Developing a Water & Sanitation Safety Plan in a rural community

How to accomplish a Water and Sanitation Safety Plan

COMPENDIUM PART A

3rd revised edition

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Dr. Christiane Rohleder

Foreword from Germany

Environmental policy contributes to social progress

Providing safe drinking water and sanitation is the basis for a dignified life and public health. A well-functioning, modern public water supply and a connected wastewater system are key public service tasks and a prerequisite for good living conditions and securing livelihoods. Therefore, water and sanitation are major tasks for the environmental policy agenda worldwide.

We want to achieve good water quality for all. The EU focuses on strengthening local actors and active public participation through competent authorities. Safe water supplies and sanitation systems need the active involvement of local actors: environmental organisations and other interest groups as well as every single citizen.

This "Water & Sanitation Safety Plan" (in short WSSP compendium), which is in its third edition, provides an excellent basis for all stakeholders to raise awareness on the nexus of water, sanitation, environment and health. It also gives advice to jointly improve local hygienic conditions and to support the water protection policies.

The funding program "Export Initiative Environmental Protection" of the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) supports Women Engage for a Common Future WECF e.V. and its project partners in the Balkan region because their engagement proofs on how Environmental policy can contribute to social progress.

The compendium is regularly presented to an international audience - including at Stockholm World Water Week or the UNECE Regional Forum on Sustainable Development in Geneva - and has already been applied by various stakeholders.

I would like to express my greatest gratitude to WECF and its partners for the commitment and support. The compendium is therefore also an outstanding example of successful cross-regional and cross-national collaboration. I wish that many people in as many locations as possible will get access to and work with this WSSP compendium. Of particular importance is the fact that children and youth, especially women and girls, are being involved so that they learn in practice how to make a difference through their engagement and change the world for the better.

Dr. Christiane Rohleder
Staatssekretärin im Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz

Foreword from the Republic of North Macedonia

Prof. Mihail Kochubovski

In the pan-European region* some 200 million people rely on small-scale water supplies (SSWS), mainly in rural and remote areas. In the European Union water supplies serve up to 5000 people or those that have a daily production of up to 1000 m^3 are generally considered as SSWS. Other countries may consider public non-piped or individual supplies as SSWS.

In many countries the quality of small-scale water supplies and sanitation systems are a matter of concern. In the EU the level of non-compliance for microbiological parameters of drinking water is estimated to be 40% for SSWS. Every day, over 700 children under five years old die from diarrhoea linked to unsafe water, sanitation and poor hygiene. 2.3 billion people – lack basic handwashing facilities at home.

Public health, safe water supply and safe sanitation are very much interrelated and are neglected or have their relevance underestimated, particularly in rural communities. Better protection and management of drinking water sources and sanitation facilities are possible, if weaknesses and strengths are identified. For the identification of possible sources of hazards and risks, the knowledge about adequate quality of water and sanitation, the pathways of contamination and the associated risks, as well as the prevention of risks are essential.

A water and sanitation safety plan (WSSP) can be one way to obtain and maintain safe drinking water and sanitation systems and to minimise related diseases. The approach of Water Safety Plans was laid out by the World Health Organisation (WHO) in the WHO Guidelines for Drinking Water Quality. The approach of risk assessment and risk management of water (and sanitation) systems are internationally recognised principles on which the production, distribution, monitoring and analysis of parameters in drinking water is based. This approach was adopted in the revised and entered in force 2021 EU Directive on the quality of water intended for human consumption (2020/2184).

The provision of safe and sufficient water and adequate sanitation and hygiene is key to protecting human health during the infectious disease outbreaks, such as COVID-19. Frequent handwashing according to appropriate hygiene standards require a continuous supply of safe water and sanitation systems that are operational. Recent developments in the environmental surveillance of SARS-CoV-2 in wastewater, encouraged countries to make use of the WHO guidance in improving the work in this area.

The presented Compendium aims to enable communities to develop a WSSP for small-scale water supplies, e.g. dug wells, boreholes, springs and piped centralised water supply systems, as well as to assess the quality of sanitation facilities such as school toilets. It gives guidance and background information for managing and planning safe drinking water and sanitation.

The management of a safe drinking water supplies and sanitation systems, concerns many stakeholders, such as public health institutions, water operators, local authorities, schools, citizens and non-governmental organisations. More activities with education stakeholders who have expertise on existing and planned inclusion of environmental issues in primary and secondary education is introduced.

