Improving water security and management of water resources in Sahelian WASH programmes: a toolkit

www.wateraid.org/ppa wateraid@wateraid.org 47-49 Durham Street, London SE11 5JD

Contents

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The toolkit is based on field experiences emerging from integrated WASH-water resource management programmes implemented over the past six years in Burkina Faso, Mali and Niger.

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Cover image: Bamogo Salam, 60, (left) hoes the earth while Bamogo Salifou, 30, waters crops in a market garden using water from a WaterAid well, in Basbedo, Burkina Faso, October 2014. Credit: WaterAid/Andrew McConnell.

The problem

Standard approaches to water, sanitation and hygiene (WASH) programming do not adequately prepare communities to manage ongoing threats to their water supplies. While the combined burdens of water collection and disease are greatly reduced when improved WASH services are introduced, communities remain vulnerable to changing water availability, changing water quality and competing demands for water, with negative consequences for health and livelihoods. Local coping strategies can be

fragile, and communities often lie outside the reach of local government and basin management authorities tasked with improving WASH services and integrated water resource management (IWRM).

Sufficient supplies of groundwater cannot be found everywhere, limited financial and human capital is available to develop groundwater access. In short, households and communities suffer from water insecurity and uncertainty about their water supplies.

In the dry countries and regions of Sub-Saharan Africa, people need water for domestic uses, for their livestock, for agriculture and for small-scale industries such as brick-making. Water is also needed to support wetland vegetation that is used by people and livestock. In these environments, water resources are highly seasonal, and they vary greatly in amount from year to year. Water quantities may be limited and water may be prone to contamination. Rising populations, increasing demands for water and an uncertain future posed by man-made climate change exacerbate this situation.

Pressures on water resources vary over time, yet ongoing community or local authority-led monitoring of rainfall, groundwater levels and demand is almost always missing from WASH programmes. This makes water-related threats difficult to manage because early signs of trouble are not measured.

Communities can play an active role in monitoring their own water resources and managing threats to their water security, together with support from local and national governments.

The securing water resources approach (SWRA)

The securing water resources approach (SWRA) aims to improve household and community water security by combining WASH service delivery with principles and activities associated with IWRM. We are defining water security as reliable access to water of sufficient quantity and quality for basic needs, small-scale livelihoods and healthy ecosystems, coupled with a well-managed risk of water-related disasters. Water security depends on well-managed water supply services and sufficient, good quality, well-managed water resources. Essentially SWRA seeks to strengthen resilience to ongoing threats that impact on water supply services and water resources. The approach, which incorporates actions that identify, monitor and mitigate water-related risks, has been tested over six years in Burkina Faso, Mali and Niger.

Despite being an important climate change adaptation tool, the SWRA seeks to address multiple issues simultaneously, including climate variability, the availability of improved water supplies, the need for multiple use services (MUS), water allocations and conflict over water access. These issues are assessed through fieldwork at the local level. In addition, the SWRA recognises the need for effective coordination with

external institutions, such as national-level government ministries. The aim here is to complement national strategies for Water Resources Management (WRM) using WASH as a vehicle for its implementation.

The approach has the following objectives:

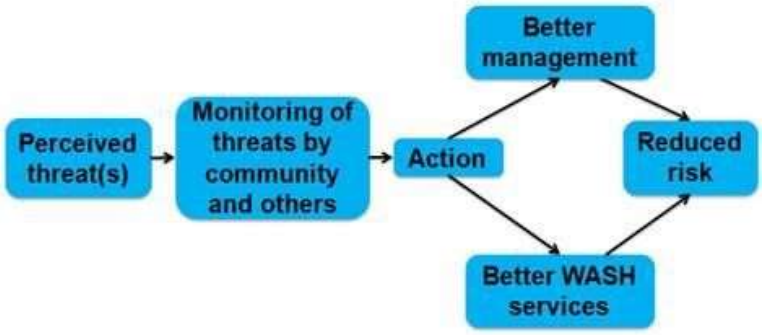
1. Strengthen community adaptation and resilience to climate change, climate variability and other threats to water supplies and resources.
2. Provide a structure for community-level, risk-based planning.
3. Provide a framework for the local allocation of water resources.
4. Reduce conflict between different water users at water points.
5. Acting as an early warning system to alert communities to emerging threats.
6. Inform the design of WASH services to better meet multiple water needs.
7. Strengthen the voice of communities to call for assistance from government authorities when their access to water is threatened.
8. Supporting national efforts to improve water security for poor people in rural areas.
9. Strengthening support offered to communities by government institutions.

Components of the approach

Although this approach has been developed and tested in the Sahel region, it consists of generic components that can be used to improve water security anywhere. These include:

1. Linking with appropriate national, regional and district authorities.
2. Participatory identification of threats to water resources.
3. Participatory monitoring of water resources.
4. Risk-based planning aimed at improving management of water resources.
5. Risk-based planning aimed at improving access to WASH services.

Figure 1: The different steps involved in strengthening water security using the SWRA.



Overview of stages involved in establishing a programme of work aimed at improving water security using the SWRA

Initiation of a programme of work on SWRA involves four stages. The appendix of this document includes tools to assist with the completion of these stages.

PROGRAMME INITIATION

- **Identification of relevant stakeholders, achieving government buy-in and involvement**
- Establishment of a 'monitoring and documentation committee' or basin water security observatory group and a 'technical unit'
- **Community selection**

DESIGN AND IMPLEMENTATION

Identification of threats to water resources

- Tool 1: Questions to ask to gather detailed information about the need for improvements to water security
- Tool 2: Questions to ask when developing a historical timeline of water-related events

Collectively assess water users and water uses

- Tool 4: 'Water user, water usage' survey
- Tool 5: 'Water-source-based water usage' survey

Identification of existing support structures/systems

- Tool 6: Identification of existing coping strategies
- Tool 7: Understanding the level of external support provided by local authorities

INITIATION OF WATER RESOURCE MONITORING

- Tool 8: Rainfall record sheet
- Tool 9: Groundwater level record sheet
- Tool 10: Recommended devices to monitor groundwater
- Tool 11: Operating instructions for Rugged TROLL devices
- Tool 12: Recommended devices to monitor water quality

DEVELOPING OPERATING PRINCIPLES AND SERVICE IMPROVEMENTS FOR BETTER WATER SECURITY

- Agreement of operating principles for better management of water resources
- Agreement of service improvements for greater water security

About this toolkit

This toolkit provides a series of practical tools and resources that support WASH practitioners to incorporate activities that strengthen water security into WASH programming. Specifically it provides resources to help:

1. Decide if communities will benefit from efforts aimed at strengthening water security.
2. Achieve the support and engagement of national and local government officials.
3. Support communities to identify and understand vulnerabilities to water-related threats.
4. Support communities to monitor water-related threats.
5. Support communities to develop resilience strategies that mitigate water-related threats.

How to use this toolkit

This document is divided into sections that outline different steps involved with strengthening water security in a rural context. Each step should be followed sequentially. Some sections link to tools that guide users through specific processes. Each tool can be found in the appendix of this document.

