9 Learning lessons

9.1 Why lesson-learning is important

Many communities are subjected to repeated mistakes made by a succession of rural water supply projects. The following scenario is not uncommon: one project team comes to a village, drills several boreholes, finds no water and disappears. Several years later, another project team, with different funding comes to the village, tries again and fails. This pattern can continue until a sustainable water point is found, either through science or good luck, or the area is avoided as it is known to be difficult. One of the main reasons for continued low success rates of water projects is the lack of time set aside to learn lessons from our own, and others', experience. Central to this process is the mundane process of keeping, and making available, records from all aspects of our projects.

Therefore, once the water point is completed, and the water quality assured, a little time should be set aside to look after the data generated. The information gathered from constructing a water point, even if that water point is unsuccessful, is of great value. There is no other way of finding out how groundwater occurs in an area than by drilling and testing boreholes, examining the geology, carrying out geophysical surveys and undertaking a water quality assessment. The routine procedures described in this manual, used in the first instance to provide information about the success and potential sustainability of an individual water point, can be used to construct the bigger picture of how groundwater occurs across the whole project area, supporting other projects and programmes.

Much of what is said here should be obvious from preceding chapters. Here we recap and expand on Chapter 4 (reconnaissance) with a focus on how raw data (unanalysed facts and figures) can be converted into information (analysed data in a form useful for decisions) and ultimately, knowledge (assimilated and understood information).

9.2 The uses and users of project data

Before looking at issues of data management, it is important to remind ourselves of the end uses and users of the data. An understanding of user requirements – within and beyond the project – should always inform what we do. The harvesting and storage of data is not the end goal!

First and foremost, the collection of data has value within the project itself. As more data are generated, groundwater development maps (described in Chapter 4) can be revised and produced in more detail. This can enable more informed choices to be offered to communities with greater confidence. Other options can be offered in areas where groundwater resources are known to be problematic, or investigations commissioned to help overcome problems which have been identified from reviewing the data.

However, data generated on a project also has value to others beyond any current or future application on that particular project. Adding to the stock of publicly available good data is vital. There are many potential 'data stakeholders' with various interests and needs. These stakeholders may range from international donors and UN agencies to individual communities.

- **National government** can use data to help develop national planning tools and maps, such as water resources maps, drought maps, coverage maps, etc. Data are also required to help make water supply audits and to provide information to UN agencies and donors.
- **Regional/district hydrogeologists** can make significant use of hydrogeological data to develop an understanding of how groundwater occurs in an area; this understanding can then be used to guide decisions on individual projects in their region. Priority areas can also be identified using the data, and areas for which little information is available.
- **The private sector**, including drilling companies, need information on how easy/difficult it is to find and develop groundwater resources in an area, and what methods are most cost-effective. Data are most useful where compiled into hydrogeological maps and regional reports.
- **NGOs and other partner organizations** also need information on how easy or difficult it is to find groundwater in an area, what methods need to be used to develop water resources and what technologies are likely to be viable.
- **Communities** need information on any boreholes/wells constructed in the community to help with the maintenance of any working source, or to make sense of any failures.

The most efficient way of ensuring that all stakeholders have access to the data they require is through national or regional databases. The more data that is put into a system, the more useful it can become to all users. Therefore any individual project needs to find out about the procedures and systems already in place for submitting and retrieving data and make sure they are followed. In many countries, however, data storage and retrieval systems have fallen into disuse (in part) because data remain with individual projects and the cycle of data pooling and data retrieval starts to break down.

This has been made worse by the decentralization of government which has led to the fragmentation of records that were previously held nationally. Where this is the case, projects will need to find other ways of sharing and accessing data. These may include workshops for rural water supply stakeholders, where a day can be set aside to share experience and learn lessons, and other formal or informal networks.

9.3 Storing useful information – a project perspective

To be useful, information should be recorded in a usable format and then stored in a number of safe, but accessible locations. This should not be a difficult task, or cost much in terms of time or resources to a project – it is just being conscious of how precious this information is to the project, and other potential users. If contractors are carrying out the work it is necessary that all field data and related information are lodged with the project. Sometimes arguments can arise about data ownership. Contractors who undertake geophysical surveys, geological logging and pumping tests may be reluctant to part with data. This is partly due to time constraints; more serious, however, is the belief that knowledge and information is power. The concern may be that another contractor will use the geophysical data to site additional boreholes. As a basic rule, whoever pays for the work to be carried out should have access to the data, although they may also be retained by the contractor. For clarity, this should be written into every contract.

