4 Reconnaissance

4.1 Why is reconnaissance important?

Every good football manager and army general knows the importance of reconnaissance. Only with accurate intelligence on key parameters is it possible to plan a strategy for success. The same is true for water projects. Before a water project can be planned, key socio-economic, institutional and physical information must be gathered. There is little point in planning a groundwater project if there is no groundwater available, or buying sophisticated exploration equipment if groundwater can be found everywhere. In this chapter we describe how to carry out simple, effective reconnaissance on the groundwater resources.

The main aim of reconnaissance is to develop an initial conceptual framework of how the groundwater resources occur in the project area and therefore to guide expectations (and budgets) for the project. By the end of the reconnaissance period it should be possible to have answers to most of the following questions:

- Is groundwater easily found in the area?
- Is the hydrogeology fairly uniform across the area, or do conditions vary?
- Is groundwater best exploited through boreholes/hand-dug wells/springs, or a combination of these?
- What level of expense and expertise is required to develop groundwater supplies in the area?
- Are there any concerns over the water quality?
- What is the condition of the roads: will significant improvements be required before work can commence? Will work have to stop in the rainy season?
- Are there any special circumstances; e.g. very deep groundwater, saline water?
- Are there viable alternatives to groundwater (e.g. rainwater harvesting)?

Building a conceptual model of how groundwater exists is of course only one aspect of planning a rural water supply and sanitation project (as discussed in detail in Chapter 3). Consultation with local communities and institutions is fundamental to building a successful project. Other information, such as the water requirements of the area, the socio-economic conditions, health, legal aspects, population etc. are also required. Other manuals, such as Ockleford and Reed (2002), give valuable guidance on where to gather such information and how to integrate all stakeholders into the planning phase of water programmes.

4.2 Checklist for useful information

Below is a description of the different types of data to be collected during the reconnaissance phase of a groundwater project. Gathering this information should give sufficient knowledge to build a first conceptual model of the groundwater resources.

4.2.1 Topographic maps

Fundamental to any water supply project is knowing the size and shape of the project area. Topographic maps come in many different scales, from very detailed (1:10 000) to general (1:1 000 000). Throughout much of the world topographic maps are available at scales of 1:250 000 or less. Many of these maps were made after 1950, when aerial photographs began to be used widely for surveying. The location and names of communities may be out of date or inaccurate, but the topography and rivers are usually correct and form a useful base for reconnaissance.

Often, topographic maps are difficult to get hold of. If none are available locally in local or regional government offices, then the national survey department should be visited. If no maps are available in country then US and Soviet military maps at 1:250 000 and 1:200 000 scale respectively are available for much of the world. The Soviet maps have the best coverage, but are in Russian. These, and other maps, can be purchased online (see the 'Further resources' section at the end of the chapter).

4.2.2 Geological maps

Geological maps are the basis of any hydrogeological understanding of an area. Without a geological map, it is very difficult to build a conceptual mode of the hydrogeology of an area, particularly if the geology is diverse or complex. Fortunately, geological maps exist at some scale across the world. Most countries have at least a national geological map which can give an idea of what geology is likely to be present in a project area. For Africa, maps at 1:5 000 000 scale have been produced across the whole continent and can be bought as a six-map set.

In many countries maps are available at a more useable scale of 1:250 000 or 1:500 000. The availability of these maps can be checked at the offices of the national Geological Survey. If available, these maps can usually be bought, or at least copied or traced. Some maps are also held in international libraries (e.g. the British Geological Survey or the Geological Society of London) or available to buy from international retailers (see the 'Further resources' section at the end of the chapter).

BOX 4.1 Geological maps

Geological maps show the nature, extent and relative age of the different rocks in an area. The maps are based mainly on surface information, but may also include information from boreholes and aspects of geochemistry, geophysics, mineralogy and sedimentology.

A geological map is usually printed on top of a regular topographic base map, to help with locating features. The base map is printed in light colours, with the geology represented by colours, lines, and special symbols unique to geological maps. Each colour on a geological map represents a different geological unit where it appears at the surface.

On geological maps the rock units are generally divided up according to age into different rock **formations**. These formations may be made up of one rock type or consist of a number of different types of rocks arranged in a recognizable sequence. Formations are often aggregated to form **groups** that have broadly similar characteristics. Since on geology maps rocks are mainly divided on the basis of age, two sandstones of different ages would appear as different colours. The location of major faults, and the direction that different rocks are dipping, are also recorded on geological maps.

The map key shows all the units represented on the map and indicates their relative age. Usually there is a description of the different geological units on the map, which gives information about the character of the rock. Sometimes there is a generalized cross-section across the area. Maps can also be accompanied by a written description (often called memoirs).

Further resources describing geological maps are given at the end of the chapter.

