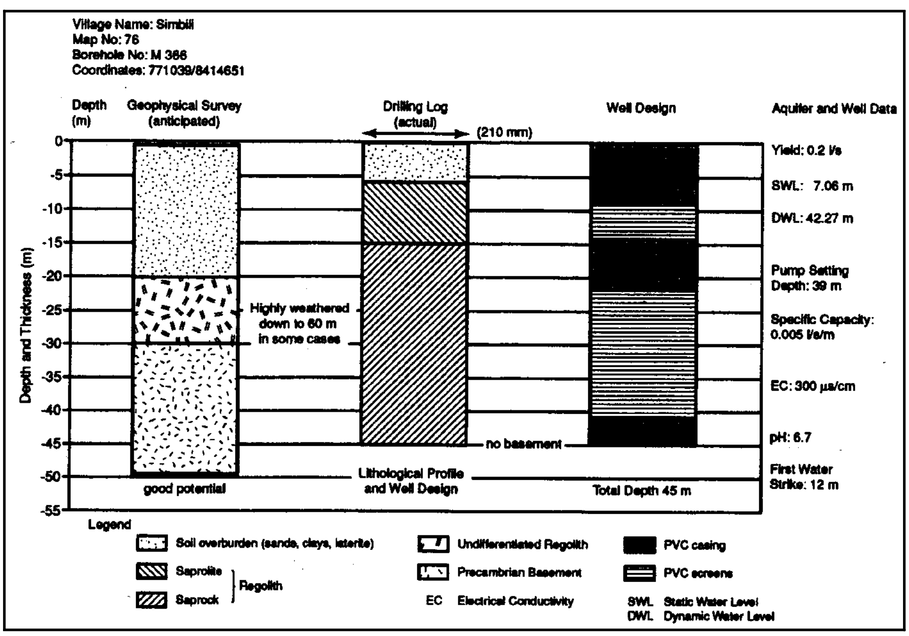


Figure 1 Typical data sheet for a Mangochi Water Supply Project borehole

The costs of data gathering, handling and access are small compared to the overall project costs, but the benefits are demonstrated by the increased drilling success rates. The communities face fewer cases of falsely raised hopes and abandoned sites. Monitoring of successful sources by the communities promotes continued ownership of the project, but it does require an assurance that potential problems highlighted by the monitored data will be attended to. Finally, dialogue is maintained with government and data are periodically transferred to the ministry. Whether government will retain the capacity to optimize the use of the data as time goes on, remains to be seen.

The costs of data gathering, handling and access are small compared to the overall project costs

Conclusions

Operation of the Mangochi Rural Water Supply Project reflects a growing realization that data gathering, collation and dissemination are vital to the sustainable exploitation of resources and the sensible operation of water supplies. Modern computing power enables data handling and dissemination to be carried out with comparative ease, and the marginal additional cost of collecting the data is more than repaid in years to come.

About the authors

Nick Robins and Jeff Davies are with the British Geological Survey, UK, and Philip Hankin and Dieter Sauer are with GITEC Consult GmbH, based in Malawi. The authors are hydrogeologists and water engineers with longstanding experience in rural community water supplies in sub-Saharan Africa. The British and German teams came together during a World Bank-funded training mission during which the Mangochi Rural Water Supply Project was used as a field centre and an example of best practice.