Skills required to use this toolkit

The role of the WASH practitioner in the process of implementing SWRA is to act as a facilitator, facilitating risk-based planning and supporting communities to identify, monitor and mitigate threats to their water supply services and water resources.

The authors assume toolkit-users are equipped with basic facilitation and community mobilisation skills. Skills in participatory rural appraisal (PRA) are useful. If toolkit users do not have these skills, it will be useful to train them before going any further. It is also assumed that toolkit-users are trained WASH practitioners familiar with methods for implementation of WASH services.

Stage 1: Programme initiation

Government buy-in and involvement

This section sets out tips on how to involve essential stakeholders, which is critical for national ownership and the uptake and scaling up of improvements to water security. From the outset, efforts to improve water security and the management of water resources should be aligned with national water resource management plans and service delivery mechanisms. If efforts to improve water security are perceived by national and local institutions as purely NGO-led initiatives then wider adoption of practices and scalability of approaches will be difficult to achieve.

The aim of the SWRA is to first scale upwards to involve national ministries in the programme, then scale outwards to more communities as approaches are adapted to the local context.

1.1 Identification of essential stakeholders who will own and scale up efforts to improve water security

Possible essential stakeholders include:

- **The Ministry of Water**, including any departments responsible for rural water supply, integrated water resource management and monitoring of surface and groundwater levels.
- **The Meteorological Authority**, which holds rainfall data and information about national standards for rainfall data collection.
- **National civil society coordination bodies** responsible for coordinating the activities of NGOs in the WASH sector.
- **Local governments**, who represent the central state and play a contracting authority role for water resource and WASH infrastructure planning. They may also ensure the implementation of national regulation on water.
- **Regional technical support authorities** responsible for extending support to local governments relating to WASH and possibly agriculture.
- **Local NGOs**, who can help to facilitate initiation of water security improvements with local and national government, by supporting communities to identify threats to water supplies and possible mitigation strategies.
- **Village development committees**, who will participate in the identification of threats to water resources, the development of equitable operating principles between the different users and voicing the need for improvements to WASH infrastructure to higher authorities.
- **Community leaders** responsible for enforcing commitments agreed to by communities.
- **Women's groups and farmers' cooperatives** engaged in collecting and using water for multiple purposes.

This list of potential stakeholders is not exhaustive. There may be others who you feel need to be involved, including members of any donor-funded special task force engaged in developing strategies for WASH service delivery and WRM.
Initial consultations should focus on understanding how improvements to water security will add value.

1.2 Getting political and institutional buy-in to the process of strengthening water security

It will not be possible to move forward on implementation of improvements to water security without consultations with each stakeholder and the active participation of government institutions.

Two processes can be initiated in an attempt to achieve the necessary buy-in:

1. Establishment of a **Monitoring and Documentation Committee** tasked with jointly overseeing, documenting and learning from the process of implementation. The committee should be chaired by a senior representative from the Ministry of Water. All stakeholders should be invited to nominate a representative to join. The committee should define clear roles and responsibilities for each stakeholder and develop an action plan. A schedule of meetings should be agreed (usually every four months or at key milestones) to review progress and update the action plan. This process enhances communication and information exchange.

Image 1: Monitoring and Documentation Committee meeting in Burkina Faso.

2. Establishment of a **Technical Unit**, which will operate in the field, carrying out facilitation and implementation. The unit should be formed by the Monitoring and Documentation Committee. They should nominate no more than three of their members with the necessary technical skills to carry out implementation of the committee's action plans. The Technical Unit will need to include individuals able to mobilise communities. It also helps if they have an existing relationship with the communities.

Community selection

1.3. Understanding if communities will benefit from efforts to improve water security

This section presents some very general, high-level questions that practitioners can use to understand if there is likely to be any demand from communities for efforts to improve water security. It is important to recognise that not all communities will face water-related threats. They may have no interest in changing the way water is managed. On the other hand there will be many communities who will express a demand for support to mitigate water-related threats. The following questions are designed to help gauge the need to improve local-level water security.

These questions are best explored together with local government officials and communities.

- Are there prolonged dry periods?
- Is rainfall uncertain and variable?
- Are there periodic droughts?
- Is water used intensively for multiple purposes?
- Is there competition over access to a limited number of water sources?
- Do disputes arise between water users?
- Is there seasonal drying of water sources?
- Is there intensive pumping of groundwater?
- Is there any need to increase the resilience of communities to water-related threats?

If the answer to one or more of these questions is yes, the approaches set out in this toolkit may offer a way to improve local-level water security. However, more in-depth questioning is required to select specific communities for intervention (section 2.2.2). Again, this is best done with the full engagement of national and local government officials and other interested parties.

1.4. Formal selection of communities where efforts to strengthen water security will add value

This section describes how to identify specific communities where improvements in water security will help to mitigate water-related threats.

The last section set out some general questions to explore with local authorities to determine if improvements in water security are necessary. Ask their opinion about which communities they feel would most benefit from support. This document can be used to set the scene and describe some of the steps involved. Depending on the budget of your programme (Box 1), select two to four communities. Once these have been identified, you can use Tool 1 in each community to gather detailed information about the need for improvements to water security. The tool should be used in a focus group discussion with the community.

Box 1: Budgeting for improved water security

The majority of processes set out in this toolkit consist of software activities. Activity is greatest at the outset of the project. The biggest costs will be vehicle fuel and staff time. Some instruments to monitor water resources will be needed. The cost of these need not exceed £1,000 per community. Improvements to WASH infrastructure will be identified over time. These should be budgeted for in the standard way. Budget is then required for monitoring and follow-up. Local authorities should be encouraged to factor these different items into budgets over time.

Once surveys have been completed and the results have been discussed with local authorities, a final list of focus communities can be agreed, with the permission of the communities themselves.

The Technical Unit should arrange a meeting with community members to explain the approach in detail and brief them on some of the potential outcomes. Roles and responsibilities should be clearly explained, as set out by the Monitoring and Documentation Committee. Specific mention should be made of the community, who will need to play an active, ongoing role in monitoring threats to their water resources.

They will also need to collectively identify actions to improve water security. The meeting should be attended by local government officials, who will also explain their role. The community should be asked to raise any questions or concerns they may have and to state their expectations. The facilitator from the Technical Unit should provide a view on whether expectations can reasonably be met through this initiative.

Stage 2: Design and implementation of the programme

This section sets out guidance for the Monitoring and Documentation Committee on how to design a programme of work aimed at improving local-level water security, once the community has been chosen. The type of actions to improve water security will be heavily influenced by the nature of the threats and vulnerabilities that communities currently face, and existing coping strategies. The tools presented in this section should be adapted to the local context by the Technical Unit.

2.1 Identification of threats

The first step towards improving water security involves collective identification of water-related threats and vulnerabilities. This is necessary to understand what operating principles governing water use and what improvements to WASH services may be necessary to reduce the risks that communities face. The tasks involved take the form of community focus group discussions facilitated by members of the Technical Unit.

Each exercise should take around two hours, the timings of which should be determined by the community members.

Threats and vulnerabilities are identified in six stages:

1. Development of a historical timeline of water-related events, threats and vulnerabilities.
2. Field observations and sanitary survey.
3. Participatory mapping to show where water sources are, their functionality and what they are used for.
4. Identification of existing coping strategies.