4.2.3 Hydrogeological and geophysical maps

Hydrogeological maps are interpretations of geological maps which give information about the likely groundwater conditions. If available, they are a very useful resource, effectively carrying out much of the reconnaissance work for you. Unfortunately, it is rare to find a hydrogeological map at a scale useful for using on a project. Many countries, however, will have at least a national hydrogeological map, which can give an approximate indication of the likely conditions that the project will meet. The availability of hydrogeological maps can usually be checked at the national Geological Survey office. If no national map exists, then regional maps, such as the 1:5 000 000 hydrogeological map of Africa can be used (see websites in the 'Further resources' section at the end of the chapter).

Geophysical maps (also to be found in the national Geological Survey, or mining office) can also be useful. Maps of variations in the earth's gravity or magnetic field are available for many parts of the world. Of particular help in some areas are the magnetic maps (sometimes known as **aeromagneti**c maps since they have been created by towing scientific instruments behind aeroplanes). These can help identify variations in geology – particularly igneous rocks, which are often more magnetic than sedimentary rocks.

4.2.4 Borehole data

Information from any boreholes or wells already drilled in the area is fundamental to reconnaissance to the area. Many places will have had some attempt at borehole drilling or well construction. However finding records of this is often very difficult. Data that should be (but generally aren't) recorded from an existing borehole are listed below. (Later on in the book we describe in detail how to leave good records from a drilled borehole):

- borehole location
- borehole construction (e.g. depth, diameter, screen depth and size)
- the geology or a driller's log
- borehole yields
- drilling methods
- water strike; water levels.
- aquifer properties, such as transmissivity or specific capacity.

Borehole records may be lodged with the local or regional government or the organization for which the boreholes were drilled. In some countries a national agency will hold records, and every new borehole must be lodged with them. It is worthwhile searching in offices and filing cabinets and getting in touch with anybody who worked in earlier projects, not just to get the records, but to get inside knowledge of the area. Few people make adequate records of abandoned boreholes, so it is important to remember that any borehole records found for an area may give an optimistic view of the likely success rate.

Borehole information is only useful if you know where the boreholes are located on the ground. Some boreholes records may have accurate co-ordinates, particularly recent records since the widespread use of GPS (see Box 4.2). More often the record will just contain a village name, and even then it can sometimes be difficult to match up this name to any villages that local residents have heard of! However, with a little time and consultation it may be possible to plot many of the villages on a map.

4.2.5 Technical reports and scientific papers

Reconnaissance becomes a whole lot easier if someone else has done some of the work for you. For some parts of the world technical reports on the hydrogeology may already have been written: maybe as part of a previous water project or a student's thesis. Getting to know of the existence of these reports may be difficult, but it is always worth trying. They are unlikely to be in libraries, or widely distributed, but will be in a filing cabinet, or in a pile beside someone's desk. The best way to locate this sort of information is to find a hydrogeologist or water engineer who has worked in the area before. If there is no one available locally then it is worth getting in touch with a national resource centre, such as a university, a national water institute or geological survey. There are several international resource centres (see web links in the 'Further resources' section at the end of the chapter) that can provide access to a hydrogeologist and large libraries of reports and scientific papers free of charge to users in developing countries.

Several thousand scientific papers have been written about various aspects of the hydrogeology of Africa, Asia and South America. Increasingly, papers are indexed and available on the World Wide Web. It is possible that someone has carried out a scientific study of an area close to where you are working. It is a specialist skill to sift through all the literature to find something appropriate, so it may be more useful to link up with a local university or national resource centre.

4.2.6 Aerial photographs

Aerial photographs can be an excellent reconnaissance tool. They allow you to see what the ground is like around a community and map out the landforms, rivers, geological structures (such as faults and fractures), land use and vegetation. Aerial photographs are usually found in the same places that you find topographic and geology maps – survey departments or the national Geological Survey. In some countries access to them is restricted for security reasons and permission from a state official is required. Available aerial photographs are often more than 30 years old and some as much as 50 years, so the land use and roads may now be different.

When buying aerial photographs it is important to buy overlapping photos – usually with an overlap of at least 60 per cent to ensure that a 3D picture can be built up. The photographs should include information about the camera lens to allow corrections to be made for variations in the lens surface (Avery and Berlin 1992).

A **stereoscope** is required to interpret aerial photographs. This allows two overlapping photographs to be viewed at the same time giving a 3D picture of the ground surface. It takes a little bit of practice to be able to see the 3D image, but once the technique is mastered, the photographs come to life and much more detail becomes available. To record the interpretation, a clear plastic sheet is overlaid on one of the photos and the information drawn on top. Geologists often mark on **photolineaments** – straight lines on the photos which may be faults (and in some environments good targets for wells and boreholes).