I hope, that water operators, local authorities, and schools will largely use this compendium as a practical tool to improve the public health situation in the pan-European Region!

Professor Mihail Kochubovski

*Pan-European Region includes Eastern Europe, Caucasus and Central Asia (EECCA), South Eastern Europe (SEE), as well as Western and Central Europe (WCE).
Literature: https://unesdoc.unesco.org/ark:/48223/pf0000377362

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This compendium is the result of the work of many contributors from the pan-European Region who have become enthusiastic about the WSSP approach. Initiator was WECF senior water professional Margriet Samwel who understood the rich potential of WSSP which had been developed by WHO. During the last 15 years, WECF has been working with their local partners on improving water and sanitation in small communities. In this frame, the compendium has been consistently further developed adopting the WSSP approach to the local needs in the pan-European Region.

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HOW TO ACCOMPLISH A WATER AND SANITATION SAFETY PLAN

A

A1

INTRODUCING WATER AND SANITATION SAFETY PLANS

Authors: Margriet Samwel, Doris Möller

SUMMARY The World Health Organisation (WHO) initiated Water Safety Plans (WSP), which are considered being part of the WHO drinking water guidelines and EU directives on water intended for human consumption. The WSP addresses the identification of risks, which could affect water safety and human health in every stage of the water supply. The approach of implementing WSP for water supplies serving small communities has been expanded by integrating the sanitation system to a Water and Sanitation Safety Plan (WSSP), as sanitation is another important pillar of public health and closely linked to water. This module introduces the most important steps and basic elements for developing a community based WSSP.

OBJECTIVES In this module, the reader should gain knowledge and an understanding about the aim and the approaches of developing a WSSP.

KEY WORDS AND TERMS Small-scale water supplies, sanitation, hygiene, safety, risk assessment, control and eliminating hazards and risks, minimising health risks.

Background

In many rural areas, citizens depend for their drinking water on small-scale water supplies (SSWS). The definition of a small-scale water supply can vary from country to country. It is often based on the type of management and/or on the number of persons served and/or on the amount of the daily produced water. A small-scale water supply system can consist of non-piped decentralised (local) water system providing water via a dug well, borehole or a spring, or a centralised system serving the people via a public standpipe or in-house or in-yard connections. A SSWS can be public or individual managed. In some countries, the small-scale water supplies are defined as non-piped or decentralised or local supplies. In general, supplies producing daily up to 1000 m^3 or serving up to 5000 people are in the European Union considered as small-scale supplies. Sometimes the term very small-scale water supplies is used for supplies producing a daily volume up to 10 m^3 or serving up to 50 persons, individual wells or public springs or bore holes. According to the EC reporting methodology on drinking water quality, small water in supply zones (WSZs) are classified according to the volume of water supplied as CAT1 (10-100 m^3/day), CAT2 (100-400 m^3/day), and CAT3 (400-1,000 m^3/day). However due to several reasons, many of these small-scale water supplies have in common that the supplies are not adequately managed, hence the drinking water quality does not fulfil the requirements.

In rural communities, sanitation ranges from individual sanitation solutions to collective and centralised collection and treatment. The individual systems range from pit latrines, which is common in areas without centralised water supply, to flush toilets with wastewater discharged or infiltrated uncontrolled, with septic tanks or with individual treatment systems. The collective systems are provided with centralised or semi-centralised collection and treatment. Wastewater treatment and discharge or reuse is included in the sanitation system definition.

This WSSP compendium will target only small-scale systems and serves as guidance for a better management by implementing WSSP. Although the authors of this compendium aimed to present extended background information and guidance for implementing a WSSP, nevertheless the users are advised to look also at the provided further readings.

1. Water Safety Plan

"The most effective means of consistently ensuring the safety of a drinking-water supply is through the use of a comprehensive risk assessment and risk management approach that encompasses all steps in water supply from catchment to consumer. In these Guidelines, such approaches are called Water Safety Plans (WSPs)".
The words above open Chapter 4 of the 4th edition of the WHO Guidelines for Drinking-water Quality (2017) and capture the philosophy of the WSP approach. The chapter describes the principles of the WSP approach rather than being a guide to their practical application. This is why in 2009 the "Water Safety Plan Manual, Step by Step Risk Management for Drinking Water Suppliers" was published by the joint effort of WHO and International Water Association (IWA).