5. Understanding the level of external support available from local authorities.
6. Summary assessment of main threats to water resources and water supply services.

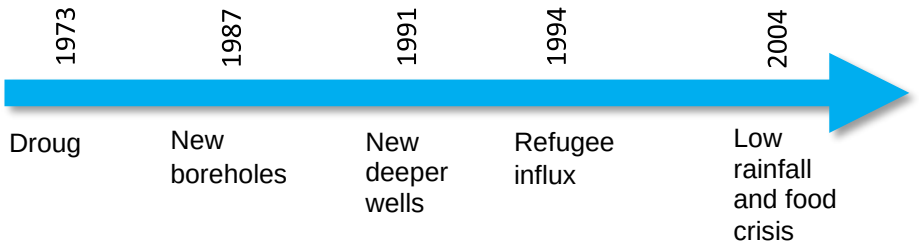
2.1.1. Development of a historical timeline of water-related events threats and vulnerabilities

This is a useful exercise to assess the local, long-term threats and vulnerabilities to water resources. It should be developed by arranging separate focus group discussions with the water user committee, women and farmers. These groups should contain elderly members of the community who will have a long-term historical perspective. The responses of these different groups can be built into a timeline illustrating changing availability of water and access. It should record major events, such as the dates of:

- Droughts and water shortages
- Periods of abundance of water
- Installation of new WASH infrastructure
- Changes in water and land use
- Strategies developed for coping with water-related challenges

The questions suggested in Tool 2 can be asked during focus group discussions with each group (the water user committee, women and farmers). The answers will inform development of the timeline.

Box 2: Example of a historical timeline of water-related events, threats and vulnerabilities



2.1.2. Field observations and sanitary survey

This involves walking with community members to see the location and condition of different water sources. It is useful to note the extent to which water sources are designed for multiple uses. Boreholes or wells with handpumps that are used for domestic use, as well as cattle watering, must be designed to accommodate dual use, minimising damage and the risk of contamination.

A sanitary survey (outlined in Tool 3) is a good way to understand potential threats to water quality for human consumption. It can be carried out on two or three water

sources used for drinking water. Once the results of the sanitary survey are known, any risks identified can be discussed with the community.

2.2 Collectively assess water users and water uses

2.2.1. Participatory mapping to highlight where water sources are, their functionality and what they are used for

This exercise involves understanding where each water source is, what it is used for and whether it provides water in the dry season or not. The maps help to build a picture of dependence upon different water sources, especially during dry periods. They also show whether sufficient water supply infrastructure is in place to meet different water needs. Once the maps are assembled they can be used as a planning tool to initiate new services.

Maps should be set out on the ground using various objects to denote the presence of functional and non-functional water sources, boreholes, wells, dwellings and community boundaries. This is done during a community assembly involving all community members, including men, women, livestock keepers and farmers. Ideally the mapping will gather the following information.

Information about the town	**Information about WASH services**
The limits of the town and surrounding villages	Locations of water and waste water systems
Tracks and roads, waterways, swamps and lowlands	Potential public health risks impacting on water sources (e.g. when near an area of open defecation)
Land use (e.g. forests, farming, gardening and quarries)	The type of structure (e.g. modern wells, traditional wells, mini water supplies, etc.)
The infrastructures of the town (e.g. schools and health centres)	Level of infrastructure (e.g. private, community, municipal, etc.)
Locations where vulnerable people live (e.g. elderly people, chronically ill people, and female heads of households)	Condition of the structures (functional or non-functioning)
	The use of water points (for human consumption, laundry, etc., or for agriculture and livestock)
	The sources that provide water all year round and those that do so only in the wet season

	Differences in access to water points (e.g. if only certain people are allowed to use them)
	Places where there are conflicts between individuals or communities

Image 2: Community mapping with farmers to highlight differences in access and water use between wet and dry seasons in drought-prone Konso, Ethiopia, 2015.

Image 3: Balima Karim creates a map of the local area with sticks, pieces of fruit and ash in Basbedo, Burkina Faso, 2014.

Image 4: Map of water resources drawn in Sablogo village in Burkina Faso, 2015.

2.2.2. Identification of different water users and their water demands

Once the location of water sources is clearly set out, a survey can be carried out to identify the main water users and their respective water needs. Two levels of analysis can be undertaken.

First level: A 'water user, water usage' survey

A 'water user, water usage' survey can give insight into what people use water for. Tool 4 uses a sample of randomly chosen households, varying in size and location. Farmers and cattle keepers should also be interviewed. The survey should be

continued until you start to get repetitive results from respondents. This is called 'survey saturation'.

Second level: A 'source-based water usage' survey

Tool 5 is an assessment of the amount of water collected at water sources by different water users. It involves observing water users at a water point and noting every water collection, the quantities collected, the number of recipients, types of recipients and uses of the water. The observation should be planned for one day during the dry season and one in the wet season to compare the changes which occur during the year.

2.3. Identification of existing support structures/systems

2.3.1. Identification of existing coping strategies

By asking the questions suggested in Tool 6, this exercise should explore some of the methods communities have used to cope with water-related threats in the past. This information can help build a picture of what processes communities have in place for management of water and what coping strategies they employ when supplies are threatened. It should show whether there are any existing early warning systems that communities use to predict problems with water supplies. The information gathered can be used to help develop contingency plans, including operating principles governing management of water.

2.3.2. Understanding the level of external support available from local authorities

Local authorities can provide insight into government policy regarding the support provided to communities to improve WASH services, keep WASH services running and assist communities in times of water shortage. The survey aims to understand what level of support is actually provided and whether local authorities have a role in resolving water-related disputes between different users. The suggested questions in Tool 7 can be used.

2.4. Identification of the most significant threats to water security

Once all surveys and meetings have been concluded, a community meeting can be held to identify the most significant threats to water security. Threats identified might include:

- Very long dry seasons
- Unpredictable rainfall and high drought risk
- Surface water sources prone to drying and pollution
- Seasonal flooding
- Very limited numbers of boreholes and wells

- Large numbers of livestock dependent on boreholes when surface sources and wells dry up
- Damage to water sources by livestock
- Crop irrigation increasingly practised in absence of water resource monitoring or allocation process
- Limited assistance provided by local authorities.

These threats may manifest themselves in the following ways:

- Long queues at boreholes
- Queue-jumping leading to conflict at boreholes and wells
- Arguments over who can use boreholes or wells
- Individuals taking more than a fair share of water leading to conflict at boreholes
- Heavy mechanical stress on pumps leading to failure
- Heavy use by animals leading to damage to infrastructure and pollution around boreholes
- Drought
- Water shortages
- Food insecurity.

Once the main threats to community water security have been identified, work can begin to monitor water resources, which will indicate the likelihood that threats will occur and give an idea of their potential magnitude. Water resource monitoring essentially acts as an early warning system.

Stage 3: Initiation of water resource monitoring

This section sets out how to initiate water resource monitoring at community level. Monitoring of rainfall, groundwater levels, surface flows, water abstraction, and water quality is important because it provides an indication of emerging threats to water resources. It helps to identify what might be driving water insecurity and can help to identify long-term trends. Without ongoing monitoring of these parameters, it is not possible to understand if water shortages or contamination will become a reality or associated problems will arise.