4.2.7 Meteorological and hydrological data

Rainfall and evaporation are used to find information about the length of the dry season, the potential for groundwater recharge and the feasibility of using other sources of water, such as rainwater harvesting. Data from stream gauging can be interpreted to give useful information on the importance of groundwater in a catchment, by giving a measure of contribution of groundwater to streams. However, in many parts of the world stream gauges are not available.

Rainfall gauges are often located at schools, clinics, hospitals, churches and government departments, and there is likely to be a local enthusiast who has kept records for many years. Evaporation pans are more difficult to maintain and are, therefore, usually only found at airfields or large irrigation schemes. If no raingauge is available in the area, it is worth setting one up. The most important consideration is to find someone with an interest (maybe at a hospital, school or local government department) who will keep the measurements year after year. Gunston (1998) has written an excellent practical manual for setting up realistic monitoring networks across the world.

However, for reconnaissance purposes the information is required straight away – the project cannot wait 5 years until representative data have been collected. A rough idea of climate can be obtained from national rainfall charts or a map of rainfall across the country. Some international datasets are available, for example from the World Meteorological Organization (WMO) and the Intergovernmental Panel on Climate Change (IPCC); see the links in the 'Further resources' section at the end of the chapter.

4.3 Tapping into existing knowledge

It is always helpful to find someone who has worked in the area before. Not only can they give their own opinion of the area, but also they can help point in the direction of other projects in the area or maps and reports that might have been written. The local hydrogeological expert, however, can be elusive. S/he may be in the local or regional government, attached to a drilling company or in a local or international consultancy. Many of these places will be visited anyway, to try and gather some of the data and information required for reconnaissance (see Table 4.1), so it shouldn't add too much time to search out a valuable 'key informant'.

Once one has been found, it is important to ask the right questions and if possible to keep the lines of communication open. Here are some examples of questions to ask:

- What was their involvement in the area?
- How easy is it to find groundwater – what was their success rate?
- What do they know about the geology?

Table 4.1 Information available from different organisations

Institution	Data and information
Mapping or Survey Institute	Topographic maps, aerial photographs
Geological Survey	Geological maps, aerial photographs, hydrogeological maps, aeromagnetic maps
Rural Water Department	Databases of boreholes, reports of previous projects or district-wide surveys
Universities	Geological maps, local research in the area, student theses, academic literature
Agricultural/irrigation programmes	Borehole databases and reports. Possibly some maps
Local consultancies	Databases of boreholes, reports of previous projects, files on geophysical surveys
Drilling company	Local knowledge, databases of existing (and abandoned) boreholes
Local NGOs, local government	Databases of boreholes, consultants' reports, records of those who have worked in the area, local hydrogeological knowledge
International geological organisations	Geological maps, consultants, reports, academic literature

- Do they have records or reports of borehole drilling, or the project in general?
- Is there any poor water quality in the area?
- What techniques would they consider for finding groundwater?
- What knowledge do they have of other projects, or of people knowledgeable about the area?

Most engineers or geologists think best when they are drawing. It can often be highly instructive to get them to draw the following:

- a map of the area, showing geology and easy/difficult areas to find water
- a conceptual diagram of how they believe groundwater exists in the area.

However, all advice and information given should be treated cautiously and always checked in the field: people can often give misleading information in their enthusiasm to be helpful.

4.4 A reconnaissance site visit

The first visit to a project area is very important. It is at this time that lasting impressions are made. The project is also at its most fluid in the early stages, so design alterations are much easier. If possible, a visit should be made when the water problems are likely to be at their worst – during the height of the dry season. Several days should be spent visiting different parts of the area, trying to get a balanced overview of the water situation in an area. This will be helped if some of the other reconnaissance information (particularly maps) has already been gathered. It is better to cover more ground and make a rapid assessment, rather than making a detailed assessment in only one or two areas.

The main aims of a reconnaissance hydrogeological visit are:

- to triangulate information already collected
- to meet and discuss issues with the local engineers (note that within the project there will have been much contact with local partners in preparation for the project – so it is important to work within this framework)
- to make rapid assessments of geology, hydrogeology and existing water points
- to get an impression of road access and other practical difficulties in the area
- to get an early impression of the population distribution and settlement types (for example, are they clustered or scattered) as this will have an impact on the type and location of new water sources.

4.4.1 Equipment

Below is a list of equipment that it would be useful to take.