BOX 9.1 What data should be kept?

- Geological field notes for the area and any other reconnaissance data.
- Data from any geophysical surveys (and their location).
- The drilling report (including all data relating to the drilling, construction and geological/geophysical logging of the borehole as described in Chapter 6) including all dry holes.
- Data and results from the pumping tests.
- Information from sanitary inspections, etc. and from the water quality assessment.

To build up as full a regional picture as possible, it is vital to hold on to detailed information from unsuccessful boreholes. This information is as useful as that from a successful borehole: it should help build up a picture of areas with poor groundwater resources and, therefore, help to offer better informed choices to communities based on an understanding of what options are feasible in different areas. This will save the project time and money, and help build the confidence of communities in the project.

It is also useful to write a summary (less than one page) of the data, just highlighting the important facts for the source and as a quick reference. An example is given in Box 9.2.

BOX 9.2 Summary data

- Georeference data: longitude and latitude or local grid reference
- Name: Okumbgo, borehole OB37a
- Geology: weathered crystalline basement (granite)
- Siting methods: borehole sited using ground conductivity: EM34 with 20-m separations – where conductivity (horizontal coils) was greater than 10 mS/m
- Drilling: borehole drilled to 36 m; 100 mm open hole
- Construction: surface casing pressure grouted to 10 m through soil and highly weathered zone
- Test pumping: 6 hour pumping test gives transmissivity of 4 m^2/day from recovery;
- Water quality: TDS 150 mg/litre, pH 6.8 – no other constituents measured
- Sanitary inspection: no obvious signs of contamination within 50 m
- Installed pump: India Mark 3 hand pump set at 25 m.

Project data do not need to be stored on computer. A well-ordered paper filing system should be the foundation for any database of the information. Each borehole should be given a unique number, to avoid confusion between different sources. It is also useful to check when filing that all appropriate information is present; e.g. coordinates, drilling report, geophysics reports, pumping tests, etc. This is the best opportunity to gather the data together – if it is not done at this stage it is unlikely to actually happen and the data will be lost. Chapter 4 describes a geographical information system (GIS), which is an excellent computerized method of storing and analysing data.

As a safeguard against loss, copies of data should be held by various people. This could include the contractor, partners, donors, appropriate ministry and communities.

9.4 Making use of information

Once some data has been collected it can start to be used to help give a better understanding of the hydrogeology of an area and how to improve the success of this and other projects. In this section we suggest various ways in which data collected on the project can be interpreted to provide information and improve knowledge: Here are several ideas:

- Review the effectiveness of siting techniques by comparing geophysical surveys with actual geological logs and borehole success.
- Refine the initial groundwater development maps made for the area during the reconnaissance phase to create a more definitive groundwater development plan.
- Make predictions about areas with similar conditions.
- Develop a better understanding of why wells and boreholes fail.
- At a national level develop planning tools, such as drought maps, or national water resources maps and inform rural water supply policy.

9.4.1 Review siting methods

After several tens of boreholes have been drilled, or wells dug, it can be useful to examine the effectiveness of the siting techniques. For example, geophysical surveys can be compared with the actual drilling logs to see if any consistent patterns emerge. It is particularly important to examine the geophysical surveys of unsuccessful boreholes: are there any features of the geophysical log or geological log that explain why the boreholes were unsuccessful?

In Malawi, the Mangochi project has used this review process to good effect (Robins et al. 2003). By collecting and interpreting data from all drilling, the methods used to site future boreholes were refined and the success rate gradually improved from 40 per cent to more than 75 per cent.

9.4.2 Making groundwater development maps

With good data, it is possible to make excellent groundwater development or hydrogeological maps. To do this, essentially the same process as described in Chapter 4 (Reconnaissance) is followed – except this time you have much more data, and information that you know you can trust. Local groundwater development maps were made for Oju and Obi local government areas (Nigeria) after 50 boreholes had been drilled throughout the area (Davies and MacDonald 1999). Given a small amount of training, the maps were then used by the local government water and sanitation unit to offer realistic options to communities for improved water supplies, ranging from rainwater harvesting to borehole drilling and well construction. After the maps had been in use for several years and more than 100 water points had been constructed, the success rate rose from less than 20 per cent to more than 80 per cent. Figure 9.1 shows local community members using the groundwater development map.

Groundwater development maps can also be useful training aids. They can facilitate discussions with local partners and also communities. In Oju and Obi (see above) they were used in conjunction with simple models to show why boreholes were more successful in some areas and inappropriate in others.