At least two volunteers (referred to as ‘lecteurs’) should be trained to carry out water resource monitoring in each community. These two volunteers should have a basic level of literacy. They should be nominated by the community and be provided with templates for recording water resource data.

Box 3: Principles for water resource monitoring

The following general principles should be implemented to ensure the best results:

- Water resources should be monitored jointly by all stakeholders – village communities and municipalities.
- Management and data collection, analysis and distribution should be done directly by the community, with continuous support from local government.
- Women should be involved in collecting data on rainwater and groundwater, and analysing the changes over time.
- The process of monitoring water levels must be hygienic and probes should be cleaned before being lowered into wells.
- A water warning level should be set in boreholes and surface sources. If water falls below this level, contingency plans for water shortages should come into action.
- Collected data should be shared with communities and local/national authorities. Data sharing and action planning is the role of the local water user group.
- Data should be standardised so comparisons can be drawn with other locations and embedded in monitoring networks and national early warning systems.
- Trends should be displayed, for example on the face of a building close to the water point.

3.1. Rainfall monitoring

Rainfall monitoring gives an indication of the amount of water available for rain-fed crop watering and groundwater recharge. Monitoring of rainfall year-to-year highlights long-term trends or degrees of variability with implications for water availability. When low annual rainfall events are observed, contingency measures agreed by the community can begin to mitigate possible water shortages. This section describes how to initiate rainfall monitoring. It is useful to involve national meteorological authorities in the establishment of the process.

Manual rain gauges with a minimum capacity of 100mm should be procured and installed near the dwellings of the volunteer lecteurs in line with national standards. Lecteurs should record rainfall at the same time every day (ideally at 09:00 hours). This reading should be considered to be the rainfall from the previous day.

Image 5: A lecteur demonstrating installation of a rain gauge, supported by a member of the meteorology centre, 2015 .

Image 6: A rain gauge, 2015.

Image 7: Example of a rainfall record sheet, 2015.

Image 8: A rainfall graph in Basbedo village in Burkina Faso, 2015.

Rain gauges should be placed away from trees and tall buildings – at a distance of at least twice the height of the tree or building, and, if possible, four times the height. For example, if a tree is 5m high, the gauge should be placed at least 10m, but preferably 20m, from this tree. They should not be positioned in open or exposed places, such as rooftops or open plains, because of turbulence that may reduce the accuracy of reading. They should be situated away from roads or paths to reduce the risk of people touching them.

Once rainfall has been collected (see Tool 8), the community can plot it (with assistance) onto paper showing monthly totals throughout the year (image 8). This could be done at a local school where a teacher may be able to help.

3.2. Groundwater monitoring

Groundwater is an important water source, because it may be available when surface sources run low or dry up. It can be developed locally, close to the area where it is needed. It is important to understand groundwater availability, as there is such a high dependence upon it. This is achieved through groundwater level monitoring, and which this section explains how to do.

As outlined in Tool 9, a selection of tools can be used for water level monitoring. The most appropriate tool for lecteurs is a manual dipper attached to a piece of graded string. Submersible water-level loggers can be installed in boreholes, but local government or a supporting technical institution will need to check these every three months. Their use is not advised unless there are individuals with sufficient expertise to use them. Their cost is high and it is not economical to install them in all locations. They do, however, provide a useful means of understanding water levels in boreholes without repeatedly opening them. An electronic dip meter is also useful, but expensive and not economical to use in one community. Hydrogeologists Without Borders are trying to develop a lower-cost alternative dipper. It is essential that the technical unit has an electronic dip meter, as it is required for the calibration of level loggers, if they are used.

- Manual dippers are used by community lecteurs.
- Level loggers are installed by the technical unit who train local government in their use. Their use is optional depending on the capacities of local government.
- Electronic dip meters are used by the technical unit and local government to calibrate loggers and verify manual readings during lecteurs' training.

Volunteers or lecteurs nominated to record groundwater level readings should record water levels at least once per week in a selection of open wells, ideally early in the morning before water has been drawn (Tool 10).

Image 9: A lecteur explaining the variation of groundwater levels in Burkina Faso, 2015

Image 10: A lecteur explaining the water cycle, 2015.

Installation of level loggers requires that the pedestal of India Mark II handpumps be modified. A local metal worker cuts a hole measuring 6cm by 12cm is cut in the pedestal. A metal hatch is shaped to bolt over the hole, with a bolt on the top and bottom of the hatch. The inside of the hatch should feature a metal loop to hang the logger from (see photos).

A datum should be set at each well and borehole. This can be an agreed place at the top of each well or the bottom lip of the measuring hatch in a pump pedestal. All groundwater measurements should be read against this datum.

Image 11: Local lecteurs demonstrating a measure of the water level in a well with a whistle device, 2015.

Image 12: Example of groundwater measuring sheet used by lecteurs, 2015.

Image 13: Groundwater level graph drawn by lecteurs, 2015.

3.3. Surface water monitoring

Water flow is measured to assess how much surface water is available and to check the quantity of water flowing through systems. Ideally, water flow measurement should be carried out when the flow is at its lowest – usually at the end of the dry season – to assess whether the source is able to provide sufficient water all year round.

Different sources of water require different methods of flow measurement. Tools made with local materials can be set up to measure the level of surface water in a tank, lake or wadi. A V-notch weir can be made to assess spring water flows. All monitoring techniques are chosen according to how appropriate they are in the local context.

3.4. Water quality monitoring

Training community members to carry out water quality testing can help raise awareness of the importance of protecting local water sources and the benefits of this to food safety and health.

Communities can assess water quality on the basis of its appearance, taste and odour. Local government, with assistance from WaterAid, should measure microbiological contamination, conductivity, turbidity, pH, levels of iron and nitrate, and any other parameter deemed to be a risk. This should be done at least twice a year (during wet and dry seasons) and when changes to water or land use occur.

Local governments and NGOs can use rapid assessment kits, such as the WAGTECH Potatest, the Portable Microbiology Laboratory (PML) or The Aquagenx Compartment Bag Test for testing microbiological water quality in the field (these are described in more detail in Tool 12).

Image 14: Water quality analysis with the Portable Microbiology Laboratory in Uganda, 2015.

Stage 4: Developing operating principles governing how water is managed for better water security

This section describes how information about threats to water resources, coupled with the results of monitoring, is used to develop rules that the community implements, sometimes with assistance from local authorities, to improve water security.

4.1. Visual presentation of water-related threats to the community

The findings from the mapping, threat assessment, household survey and water resource monitoring should be presented to the whole community, at a community meeting. Community monitors and leaders should help explain the trends and impact on access to water for multiple use services (MUS).

4.2. Prioritisation and analysis of water resources issues

During the village assembly, community monitors and leaders should aim to facilitate a discussion with the community to determine the main priorities, decisions and actions they can take to improve water management and the better allocation of water.