The consolidated text of the Directive 98/83/EC with its latest amendments included in the Directive 2015/1787/EU, has specifically introduced the risk assessment and risk management practice, which is actually the concept of the Water Safety Plans. The risk assessment referred in the Directive is based on the general principles of risk assessment set out in relation to international standard EN 15975-2 Security of drinking water supply, guidelines for risk and crisis management.

The new Directive 2020/2184/UE on the quality of water intended for human consumption makes the link between environmental legislation represented by Water Framework Directive 2000/60/EC, and the health requirements based on UNECE and WHO-Europe Protocol on Water and Health. The Directive 2020/2184/UE is asking for full implementation of the risk assessment and risk management for the entire drinking water supply system from the catchment to the consumer's tap, which means the principle of the Water Safety Plan (WSP), based on the WHO's Guidelines for Drinking Water Quality.

The risk-based approach should be applied by all water suppliers, including small water suppliers, as the evaluation of Directive 98/83/EC showed deficiencies in its implementation by those suppliers, which were sometimes due to the cost of performing unnecessary monitoring operations.

The new Drinking Water Directive states that the Member States may exempt water suppliers providing 10 to 100 m³ per day as an average or serving between 50 and 500 people, from the requirement to carry out risk assessment and risk management of the supply system. However, to do so, the competent authority must be satisfied that such an exemption would not compromise the quality of water intended for human consumption.

The WSP focuses on the safety of all the different aspects of a water supply, which can vary from a large-scale supply providing water to several million consumers, to a very small-scale system, e.g. a bucket-well.

The WSP is a concept to develop a process-orientated observation of the water supply, and its goal is to identify and eliminate all the possible risks of the entire water supply system: from the potential risks of water pollution in the catchment area to the end users, the consumers.

1.1. Water and Sanitation Safety Plan (WSSP)

The issue of sanitation (which also includes hygiene) is part of a WSP and cannot be left out, but is often neglected because of the focus on drinking water. In many rural areas, water related diseases are based on unsafe sanitation facilities, unsafe management of wastewater and health risks are increased, due to the lack of water for handwashing or cleaning the sanitary facility.

In this compendium, the assessment and planning of water, sanitation and hygiene safety are approached in an integrated manner. To emphasize those aspects are crucial for public health and therefore looked at jointly, we are talking in the following about Water and Sanitation Safety Plans (WSSP).

1.2. Basic elements for developing a WSSP

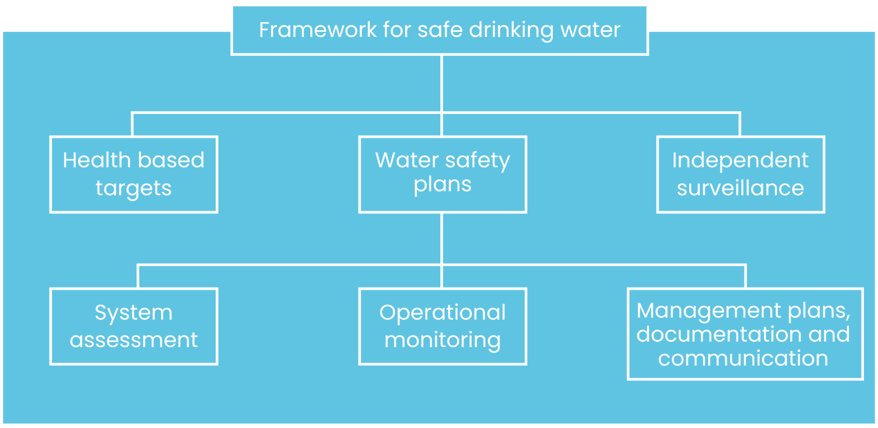
Identifying the weaknesses and strengths of the water supply, the possible sources and risks of drinking water contamination as well as the status of the sanitation system is the basis for a WSSP. Therefore, understanding the mechanisms of the water supply, of the sanitation system, identification of the existing and potential hazards and related diseases are important requirements for developing a WSSP for a certain system. As well as the possible risks pertaining to the individual processes involved in the water supply and standard of water quality, the causes for the potential and real risks have to be identified. Moreover, all stakeholders involved in water and sanitation as well as “this is” and “the should be” situation have to be defined. In addition, the means and tools on how to monitor and assess the different stations, how to report and share the information and activities for improvement of the supply have to be identified. A well-managed WSSP is a continuing process and will not stop after carrying out some improvements.