- Field notebook: obvious – but make sure it is a good notebook (not scraps of paper) and that all observations are written carefully.
- Camera: a photograph is an excellent way of recording information – make sure you record the location of the photograph and try to match up photos to locations soon after the visit.
- Magnifying glass: for examining rocks in more detail – Appendix 1 contains a detailed description of how to assess the geology.
- Geological hammer: for breaking rocks to get fresh unweathered samples to look at.
- GPS: this is a small, inexpensive piece of equipment about the size of a mobile phone or calculator which can accurately locate where it is on the ground (see Box 4.2).
- Water conductivity meter: this is a simple robust field instrument that can measure the salt content of water (see Chapter 8 on water quality).
- Water-level dipper: for measuring the depth of water levels in existing wells or boreholes (see Chapter 7).
- Bags and labels: for keeping samples of rocks that you are unsure of and need a second opinion on.

BOX 4.2 Using a global positioning system (GPS)

A GPS is a robust pocket-sized instrument that can accurately give the location of where it is (see Figure 4.1). It is very easy to use – when switched on it should automatically give the coordinates of its position after a few minutes. When switched on, the GPS tracks the position of satellites and from this information uses mathematics to work out where it is. It is, therefore important that the equipment has a clear view of the sky, to be able to pick up the satellites.

It is important to have the GPS set up to give the same readings as the base map being used on the project. For example, if the map is in degrees and minutes, then the GPS should give readings in degrees and minutes; if the map uses local grid coordinates (e.g. 125600, 034560) then the GPS should be set to read in these coordinates. The GPS should also be set up in the correct datum: the maps should have the datum used to make the map written on them (e.g. Transverse Mercator, etc.). If this information is not easily available then a standard datum (such as WGS84) is usually fine for accuracy up to 1 km.

Figure 4.1 A GPS being used in the field; carrying it on your head is not obligatory. Photo: BGS; © NERC 1998.

4.4.2 A rough procedure

Meeting local officials and partners

The first thing to do when visiting the project area is to meet up with the local partners (or potential partners). By the time that a reconnaissance survey is necessary, there will have been several other meetings with partners to discuss the potential project – it is vital that the hydrogeologists and water engineers work within this framework (see Chapter 3).

Take your time in these initial discussions, and go over all the details you have written down to make sure that nothing has been missed. It is often useful to have a number of questions prepared beforehand. The following questions may be useful.

- With the partners, discuss all the reconnaissance information that has already been collected and if possible give them copies. Discuss in detail what other data may exist.
- Discuss what other projects have occurred in the area and who was involved.
- Prepare a plan (with the partners) of key informants to meet.
- With a base map for the area (even a rough sketch), ask them to draw a map of existing water points and also areas where it is easy or difficult to find groundwater.
- Prepare with them a field visit which will cut across the area to show a variety of hydrogeological environments.
- Discuss the condition of the roads and bridges for access of a drilling rig.

These discussions can then be repeated with other key informants identified by the partners.

A field visit

Plan a drive across the area which takes in the variety of geological conditions and existing water points. To get a representative sample it is useful to make two traverses across the area, perpendicular to each other (see Figure 4.2). For this rapid reconnaissance it is generally sufficient to keep to the better roads so that more ground can be covered in the time. A project partner should accompany you on a field visit, both so that s/he can learn about the geology, but also to facilitate and explain to local communities what is being done.

- Stop at rock cuttings and examine the geology: describe the rocks (see Appendix 1), take a sample, and also a GPS reading so it can be marked on the map. Check the geological maps available for the area, and try to work out how variable different rock types are.
- Stop at water sources. Make a description: pump type, whether it is working, depth (measure with dipper if it is open – a dull thud is felt