4.3. Identifying solutions to priority threats with the community and agreeing an action plan

For every identified threat, encourage the community to:

- Identify solutions for the short-, medium- and long-term
- Choose the means of preventing and/or managing different threats
- Distinguish between operating principles and improvements required for MUS
- Identify who will implement operating principles within the community
- Identify what assistance is required from external authorities
- Identify what finances will be required to implement prevention and management options.

Operating principles developed by communities to better manage threats to water security could include:

- Agreeing water allocations for different water users
- Agreeing times when different users can and can't access different water sources. A water warning level should be set in boreholes and wells. If water falls below this level, contingency plans for water shortages should come into action.
- Rationing water when it is known to be in short supply, for example during droughts
- Temporarily restricting certain water uses (e.g. brick-making) when water is known to be in short supply
- Enforcing protection of water source catchments to protect water quality and quantity.

Stage 5: Agreeing improvements to WASH services for better water security

In addition to developing operating principles governing how water resources are managed, it is necessary to improve service levels for better water security. This could involve the introduction of new services and the rehabilitation of existing services that have fallen out of use. Specific actions to improve services could include:

- Designing services for multiple uses
- Deepening or constructing new hand-dug wells
- Constructing new boreholes
- Investing in rainwater harvesting
- Constructing small dams to enhance surface water availability, encourage infiltration and boost soil water and groundwater
- Bringing about total sanitation to eliminate faecal contamination
- Improving hygiene practices

Appendix

Tool 1: Questions to gather detailed information about the need for improvements to water security

Village: _____ Date: _____

		Yes	No
1. Does your community want support to improve the way water is managed?			
2. Do you feel that water shortages could put livelihoods (e.g. agriculture or livestock) in your community at risk?			
3. Do most of your community depend on water for their livelihoods?			
4. Does your community feel a sense of ownership over water resources? What makes you think this?			
5. Does anyone monitor water resources within your community?			
6. Do you think your community feel that change will be possible as a result of this work?			
7. Has there already been collective action of any sort within your community? If yes, discuss examples.			
8. Is there a water user committee? What is its role?			

Surveys returning a high number of 'yes' answers indicate an increased likelihood that support to improve water security will add value.

Tool 2: Questions to ask when developing a historical timeline of water-related events, threats and vulnerabilities

Village: _____ **Date**: _____

1. How has your water supply changed over time?	
2. In which years was water less available? What was the impact (positive or negative) on the community at large, on women, on livelihoods and patterns of subsistence, and on health?	
3. In which years was water more available? What was the impact (positive or negative) on the community at large, on women, on livelihoods and patterns of subsistence, and on health?	
4. What methods did you develop to deal with water issues during these times and what support did you receive? From who?	
5. When was WASH infrastructure installed or upgraded?	

Tool 3: Sanitary survey

Village: _____ Date: _____

Type of facility:	**Facility location:**		
General information:			
Water authority/community organisation responsible:			
Water sample taken? Yes/no	Sample number:		
Questions	Comments	Answers	
		Yes	No
1. Is there a latrine within 30m of the facility?			
2. Is the nearest latrine on higher ground than the facility?			
3. Is there any other source of pollution (e.g. animal excreta or rubbish) within 30m of the facility?			
4. Is the drainage poor, causing stagnant water within 2m of the well?			
5. Is there a drainage channel? Is it broken, permitting ponding?			
6. Is the wall around the well inadequate/allowing surface water to enter the well?			
7. Is the concrete floor less than 1m wide around the well?			
8. Are the walls (parapet) of the well inadequately sealed at any point for 3m below ground?			
9. Are there any cracks in the concrete floor around the well which could permit water to enter the well?			

10. Are the rope and bucket left in such a position that they may become contaminated?			
11. Does the installation require fencing?			

Tool 4: 'Water user, water usage' survey

Village: _____ Date: _____

Total number of people in respondent's household:_____			**Total number and type of animal the household is responsible for:_____**		
3. **What kind of water points do you use? (Please circle answer)** **Unimproved water source** **Community tapstand connected to pipe system** **Community borehole** **Private borehole** **Rainwater harvesting tanks Other (please specify):**			4. **How long does it take for you to reach your water points? _____** 5. **How long do you spend at the water point to fill your containers? (Please circle answer)** Up to one hour One to four hours Four to eight hours Other (specify) _____		
6.**Type and number of containers used daily**					
	Barrel (1) 	Can (2) 	Jar (3) 	Bottle (4) 	Other (5)
Container volume					
Number					
Uses					
Domestic uses (e.g. drinking, cooking or washing)					
Construction					
Cattle watering					
Irrigation					

Water selling					
Others (detail)					
Water collection frequency by day (work this out for both dry and wet seasons): Less than an hour: Up to four hours: Four to 12 hours: More than a day: Other (specify):			When do you collect water during the day? (tally both dry and wet seasons) Morning: Afternoon: Early evening: Late evening: At night: Other (specify):		

Tool 5: 'Water-source-based water usage' survey

Village: _____ **Date:** _____

Type of facility:			**Facility location:**		
General information:					
Water authority/community organisation responsible:					
No	Time of sample	Type of container	Number of containers	Type of use	Observations
1					
2					
3					
4					

Tool 6: Identification of existing coping strategies

Village: _____ Date: _____

1. What do you think are the risks to your water supply or infrastructure?	
2. What can you do to mitigate these risks?	
3. How are decisions made about water usage in the community?	
4. What rules do you have governing water use in your community, and how do they address both water quality and quantity aspects?	
5. How were these rules made and who made them?	
6. Are there certain times of day that people can collect water?	
7. Do people pay for the amount of water they use? What is the unit price?	
8. What is the penalty if someone does not pay? Who keeps the money?	
9. Who decides how the money will be spent? What are some examples of the use of water fees?	
10. What happens if people from outside the community want to use the water? (i.e. pastoralists travelling with their animals).	
11. How are any disputes about water use or access resolved?	

12. What do you do if there is a water shortage in the village? How do farmers water their cattle and crops?	
13. Do any of these crop or animal watering activities have any negative impacts on the water source or water resources?	
14. What other actions could be taken to address the water shortage?	
15. What do you think is the role of the water management committee in managing water?	
16. What do you think is the role of the local government in relation to managing water?	
17. How do local government and external agencies coordinate with you as a community in relation to water development and management?	
18. How can water usage rules be enforced without creating conflict?	
19. If a water shortage is identified, at what point would you alert leaders or government authorities that the situation is very serious and action needs to be taken? (e.g. financial/technical support to deepen wells or repair of hand-pumps)	

20. What is the structure of the water user committee in your community?	
21. What does this committee do?	
22. What are the rules for collecting the water in your community? (e.g. only two jerry cans can be filled at the same time, people have priority over animals, shoes must be removed, etc.)	
23. What is the price of water for households? Are there price differences between types of household? (e.g. for older people or widows) What is the frequency of payment for water? Who is responsible for payment? To whom is payment made?	
24. What is the price of water for people engaged in subsistence activities? (e.g. pastors, farmers, brick-makers, etc.) What is the frequency of payment for water? Who is responsible for payment? To whom is payment made?	
25. Are the payments put into a bank account or is the cash stored in the community?	
26. Who decides the price of water? What is the money gathered spent on?	