The steps to be undertaken for the development of a WSSP can be:

1. Setting up a team, discussing and deciding about the methodology, activities and tasks to develop a WSSP
2. Description of the water supply system: making a detailed description of the whole system from the water catchment area to the extraction, the water treatment, water storage, distribution and transport, until the consumers tap or storage place
3. Description of the sanitation system: mapping of the main areas in the municipality, type of sanitation systems implemented, collection and treatment, discharge and/or reuse of wastewater
4. Identifying stakeholders and responsibilities of the supply and sanitation systems.
5. Collecting available documentation and carrying out water analyses and interviews
6. Hazard assessment: Identification of the hazards that can affect the safety of the water quality: e.g., water pollution by untreated wastewater, agriculture, by leaking pipes, unsafe pit latrines, cracked wells or by dirty buckets or containers, etc.
7. Identification of local and regional water borne diseases and WASH related diseases (for example blue baby diseases or helminth parasite infections)
8. Identification of existing regulations, control measures, surveillance and programs for water and sanitation
9. Reporting and sharing information on the findings: organising exhibitions, meetings/discussions with citizens, authorities and mass media
10. Developing actions for improvement and maintenance of the system, improvements and follow-ups of the WSSP

Water Safety Plans are considered by the WHO as the most effective means of maintaining a safe supply of drinking water to the public. Comprehensive risk assessment and risk management analysis forms the backbone of these plans, which aim to steer management of drinking water-related health risks away from end-of-pipe monitoring and response. The principles and concepts of other risk management paradigms are extensively drawn upon in WSSP design, including the multi-barrier approach and hazard analysis and critical point (HACCP).

In order to produce a plan, the water provider must carry out a thorough assessment of the water supply process from water source to the consumer's tap. Hazards and risk should be identified, and appropriate steps towards minimising these risks are then investigated. Stakeholders' communication and cooperation is vital for the success of WSSP's implementation. Keeping accurate records is essential for transparency and justification of outcomes.



Framework for safe drinking water (Adapted from: WHO 2005, Water Safety Plans)

1.3. Planning safe water and sanitation

The results of the overall assessment of the system, the identified weak aspects and risks should be documented, shared and discussed with all relevant stakeholders. Realistic targets to improve the system, to control the risks and hazards, and to minimise in particular the health risks, should be set. The public should be involved and have access to all information and be involved in participating in the decision-making processes depending on current situation. Due to several reasons, often the needed and wishes for improvements cannot be realised immediately, but step by step improvements could be planned. May be more expertise and/or trainings are requested. For the implementation of the planned actions also the needed budget, the financial and human resources, the time frame of implementation should be identified and documented. The planning and implementation of the actions with all its aspects should be transparent and understandable towards the broader public.

Summarising, the main goals of WSSP programme are:

- Minimising the health risks caused by unsafe drinking water in every stage of the water supply system
- Minimising the health risks caused by inadequate sanitation conditions
- Monitoring, documenting and controlling the whole chain of the water supply system, as well water quality and sources of pollution
- Monitoring, documenting and controlling the sanitation chain
- Raising awareness and motivating relevant stakeholders and citizens to take local action for improving their environment, access to safe water and sanitation

The WSSPs for small, centralised drinking water supply systems located in rural area, very often has to be accomplished with limited technical, financial, and human resources in comparison to professional water operators serving big cities or urban areas in general. Simplified tools have to be developed to translate the formal WSSPs into a format that is meaningful and accessible for communities to use. The international experience acquired show that WSSPs can be developed and implemented for small community managed water supplies, and they improve the sanitary condition and water quality at source and at the consumer end point.

In the two following modules the main elements of small-scale water supply systems, boreholes, dug wells, springs and for small-scale piped water distribution systems, are presented with the main steps for developing a WSSP for the respectively supplies. The aspects of sanitation and hygiene are addressed throughout the whole compendium.