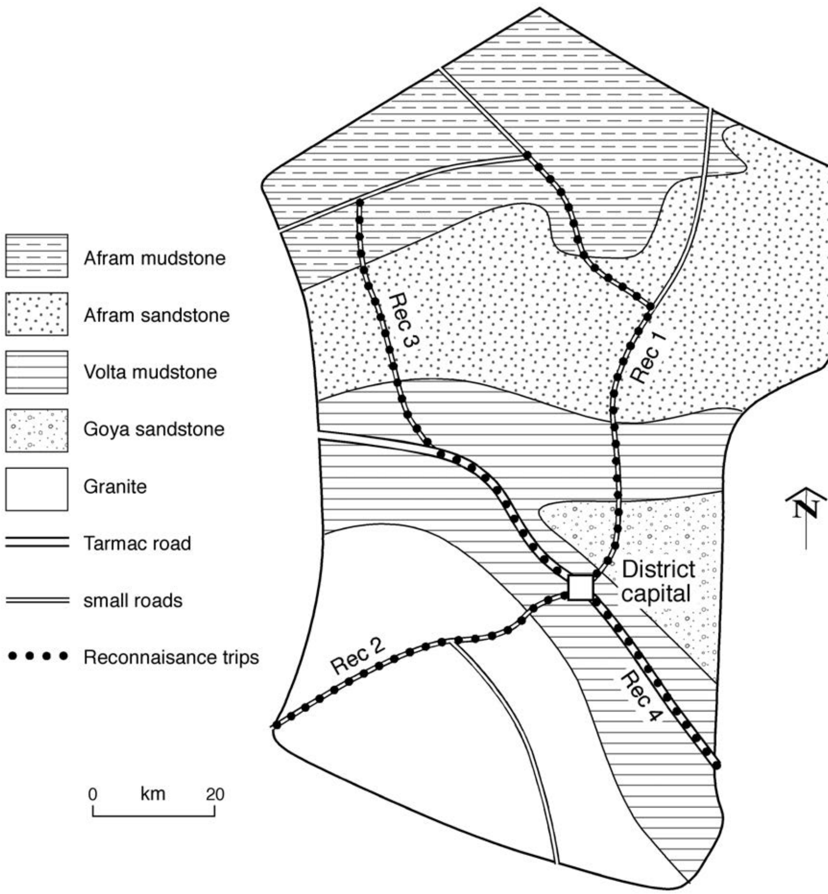

Figure 4.2 How to design reconnaissance field visits for understanding the geology and hydrogeology. Each of the geological units should be visited – preferably using good roads.

when the dipper touches the bottom), water level and electrical conductivity (SEC) of the water. Discuss with the community how well the source works at different times of year (how many basins or jerrycans can be collected? does a queue form? does the colour or taste change during the day or year? does it frequently break down? does the yield decline over the year? etc.). Ensure that the community know exactly why you are there; it is often useful to discuss with the project partner beforehand a strategy for approaching communities so that hopes are not raised or a false impression given.

- With local partners, visit one or two villages in different hydrogeological areas to discuss the water supply problems in more detail. Walk to the dry season water sources to try to work out why water occurs there: maybe a river, a small pond, or groundwater seepage. Note any successful or dry wells and boreholes and work out the geology for the village from the material excavated from hand dug wells, or nearby river valleys. (More information on how to carry out a community reconnaissance visit is given in Chapter 5.)

- Make a rough assessment of the quality of the roads – particularly noting the quality of road bridges and culverts and areas that are inaccessible to drilling rigs, or accessible only at certain times of year.

4.5 Filling in the gaps

In most areas there will be some information that is not available: no list of existing water points, or – more seriously – no available geological or topographic map at a useful scale. However, all information can be generated from scratch, given the right expertise; and this is often fairly inexpensive compared to the overall cost of a water supply project.

4.5.1 Locating villages and existing water points

A GPS can be used to locate villages, water sources and past borehole drilling sites quickly and cheaply (see Box 4.2). Anyone can be trained to use a GPS in a few hours, and provided it has been set up correctly it will provide an accurate location (within about 100 m). Arrange for someone to visit all the villages to take and record GPS readings for village centres and existing improved water points. The water points can be described briefly: type (e.g. borehole or hand-dug well), depth, condition (i.e. working or not), type of pump, etc.

4.5.2 Creating a topographic map

In the absence of topographic maps, information from satellites can be used to help create a base map for the area. Satellite images are now widely available and relatively inexpensive (several hundred dollars); however, interpreting them correctly is a specialized technique and will require input from a good consultant or university. Rivers and roads can be easily interpreted from satellite images, and sometimes land use or geology (see below). With the increasing availability of Soviet military maps over the past few years, however (see above), it should be possible and cheaper to purchase the 1:200 000 scale map rather than create a new one from satellite imagery. The map could be traced and the Russian translated to a more useful language for the project.

4.5.3 Creating a geological map

If there is no geological map for the area apart from a small scale (1:1 000 000) national map it may be useful to have a new geological map made of the area. A university, consultant or Geological Survey is best placed to carry out this work – a map at 1:250 000 scale could be made in a matter of months. More detailed maps can also be made for selected areas. Reconnaissance geological maps are made using satellite images along with aerial photographs. The geologist will then visit the area to 'ground truth' the map and take samples of the rocks for further analysis.

4.5.4 Hydrogeological understanding

If during the reconnaissance phase there is little or no information about how groundwater occurs, it may be necessary to carry out a more detailed hydrogeological survey. Again, this is something that a good consultant would be best placed to carry out. A detailed hydrogeological investigation generally involves testing the different rocks units on a geological map. If no boreholes are available, test boreholes are drilled and the aquifer properties estimated using pumping tests (see Chapter 7). Several boreholes are required in each rock unit to try to give a more representative impression.

In areas where little is know about the water quality, it can be useful to take water samples from existing sources to map out variations. There are certain procedures for taking samples (see Chapter 8) and samples need to be sent to a reliable laboratory. Again a good consultant or university should be able to carry out the work and interpret the data.