27. How do you repair or maintain your water points? How often do you do this? Who performs the repairs? How do you pay for them? Do you receive government assistance for repairs/maintenance?	
28. Are there households or groups in the community who have limited access to water? Why?	
29. Are there times of year when water is less available in your community? (e.g. in the dry season or due to defective hand pumps) What have you done (or planned to do) to improve the situation?	
30. Does someone carry out monitoring of water levels in wells? If yes, who does it and how? If no, do you think that information about water levels would be useful to your community? How do you think monitoring could be carried out?	
31. Does anyone carry out rainfall monitoring? If yes, who does it and how? If no, do you think that information about rainfall would be useful to your community? How do you think monitoring could be carried out?	
32. Are there conflicts over water points in the community? Who is involved? Why are there conflicts? How are they solved?	
33. What ideas do you propose to improve the availability of water in your community?	
34. Do you have other ideas or suggestions concerning the management of water in your community?	

Tool 7: Understanding the level of external support provided by local authorities

Village: _____ Date: _____

District name: _____	**Name and position of interviewee: _____ Interviewer: _____**
Questions	**Comments**
1. According to national policy, what is the role of this authority in providing support to communities to establish WASH services?	
2. Does your authority have a budget for initiation of new WASH services? How many boreholes and wells do you construct per year?	
3. According to national policy, who is responsible for managing WASH services?	
4. Does your authority provide any support to communities to manage, finance and repair WASH services? Do you have a budget for this ongoing support? How much is it per year and what does it enable you to do? What percentage of the overall budget for WASH is allocated to ongoing support?	
5. Does your authority provide any assistance to communities when there is a water shortage or drought? If yes, how?	
6. Do you get involved in resolving disputes between community members or communities over water use? What kind of disputes arise and how do you go about resolving them?	

7. Do you receive any revenue from communities for the use of water? If not, does any other authority receive revenues for use of water?	
8. 9. If a community needs your support to improve WASH services, manage	
9. WASH services, help cope with a water shortage or resolve a water-related dispute, what is the process for them to call for assistance and how long does it take for your authority to respond?	
10. 10. Are there any processes in place for ongoing monitoring of water resources in the district? Is there any data available? Are communities informed about any ongoing groundwater-level trends?	
11. 11. Are there any weather stations in the district and is any rainfall data available? Are communities informed about ongoing rainfall trends?	

Tool 8: Rainfall record sheet

Village: _____

Name of person in charge of monitoring:				**Month:**	
Reading number	Day	Date	Time	Amount of precipitation (mm)	Comments (optional)
1	Monday				
2	Tuesday				
3	Wednesday				
4	Thursday				
5	Friday				
6	Saturday				
7	Sunday				
8	Monday				
9	Tuesday				
10	Wednesday				
11	Thursday				
12	Friday				
13	Saturday				
14	Sunday				
15	Monday				
16	Tuesday				
17	Wednesday				
18	Thursday				
19	Friday				
20	Saturday				
21	Sunday				
22	Monday				
23	Tuesday				
24	Wednesday				
25	Thursday				
26	Friday				
27	Saturday				
28	Sunday				
29	Monday				
30	Tuesday				

Tool 9: Recommended devices to monitor groundwater

Device	About	Advantages	Disadvantages
Manual dippers	To manually monitor **groundwater levels, the whistle-based dipper is recommended.** This is a simple tube attached to a knotted rope, which produces a sound when it hits the water in a borehole. If the knots are at 1m intervals, the number of knots on the rope when the dipper hits the water can be counted to give an approximate depth between the measure point and the groundwater.	It is low cost, people need minimal training, it is a solid device and can easily be made locally, and can be used by the community without any external support.	It is sometimes difficult to hear the dipper when it touches the water. This technique is also not 100% accurate because the approximate estimation is done through the knotted rope.
Electronic dip meter 	When the probe in the electronic dip meter touches the surface of the water, a light is illuminated on the cable winder and a buzzer gives an audio signal.	It can give a precise reading of depth.	Dip meters can be very expensive. Cheaper options are being developed.

Submersible level loggers 	Submersible level loggers can be hung inside a borehole, below the water surface, and can be programmed to measure water levels at desired time intervals. They can measure static water level trends as well as peak demand and longer-term water recharge patterns. Rugged TROLL 100 loggers produced by In-Situ have been used successfully.	They can be left in situ for several months and data can be downloaded remotely to a laptop.	These devices are expensive and are not appropriate for use as part of routine community based monitoring due the complexity of their operation. They are useful where local government has the high capacity required to calibrate and use them.

Tool 10: Groundwater level record

Village: _____

Name of person in charge of monitoring:				**Month:**	
Reading number	Day	Date	Time	Groundwater level (m below surface)	Comments (optional)
1	Monday				
2	Tuesday				
3	Wednesday				
4	Thursday				
5	Friday				
6	Saturday				
7	Sunday				
8	Monday				
9	Tuesday				
10	Wednesday				
11	Thursday				
12	Friday				
13	Saturday				
14	Sunday				
15	Monday				

16	Tuesday				
17	Wednesday				
18	Thursday				
19	Friday				
20	Saturday				
21	Sunday				
22	Monday				
23	Tuesday				
24	Wednesday				
25	Thursday				
26	Friday				
27	Saturday				
28	Sunday				
29	Monday				
30	Tuesday				

Tool 11: Operating instructions for Rugged TROLL devices

Use of loggers is optional and not critical to the success of a monitoring programme. Use of loggers is only advised where it is felt that there are sufficient capacities within local government institutions to calibrate and download data from them. They are not considered to be a 'sustainable' technology that will continue to function without expert support in low-capacity environments.

Stage 1: Getting started

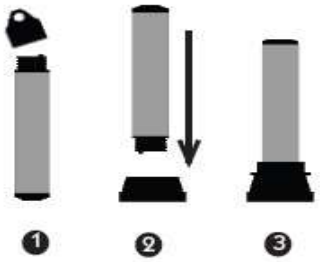
You will need:

- Rugged TROLL 100 or 200 instrument
- USB or RS232 docking station or Rugged TROLL Com (for Rugged TROLL 200 and Rugged BaroTROLL). RS232 model needed for connection to a RuggedReader device.
- In-Situ software/resource CD or internet connection
- Desktop/laptop PC

A. Install software from the In-Situ Softwater CD or www.in-situ.com → Win-Situ 5 software (version 5.6.16.0 or higher) is needed. → Click the Win-Situ 5 link and follow the instructions.

B. Connect to the Rugged TROLL docking station (Rugged TROLL 100 or 200)

→ Unscrew and remove the hanger from the Rugged TROLL instrument. → Invert the instrument. Align the notch on the Rugged TROLL body with the tab on the rim of the docking station to ensure the pins are in contact for communication.



NOTE: The hanger is the only removable part of the Rugged TROLL instrument. Do not attempt to take the instrument apart. There are no user-serviceable parts in the instrument.

→ Place the Rugged TROLL into the docking station.
→ Connect the docking station cable to the computer, following the steps below.

Stage 2: Programming the device

A. Open the software

→ Start Win-Situ by double-clicking the desktop shortcut.  Win-Situ opens at the Data tab, shown in figure 1.