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A2 WSSP FOR SMALL-SCALE WATER SUPPLIES: BOREHOLES, DUG WELLS AND SPRINGS

Authors: Margriet Samwel, Doris Möller

SUMMARY The available data on water quality of decentralised small-scale water supplies give reasons to serious concerns. The main concern is the microbiological contamination and in addition in many regions the contamination with nitrates. Small-scale water supplies such as dug wells, boreholes or springs are mostly locally managed by the community or by individuals. Due to lack of awareness often the water contamination has local sources, whereas water related diseases are not always recognized and/or registered. A WSSP developed with the involvement of the whole community can benefit greatly to the drinking water quality, hygienic behaviour of the people and reduce the water borne diseases. This module presents the basic elements of small-scale decentralised water supplies such as boreholes, dug- wells and springs. The several steps and some guidance are delivered for implementing community based WSSP.

OBJECTIVES In this module, the reader should gain knowledge and understanding about the aim and the approaches of developing a community based WSSP.

KEY WORDS AND TERMS Small-scale water supplies, wells, boreholes, safety, risk assessment, control and eliminating hazards and risks, minimising health risks.

Remark: This module does not intend to provide a complete information and guidance packet related to decentralised small-scale supplies. In several other modules and in further readings a list with websites for more detailed information on specific issues is available.

Introduction

In many countries, national regulations or laws on water quality, operation and maintenance do not apply to small non-piped, decentralised water supplies. Staff for which no educational background is specified or required usually manages these supplies. Based on estimations, in the pan-European region about 60 million persons receive water from non-piped supplies such as boreholes, dug wells and springs. In many countries, small-scale decentralised supplies are not adequately managed and monitored. Diseases related to small-scale water supplies and hygienic living conditions in rural areas are often not well known.

So far as registered and monitored, the available data on water quality of the decentralised small-scale water supplies give reasons to serious concerns. The main concern is the microbiological contamination and in addition in many regions the contamination with nitrates, waste and pesticides. The small-scale water supplies are mostly locally managed by the community, municipality or by individuals, while often the contamination has local sources. Therefore, a WSSP developed with the involvement of the whole community can be beneficial for the drinking water quality and hygienic behaviour of the people and can lead to a reduction in water related diseases.

1. Basic elements of decentralised small water supplies

Non-centralised water supplies can be found in most countries of the world and depending on the local hydrological and geographical conditions, individual or public dug wells, boreholes or artesian wells can serve the people, by natural springs where water is taken via a reservoir or by a simple pipe. Water extracted by a well can simply be done by a bucket or made available via a hand or electric driven pump. However, it is important that the wells and springs are adequately constructed and managed, that the water sources and catchments are protected against contamination, and water of those small supplies could be safe. Nevertheless, the occurrence of contaminated water is widely observed, especially in high-densely populated communities, where an adequate and safe collection and disposal of human and animal excreta is lacking, or in regions with intensive agriculture. In some regions, water is supplied through pipelines from underground or river basins.

Besides the infiltration of pollutants via the soil layers, the water can be contaminated due to dirty buckets, ropes and hands, or lacking cover, cracked walls of the well or basins, or via infiltration of wastewater and rainwater. The level of contamination will depend in particular on the type of soil, the depth of the groundwater, aquifer and the practice of human activities. Within the community, a great deal could be done to eliminate the local water contamination by raising awareness on the water quality and the sources of contamination and by improving the personal and environmental hygienic behaviour.

Furthermore, some regions depend on drinking water delivered by tanks or taken from surface waters or even irrigation channels. Unfortunately, those waters without treatment are never safe. Also for communities with persons using these unsafe water sources, the WSSP approach can be adapted with the aim to inform the users about the risks of the water and to develop a step-by-step action plan for making safe water accessible, which could include also lobbying on a national or international level for a safe water supply.

2. Developing a WSSP with public participation and access to information

In general, protecting and managing drinking water sources is not solely a task for the water provider or the responsible institution but is also a concern for the public. For implementing a community-based WSSP the public should be informed, consulted and persuaded to participate in the whole process. The views, experiences and concerns of the public should be heard and taken seriously, and since they are the main target group of a water supply, therefore their needs and behaviour, their accountability and capacity should be understood to create a reliable community based WSSP. Therefore, public participation for understanding the significance of the local issue, identifying the hazards of a supply, and for setting targets and implementing actions is fundamental for achieving a long-term success. Public participation and sharing information will contribute to transparency, in understanding and acceptance of the planned actions, and a certain ownership of the supply and a sense for community development and mobilization will therefore be achieved. For this process, various tools can be used, and schools could play a role, but also local or regional NGOs.