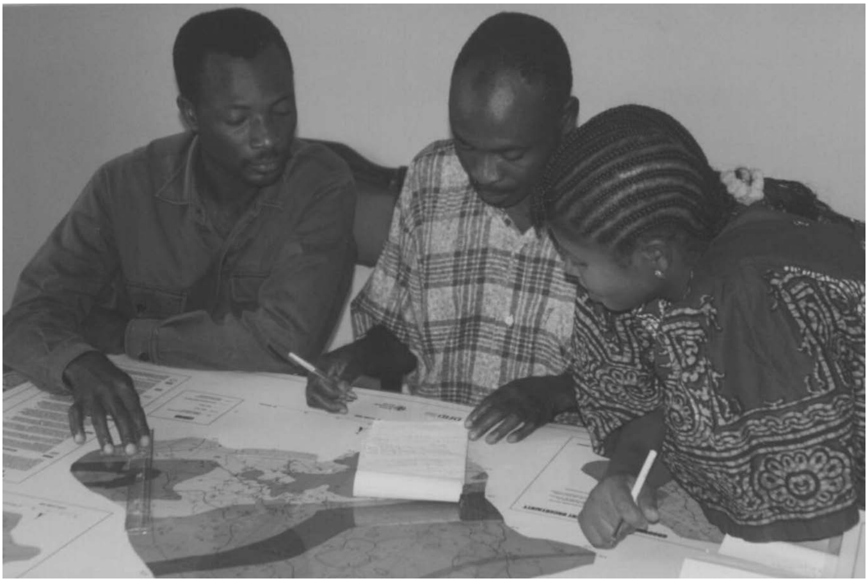

Figure 9.1 Local government officials in Nigeria using a groundwater development map.
Photo: BGS, © NERC 2000.

9.4.3 Making predictions for other areas

Often a detailed study in one area can have direct benefits to other areas with similar geology. If a project has generated sufficient data to develop a thorough understanding of how groundwater occurs across an area, it is a small step to develop general rules for this type of rock which can be translated to other areas. Such a study is often carried out in combination with research establishments or universities, who can help interpret the project data. This knowledge can then be shared through workshops, scientific papers or direct training.

An excellent example of this knowledge transfer has occurred with the development of groundwater resources in crystalline basement. This type of rock (which covers 40 per cent of the land area of sub-Saharan Africa) was once thought not to contain any usable groundwater. However, after sharing the lessons from various research and rural water supply projects in the 1970s and 1980s the methods of developing groundwater in these rocks have become well known (Wright and Burgess 1992).

9.4.4 Develop an understanding of why wells and boreholes fail

Depressingly many boreholes are not functioning 5 years after they were first constructed; in some places the failure rate is two out of three boreholes drilled. Why do so many wells and boreholes fail? There are three main reasons.

- **Poor construction or source location.** This is a common problem: often boreholes are claimed to be successful without carrying out a yield test, or have not been constructed well enough to exclude sand. This should not be an issue for boreholes or wells constructed using the guidelines in this manual. However, an examination of the borehole records will reveal the construction of the borehole and whether it was suitable for the job.
- **Drought or declining water levels.** Successful boreholes can fail because of changes in the availability of groundwater in the surrounding rocks. There are two ways in which this can occur: natural decline in a borehole in response to droughts, or pumping out more groundwater than is naturally replenished every year. These two factors are often linked: during droughts, abstraction from boreholes often increases which exacerbates the natural decline in water levels (Calow et al. 1997). Many people believe that problems of drought and declining water levels will become more extreme as a result of the impact of climate change.
- **Lack of maintenance.** Boreholes and wells need to be regularly maintained. The rubbers and seals on handpumps must be changed, connecting rods looked after and holes in the rising main detected and fixed. This cannot happen on its own, but needs interested and qualified personnel and also small amounts of money. Much research and many, many projects have shown that the single most important factor for reliable maintenance is a sense of ownership by the community. The community must have the responsibility for the borehole and handpump and be able to raise small amounts of money to buy spare parts.

9.4.5 Developing planning tools

Hydrogeological data can be interpreted to provide planning tools which may be used by policy makers and planners. Raw data, or hydrogeological interpretations, can be combined into more user-friendly maps which give a broad indication of conditions across a region or a country. One of the most common planning criteria used by central governments and donors is **coverage**, i.e. the percentage of the population in various districts with access to improved water supplies.