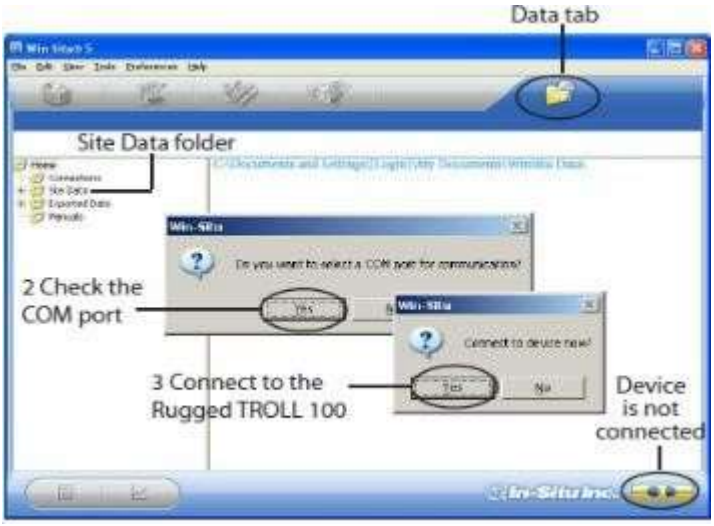


Figure 1: Win-Situ Data tab on first connection.

→ When you use the software for the first time, you may be asked to select a COM port. Do one of the following:

i. Answer yes to the prompt, then check or change the port in Preferences > Comm Setting dialog, and click OK  to close it.
ii. Answer no to bypass this step.

NOTE: The Win-Situ default is COM 1. For USB communication, be sure to select the correct VOM port.

Which USB port am I using?

When a USB docking station is connected, the drivers that were downloaded with Win-Situ 5 are installed. After installation, check which COM port the connected USB docking station is using:

Windows 2000, Windows XP: Control Panel > System > Hardware tab > Device Manager > Ports. Click the plus sign to display the ports.

Windows Vista: Control Panel > System > Device Manager (user permission required) > Ports. Click the plus sign to display the ports.

Windows 7: Control Panel > System > Device Manager > Ports. Click the arrow to display the ports.

Remember the USB Serial Port COM number. You will need it to connect to the instrument with Win-Situ Software.

→ Win-Situ asks if you want to connect to the device. If the Rugged TROLL is connected to your computer as is shown above, answer yes.
→ The software will connect and display a reading of all supported parameters in the Home tab (see figure 2).

B. Set the clock

-> Data collection schedules depend on the device clock, shown with the system (PC) clock near the top of the screen when connected (figure 2). → If the device clock is red, synchronise it to the system clock by clicking the Clock Sync button (figure 2).

Figure 2: Home tab with device readings

C. Create a site

i. When creating a site, choose a clear name for your site and type it into the 'Name' field.
ii. GPS coordinates are optional, so add these if you have them.
iii. You can import a photo of the site (if you have one) from your C:// drive.
iv. Ignore the 'selected connections' option. v. Click 'save'.

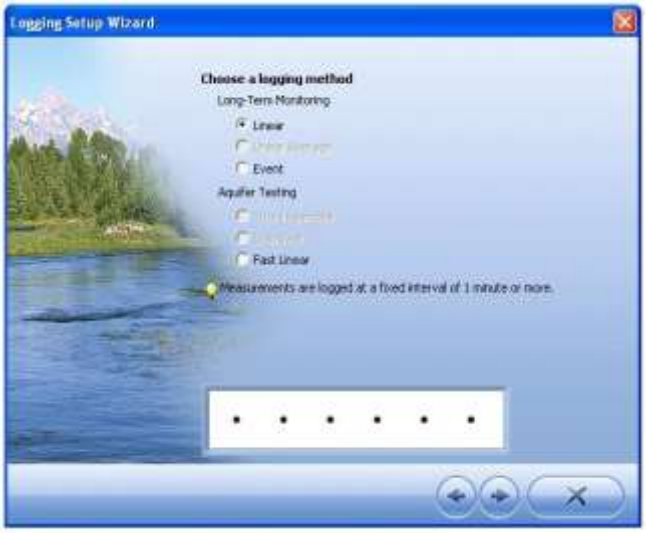
➔ When configuring a logger, the user must be on site so that site-specific parameters, such as current depth to groundwater (mbgl), can be recorded in the configuration process. It is useful to obtain details about the depth of the well/borehole, depth that the cylinder is hung at and static water level at time of construction from borehole logs in advance of visiting the site.

D. Setting up a data log

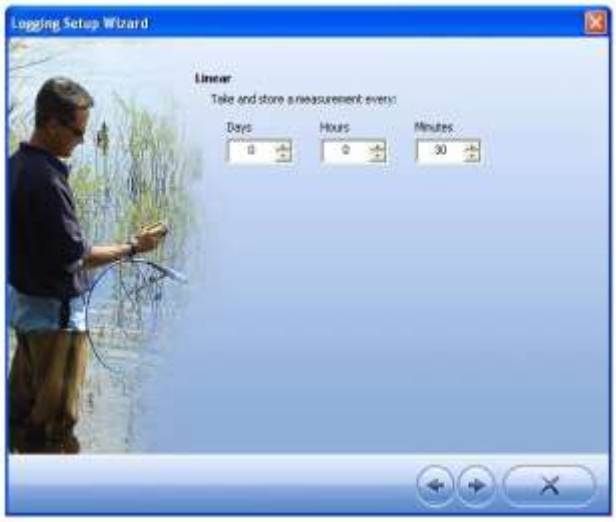
i. Enter a clear name for your new data log.

ii. In the 'select parameters and units to log' screen, choose to log 'Pressure' in 'mBar', 'Temperature' in 'C' and 'Depth' in 'm'.

iii. In the next screen titled ‘choose logging method’, under ‘long term monitoring’ select the ‘linear’ option.

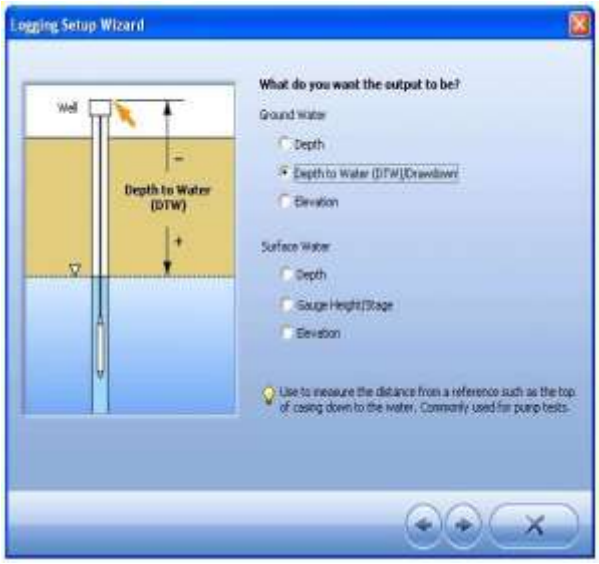


iv. On the next screen, configure the logger to take a reading every 30 minutes, so that the measurement setting becomes ‘Days = 0’, ‘Hours = 0’, ‘Minutes = 30’.



v. The log must start when the logger is submersed below the water level (2m below the pump cylinder). It is therefore necessary to select a 'Scheduled Start'. Set the scheduled start time to 1 hour before you plan to take the first reading with the logger fully installed. This gives you 1 hour to configure and hang the logger 2m below the pump cylinder before the first reading is taken.
vi. Select 'None' under the 'stop condition' option.
vii. Do not tick the box under the 'wrap condition' option.

viii. In the following screen under 'What do you want the output to be?' select the 'Depth to Water (DTW)/Drawdown' option under 'groundwater'. Do not select anything under 'surface water'.