The tools could vary from public meetings to interviews and trainings, in establishing working groups and organising exhibitions where the WSSP program and results are presented and discussed, and by sharing information via local media and of course the involvement of representatives of the public in the WSSP team. For specific situations as Covid-19 pandemic, on online communication should be encouraged and facilitated.

2.1. Organising a community based WSSP programme – setting up a team

A WSSP can be developed for large water supplies, but also for small-scale supplies such as dug wells or natural springs. The approach of identifying and controlling the hazards and the risks for small-scale water supplies are in general less complicated and better manageable than for the very large-scale supplies. However, in rural communities the availability of water and health related experts or documents and financial resources is often on a much lower level than in urban regions.

In many communities the local authorities, for instance the mayor and/or the local supplier are responsible for the public water supplies, such as street taps or wells, a water supply for a dispensary, a school or the town hall. By and large, the owners themselves are responsible for the individual water supply. Nevertheless, representatives of the local public and individual suppliers, the responsible authorities, consumers, farmers, public institutions like schools and health organizations/clinics should be invited to participate in developing local WSSPs. A WSSP team representing the different stakeholders, men and women from the community, different cultures and religions should be set up, and tasks and responsibilities should be defined. A local leader for facilitating and coordinating the WSSP program should be selected/elected. He/she has to be a respectable and communicative person and motivated to work with and for the community.

In several countries the experiences has been that schools, pupils between the age of 12 to 18 years with the cooperation of the teachers and authorities, can play an important role. For example, by assisting in monitoring local water sources and raising awareness of the WSSP program and the results in the community. See part C of the compendium for activities suggested for schools.

2.2. Description of the water supply and water sources

This module targets only non-centralised water supplies. Therefore, all the location and types of water supplies should be catalogued inventoried and described, e.g. wind wheels or pumps, dug wells or bore holes. The WSSP team should document not

Without involving the people, Water Safety Plans will not work. Participation and access to information is a key factor for the success of Water and Sanitation Safety Plans

only the public supplies, but also private water sources. The description of the supplies should include at least the source of used water, if applicable the depth of the abstracted water layer, type of construction and the number of persons served by the water source (module B1).

For other activities and for planning it is very helpful to indicate the locations and the systems of the water sources on a village map (module A6).

2.3. Stakeholder analyses: responsibilities and management

The management of a public water supply is generally under the responsibility of an institutional body. However, in practice and for the general public it is not always defined what the requirements and obligations are in operating, maintaining and monitoring the water supplies, and which persons or institutions have to analyse the water quality. Which persons or institutions have to maintain or clean the water source, and who should report the analytical results to whom. In case of the drinking water supply which could cause a risk to health and to certain vulnerable groups who should intervene and in which way.

It is very useful to review the national and local regulations concerning the decentralised small-scale water supplies. Which regulations or laws do apply to the water supply within the community? Are the needs and safety of the community sufficiently reflected? What are the requirements for the water quality, and the frequency of monitoring the supplies and which parameter should be monitored? Are there any norms and restrictions for sanitary zones within the catchment and how often should the sanitary inspections be conducted? Finally, which regulations or laws are not or only partly implemented, but what are the barriers and where are improvements required (module B8)?

2.4. Experiences, problems and perception analyses of supply owner and consumer

The users of a water system often focus on other problems or have different perceptions about e.g. water quality or about access to water compared to that of the water supplier. By using questionnaires or by participatory approaches, like group works or ranking, and an insight can be obtained about the problems and experiences of the supplier and the user are experiencing (module A8). The facilitator or interviewer should keep in mind that closed questions could easily give unreliable answers. For example, the question: 'Do you get ill from the water' might give another answer than 'How do you perceive the drinking water quality? And why? And what are the consequences of drinking this water? What is the daily /monthly water consumption and for which purposes is the water used?' Information can also be gathered by interviews from citizens, doctors or other key-informants. Be aware that if you gather information from people, they often want to know the results and the subsequent concrete actions. You can therefore organise a village meeting and inform the people of the findings.