4.6 Making use of the information: creating a conceptual model

4.6.1 Getting it all together

The aim of reconnaissance is to create a conceptual model for how groundwater exists in an area. If, for example, the geological maps indicate that the project area is underlain by granite and the field visit confirms that the granite is weathered and that there are some sustainable water supplies present in the area, then a programme can be developed based on finding groundwater in weathered granite.

To interpret all the data and information collected during reconnaissance it should be first brought together. There are two main ways of doing this: spreading out all the data collected on a large table, or putting all the data on a geographical information system (GIS) – both are equally valid. A GIS is essentially a computer method of overlaying and arranging maps (see Box 4.3).

1 First, the geological map should be reviewed with the geological data collected on the field visit and any other geological information collected from reports or interviews.

- The location of each of the rock samples collected should be plotted on the map, and also the interpretations from reports and interviews (see Figure 4.3).

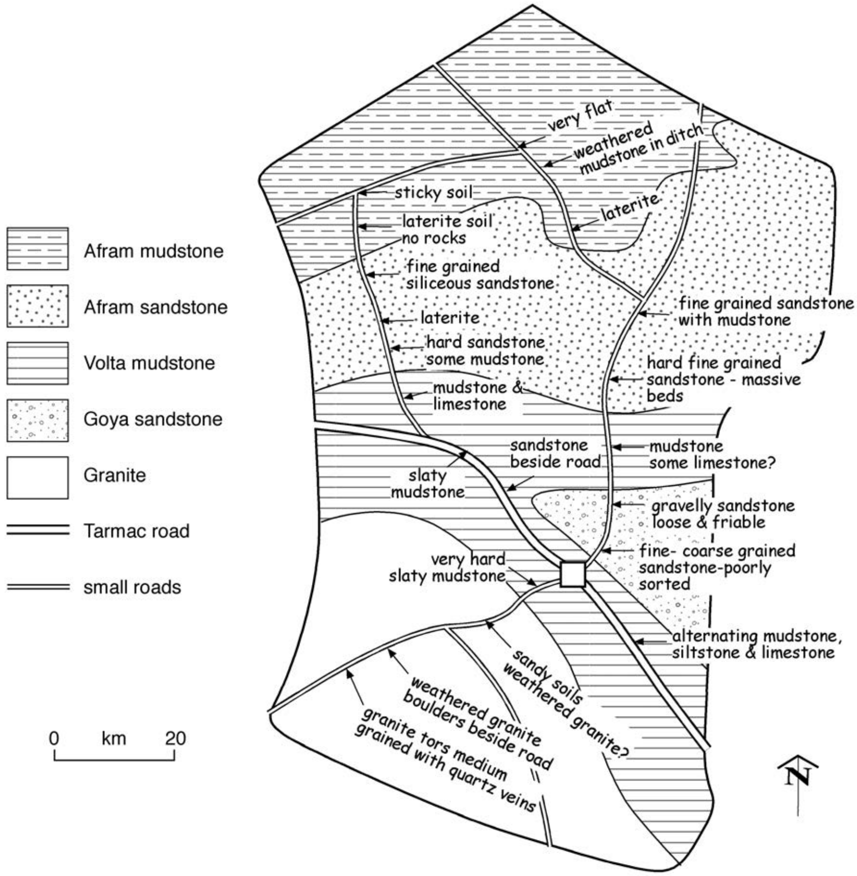

Figure 4.3 Confirming the geology – field notes are plotted on the geological base map to help interpret the geology map, and in some cases to update it.

- Ask the following questions: are the different sources of information consistent? If not, how serious are the inconsistencies? If serious then it is best to get a second opinion from a geologist at a university, consultancy or Geological Survey.
- Write a summary of the geology of each of the units: e.g. 'sandstone and mudstone layers – more sandstone in the south'; or 'granite – deep pockets of weathering throughout the area'.

2 A preliminary hydrogeological interpretation for the different geological units can then be given (see Figure 4.4).

- The location of all known existing water points are plotted on the geological map and descriptions added about depth, yield and water quality.