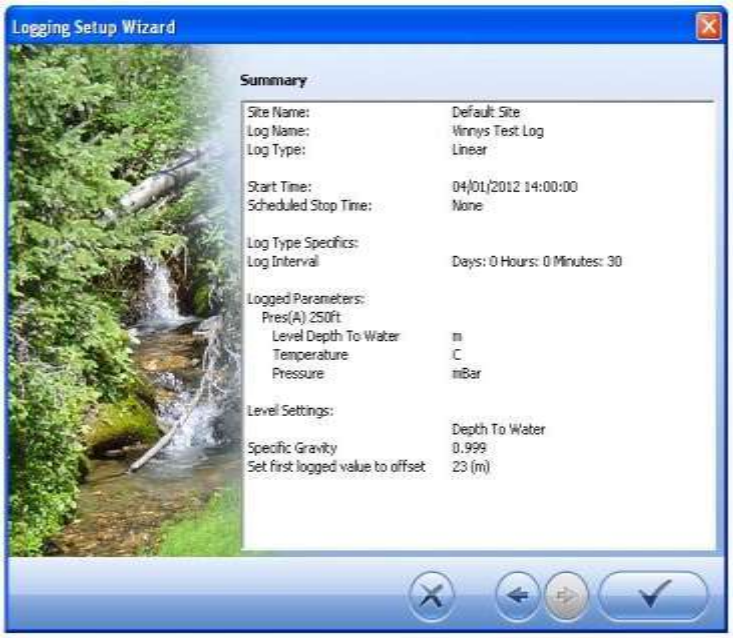
ix. At this point it is necessary to take a water-level reading from within the well or borehole using an electronic dip meter. Please ensure that the water level has stabilised after any previous pumping in the well. Do this by taking repeated readings until the water level is seen to stabilise. Record the water-level reading.

x. In the next screen of the configuration wizard, choose the 'Set logged reading to:' option and enter the water level you have recorded. The logger will measure any fluctuation above and below this level in the well/borehole.

xi. In the next screen, choose the 'fresh water' specific gravity value.

xii. In the next screen, check the configuration information you have entered is correct.

xiii. You can now connect the logger to the suspension cord or cable and hang it in the well/borehole. Loggers can be suspended from a loop welded on the monitoring hatch on the handpump. xiv. It is essential to ensure that the logger does not start taking readings before it is submerged. This will yield erroneous data.



WARNING

Tighten the backshell hanger only until it is hand-tight.

DO NOT use tools to secure the backshell hanger to the instrument. Over-tightening will damage the instrument.

E. Setting up a data log

→ Retrieve the Rugged TROLL 100 by pulling up the suspension cable. Dry the instrument and remove the hanger. Place the Rugged TROLL 100 in the docking station (see page 1) and establish a software connection.

→ Click the Logging tab  and then the log. This symbol  shows the log is running. If the log stopped on schedule, the symbol is 

> **TIP:** It is not necessary to stop the log before downloading, but if you want the device to stop logging, press 'Stop' 

→ To download, press the 'Download' button  and select a download option. The log will be copied to the PC or RuggedReader device.

> **TIP:** Use Win-Situ Sync to transfer downloaded logs from a RuggedReader to a desktop or laptop PC running Win-Situ. This will ensure that the logs are placed in the Win-Situ working directory.

F. Correcting for atmospheric pressure

Atmospheric pressure changes can exert an influence on water-level readings captured by level loggers. In low latitudes, fluctuations in atmospheric pressure are relatively low compared to those in high latitude countries, such as the UK, for example, where fluctuations in atmospheric pressure can range between 950 and 1050 mBar. In low latitude countries, differences in atmospheric pressure are generally observed across broad regions rather than locally. Use of BaroLoggers to perform data corrections for atmospheric pressure is therefore not essential in low latitude countries as part of this project; it is an optional extra. Where it is carried out, using one BaroLogger to record atmospheric pressure per country is sufficient. This can be kept in a safe, dry place in a partner office or the country programme office.

Image 16: Water-level data from a level logger being downloaded to a laptop in the field.

Tool 12: Recommended water quality monitoring kits

Device	About	Advantages
Portable Microbiology Lab (PML)  Individual components of the PML testing kit. 2007. SCInet.	The Portable Microbiology Lab (PML) is designed with portability and ease of use in mind. It contains tests for E. Coli. Each PML includes 25 water tests with sterile plastic pipettes, collecting bags and a portable UV light, all of which are carried in a resealable bag. According to World Health Organisation guidelines, if there are 1-10 E. Coli cells per millilitre of water, there is a high risk of disease. With more than 10 cells per millilitre, the risk is very high. The kits cost about US$80 each.	The testing procedure is relatively straightforward and can be carried out by anyone.

WAGTEC Potatest  The WAGTECT potatest kit. 2016. Palintest.	The WAGTEC Potatest is a lightweight microbiological test kit offering low-cost, rapid response testing of basic water quality parameters. It includes a removable water safety kit with instruments and visual test equipment to determine whether a full microbiological verification is required. It allows rapid field microbiological analysis – using membrane filtration protocols for the screening of faecal and/or total coliforms. Each kit costs around US$1800.	The Potatest is a very comprehensive kit, including parts sufficient for processing and analysing 200 samples.
The Aquagenx Compartment Bag Test (CBT)  The CBI I kit. 2016. Aquagenx.	The CBT is a simple, portable water quality test that lets anyone anywhere determine if drinking water contains E. coli bacteria and poses a health risk. It quantifies the Most Probable Number (MPN) of E. Coli bacteria in a 100ml water sample. WaterAid has used the test in several locations.	The CBT is portable, simple to use, convenient (it works at variable temperatures), flexible (no electricity, laboratories, extra equipment or specialised technicians required) and informative.

mWater Test Kits  The mWater test kit. 2016. mWater.	Each mWater kit includes a bag, a test plate, a pipette and test strips, and can be used to perform 20 tests. The 'drinking water kit model' costs US$180. This tests for E.coli, nitrate/nitrite and free chlorine residual and can be used for tap water, shallow wells, springs, tube wells, boreholes, etc. The 'surface water kit model' costs US$70. This tests for E.coli and nitrate/nitrite, and can be used for environmental monitoring, citizen science programmes, bathing or wash water. The kits can also be integrated with the mWater Apps to add water quality data using any smartphone or computer.	Designed for community health workers, it is easy to use. No prior water quality experience is required and people can be trained in less than a day. No laboratory or equipment is needed – each kit contains everything you need. All items are single-use and pre-sterilised, and if room temperature is between 27 and 40 degrees Celsius, no incubator is needed.