2.5. Inventory of the water quality

The quality of drinking water has to comply with the minimal requirements to be safe for humans and to cause no diseases after a lifetime of consumption. To a certain extend all pan-European countries specified national requirements on the microbiological (bacteria), chemical (e.g., nitrate, fluoride etc.) and organoleptic (e.g., odour, turbidity) quality of drinking water and the frequency of monitoring of the water quality (module B4). In these countries, the responsibility for the sanitary surveillance (laboratory analyses and field inspections) of public small water supplies belongs to the health authority that is caring out the monitoring program of water quality set up by a specific national legislation if the water supplies are exempted from the Drinking Water Directive, or by the Directive requirements if they are applicable. Public Health Authority it is also in charge with the recording of water borne diseases, and consumer information and counselling.

In so far as drinking water analyses are carried out all the results, including those from previous years, should be gathered, reviewed and assessed to find out if there is a trend on decreased water quality and whether to decide if additional parameters or water sources should be analysed. Primarily water can be contaminated either by natural substances or by human activities, and the contamination can be chemically (e.g., by nitrates, metals or pesticides), or biologically by microorganisms or pathogens (bacteria or viruses which cause diseases). For most substances, only laboratory analyses can give adequate information about the quality of the water.

A special attention should be paid to the chemical quality of the sources of drinking water, because for the small supplies such boreholes, dug wells and springs, the water is used by the consumers with no treatment at all. The Water Framework Directive (WFD) is the EU's main policy instrument for setting water anti-pollution strategies, including measures to progressively reduce emissions of chemicals listed as priority substances.

The new Directive 2020/2184/EU on the water quality intended for human consumption introduces a **watch list mechanism** for drinking water, that is part of the response to various relevant Union policies. This list includes emerging compounds such as endocrine-disruptors, pharmaceuticals and microplastics. Two endocrine disrupting chemicals (17 beta-estradiol and nonylphenol) are included in the first watch list of emerging substances to be monitored in drinking water, which the European Commission adopted on 19. January 2022, in view of the risk they pose to human health. Based on the latest World Health Organization recommendations regarding drinking water parameters, the guidance values of 300 ng/l for nonylphenol and 1 ng/l for 17-beta-estradiol should be established by this Implementing Decision.

It should be mentioned that microorganisms are worldwide the main cause of water related diseases (module B4). Unfortunately, it is not easy to identify and quantify water pollution. In case analytical results are lacking, a reliable and preferably an independent laboratory could be contacted to carry out the required analyses. In

UV flashlights and clear UV creams can be used to see where there is still residue of the cream after handwashing.

intensive agricultural used regions, also pesticides could be a significant source of water pollution and should be measured in a laboratory. There are many kinds of pesticides, and it should be known in advance which pesticides could be found in the drinking water, because each pesticide requires a different analysis. For some parameters, such as acidity or nitrate and nitrite quick tests are available (see module A5).

Observations and secondary data

Still, it is quite possible to gather some indications about the quality of drinking water without using laboratory analyses.

- First, doctors, teachers and other key-informants in the village or in the region can be asked about the occurrence of water-related diseases and a survey can be done among villagers about their perceptions of drinking water quality (see module A8).
- Second, the WSSP team can search for secondary data: what kind of research on water quality has been done in the past and what were the results? The authorities should be asked for the data of water analyses and if there are any possible natural elements of concern in the water such as fluoride or arsenic. Copies of the analysis's reports should be obtained. Experts can be contacted and interviewed. Probably there is some information available about the geohydrological situation (groundwater depth, soil, and direction of the flow). This could be very useful for the planning phase.
- Third, all through the seasons and weather events, observations can be made concerning the colour, taste, smell, turbidity, sediments, etc. Observations can also include potential pollution risks. It always has to be kept in mind that this method only gives an indication. Even if all the (organoleptic) results are within the norm, the water can still be highly polluted.

Bacteria – the most important parameter

As most water related diseases are caused by microorganisms (bacteria, viruses), this is the most important parameter to identify the safety of drinking water. Waters of unprotected and badly maintained sources are easily affected with microorganisms due to the contamination of human and/or animal excreta (see module B6). Drinking water has to be analysed on a regular basis and the results should be made available to the community. The presence of bacteria, such as *Escherichia coli (E.coli)* or Enterococci should be known; otherwise, a laboratory should be requested for analysing the drinking water on bacteria. Both are indicators of a bacterium

Nitrate test strips are cheap and water samples are quick to analyse

for microbiological pollution: No *E. coli* or Enterococci at all should be found in 100 ml drinking water. Primarily one analysis will not provide the information about the safety throughout all seasons and weather events. Therefore, frequently analyses should be conducted and in particular after special weather events such as heavy rainfalls, or during several seasons, to monitor the influence of weather events, agricultural activities or livestock keeping on the water quality.