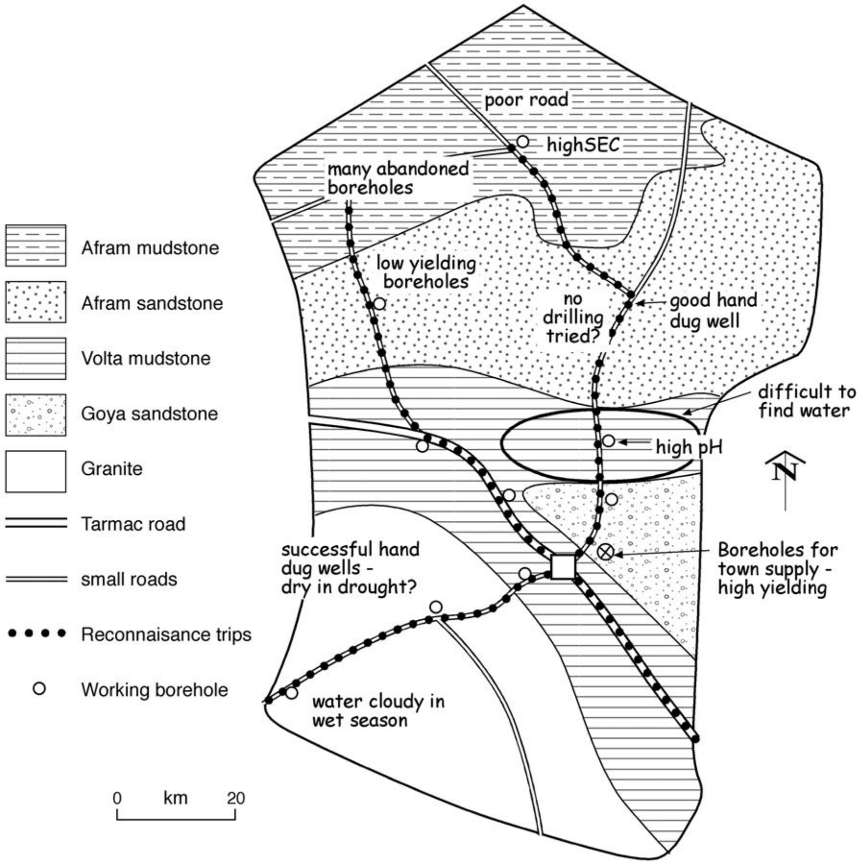

Figure 4.4 Hydrogeological field notes plotted on the base geological map.

- Information from key informants, reports and interviews is then noted on the map.
- First look for consistencies across the map – for example areas where there are many successful boreholes and the geology is marked as a sandstone, or an area where many boreholes have been drilled, but most are unsuccessful and the geology is unweathered granite.
- As a first attempt at a hydrogeological interpretation extrapolate information across the different geological units.
- Mark down areas of uncertainty and complexity – for example, a sandy area where the boreholes are unsuccessful, or geological units with no hydrogeological data.
- If there are no existing boreholes or wells in an area then a judgement has to be made from the initial geological descriptions alone. The tables and conceptual diagrams in Chapter 2 should then be used as a first guess.

This map then forms the basis for a preliminary groundwater potential map. It should be considered a dynamic map and will have to be refined several times once the project has started and information is gathered from new wells and boreholes.

4.6.2 Producing a groundwater development plan

The preliminary groundwater potential map can now be used to discuss options with other team members and project partners to form a groundwater development plan. The map should enable a judgement to be made on the expertise and equipment required to find sustainable groundwater supplies in different areas – and the likely success rates. Figure 4.5 shows a rough groundwater potential map, drawn up from the reconnaissance visit.