More sophisticated examples of using groundwater data to make user-friendly planning tools are the development of national groundwater availability or groundwater potential maps, water security and drought maps (see Figure 9.2). Although these tools are much too general to plan individual projects, they can be very useful to help policy makers or politicians make decisions about broad areas of investment, and to communicate complex

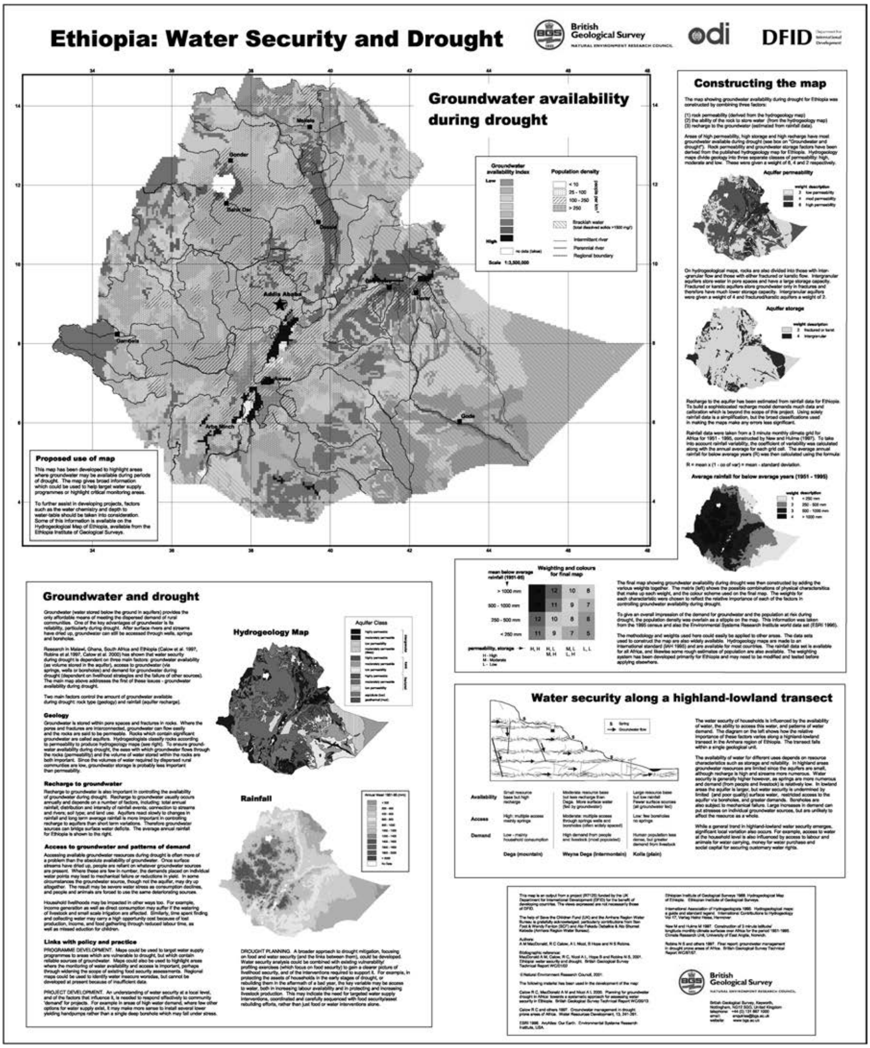

Figure 9.2 Black and white scan of a water security and drought map produced for Ethiopia.
Source: Calow et al. 2002.

ideas to non-specialists. If these tools can be underpinned with good-quality data from actual projects, they can ensure that those with the power to make decisions are actually doing so with the help of the lessons learned from projects throughout the country.

References, further reading and resources

Calow, R.C, Robins, N.S., MacDonald, A.M., Macdonald, D.M.J., Gibbs, B.R., Orpen, W.R.G., Mtembezeka, P., Andrews, A.J. and Appiah, S.O. (1997) Groundwater management in drought prone areas of Africa. *International Journal of Water Resources Development*, **13**(2), 241–61.

Calow, R.C., MacDonald, A.M., Nicol, A., Robins, N.S. and Kebede, S. (2002) *The struggle for water: drought, water security and rural livelihoods*. British Geological Survey Commissioned Report, CR/02/226N.

Davies, J. and MacDonald, A.M. (1999) *Final Report: the groundwater potential of the Oju/Obi area, eastern Nigeria*. British Geological Survey Technical Report WC/99/32.

Robins, N.S., Davies, J., Hankin, P. and Sauer, D. (2003) Groundwater and data – an African experience. *Waterlines*, **21**(4) 19–21.