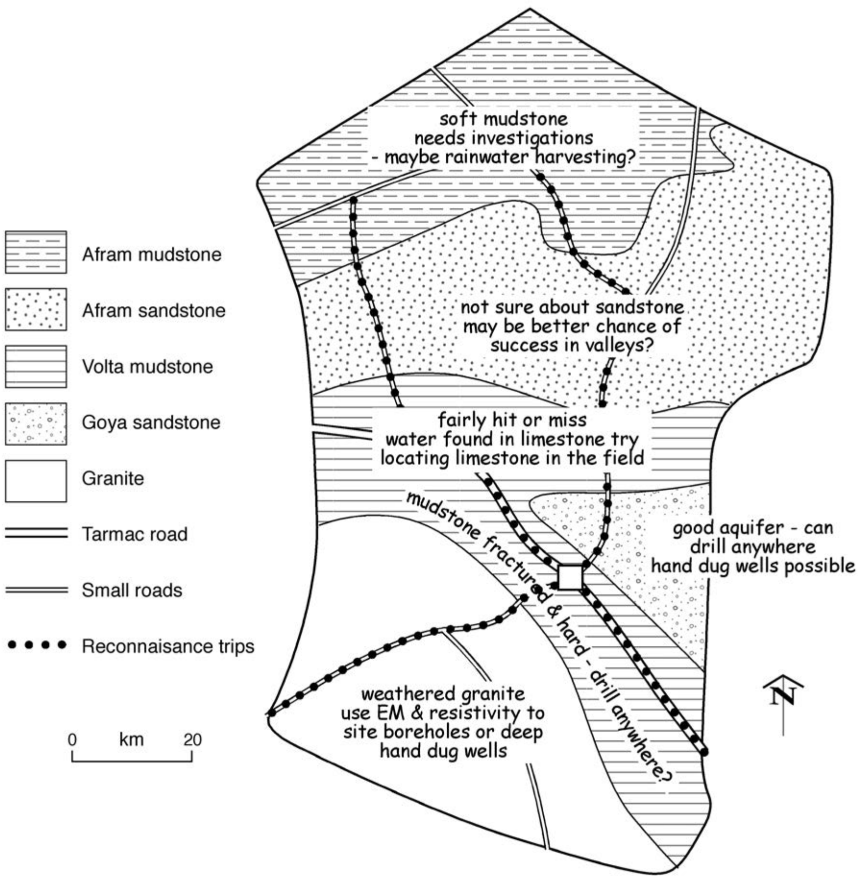

Figure 4.5 A preliminary groundwater development plan developed from the reconnaissance information.

BOX 4.3 Geographical information systems (GIS)

A GIS is an excellent tool for water supply projects. It allows digital map information to be combined, analysed and presented in many different ways. Topographic maps, geology maps and hydrogeological maps can be overlain with point data, such as the location of villages and water points (Figure 4.6). All the different types of data can be combined to produce new maps – tailor made for the project and easy to update. This means that different maps can be easily created for different project stakeholders. Once map data is in a GIS it can be rapidly analysed, e.g. to find the average rainfall over a selected area, or finding how many wells are lying on a certain rock type

To set up a GIS demands specific expertise and considerable effort to get all the data in the appropriate format. Universities and consultants should, however, be able to carry out this work. To create a GIS for an area, the available data are first put into digital form and georeferenced. That means digitizing topographic and geological maps and making sure they are in the same map registration. Once this is done, other information, such as databases of village location or water points can be added and plotted on top.

Once a GIS is set up, it is easy to manipulate and change, unlike a printed map. Therefore, when new data is available and the hydrogeology is known in more detail a new map can printed for use in the field. The main GIS programmes used around the world are Arc® and MapInfo®. Like all computer software, however, it must be remembered that GIS is just a tool to help the project and not an end in itself.

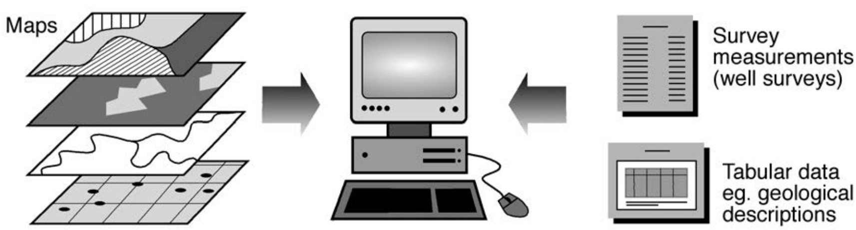

Figure 4.6 Summary of a geographical information system.

For one area, hand dug wells may be able to be constructed anywhere with no hydrogeological constraints. Another area may require boreholes to be drilled to a depth of 100 m for the best chance of success. In some places there may be little chance of success for groundwater, so another supply option may need to be considered. Such a map can be useful for assessing whether targets set by a project (such as a certain amount of water per person within a certain distance) are likely to be met over the whole project area, or whether they are unrealistic.

It is a valid (but often unpopular) approach to say that after the reconnaissance we do not know the best way to proceed and further investigations are required. However, it is much better to highlight uncertainty now, than build up expectations and waste time and resources developing a plan based on uncertain groundwater resources.

As Chapter 3 describes, the hydrogeology is only one part of the story for rural water supply. Deciding which communities to start work in is a complex process and will also depend on other factors, such as community demand, community poverty or vulnerability or where partners already have strong links. Plotting the communities onto the preliminary groundwater development map allows the hydrogeology to be factored into these decisions.

- The location of communities can be plotted on the groundwater development map.
- From reading the map, each community can then be ascribed a groundwater unit and added to the project database on communities.
- When a community is prioritized for whatever reason, the likely potential for groundwater can be quickly assessed from the map to help inform the decision as to whether to proceed or not.

To take it further (and some projects have done this successfully) it is possible to use several criteria (e.g. groundwater potential, community vulnerability and road access) to rank communities. This information can then be used to help prioritize project promotion to generate demand in the poorer areas where groundwater may be easily found.

References, further reading and resources

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http://www.maplink.com/q

http://www.omnimap.com/

http://www.cartographic.com/

http://www.bgs.ac.uk/

http://www.geolsoc.org.uk/

More information on geological maps

http://www2.nature.nps.gov/geology/usgsnps/gmap/gmap1.html

http://www.bgs.ac.uk/education

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Information and data on world rainfall

http://ipcc-ddc.cru.uea.ac.uk