Nitrate monitoring of water sources

Experiences from different countries showed that decentralised water supplies, water wells and springs are often not adequately protected against human-made pollution such as animal manure, pit latrines or fertilizers. Nitrate is a good parameter to identify this kind of contamination. However even if nitrate is not detectable, it is no guarantee for safe water.

The nitrates in drinking water are not only the result of inadequate use of fertilizers in agriculture, but also an indicator of faecal pollution of human or animal origin, because of poor sanitation conditions. There is a natural oxidation process of organic matter of faecal origin, including the presence of ammonia, nitrite and nitrate. Ammonia indicates a pollution that occurred hours ago, nitrite is related with a pollution happened days ago, and nitrates the most stable chemical form, indicates a pollution of weeks ago. If all three compounds are present in water sample, they indicate a continuous faecal pollution coming the most probably from the pit latrine or from the animal stable. The presence of nitrates is associated in most of the cases with microbiological contamination.

Monitoring of the water sources can be done in two different ways. Firstly, a good overview of the existing nitrate concentration of the water sources should be obtained. The water sources should be chosen in such a way that they are representative for the whole community. That means sources in different parts of the village, which are potential sources of drinking water for the public, must be analysed. It is preferable to test the water samples in the same season, e.g., during spring when the water flow is maximum, and autumn time, when the flow is minimum. Other observations on water quality, like colour, turbidity or others should be reported. Parameters such as suspended particles (turbidity) might be associated with a potential microbiological pollution. Secondly, it can be very informative to monitor nitrate levels in some selected wells throughout the year. For example, a high, low and medium nitrate-polluted well is chosen for the seasonal monitoring. The tests results of a whole year will give an overview of the seasonal fluctuation, and which might be useful for the WSSP. Depending on the soil layers e.g., the leakage of nutrients in the groundwater by precipitation, fertilization by manure or nitrogen can be assessed clearly by using such a monitoring program. Therefore, it is also beneficial to measure the precipitation and temperature as well since these parameters can be related to the nitrate concentration (module A5). For understanding and presenting the monitoring results, the locations of the investigated water sources and the test results have to be documented and can be transferred to a map and into graphics (module A6).

2.6. Hazard identification and risk and assessment

Assessment of the occurrence of water related diseases, the results of the water analyses and the risks and sources of water pollution, will give an insight into the level of water safety and the measures to be taken for improving water quality and minimising water related diseases. For the hazard assessment of well/groundwater pollution endangered e.g., by fertilizer, animal manure or wastewater questionnaires and checklists can be used (module A7). Observations of the catchment areas and the water sources, the state of the well or the tap and its surroundings should be investigated. E.g., is there a cover on the well or reservoir and are they regularly cleaned? Is there any rain or wastewater infiltration? Is there an apron around the pump or well, etc.? Are springs or basins adequately captured or constructed and cleaned on a regular basis. If available, are pumps and pipes functioning?

People who are living near by the wells should be interviewed about their practices of fertilising their fields. Other sources of microbiological pollution such as tools used for extracting the water or for the storage of water in houses have to be observed and identified. A checklist of the circumstances within the area should be drawn. Villagers, the medical and water administration and doctors, are important sources for information and should therefore be interviewed on the drinking water quality and related health diseases.

Because sanitation and hygiene are very much related to water pollution and diseases, also personal and environmental hygienic behaviours in households, schools and other public institutions should be assessed as well. For example, are water and soap in kitchen and near the toilet always available? Is handwashing at critical moments practiced, and are the sanitary facilities in a satisfactory condition? Are human and/or animal waste (excreta and manure) infiltrated in the soil or deposit on an unsafe landfill? See module B5 and B6.

2.7. What to do with the results?

A part of the WSSP is the documentation of the collected information and making the results and plans available to all stakeholders. All the collected information should be objective and presented in reports, and depending on the issue, the results can be made visible in graphics or in maps (module A6).

Systems and structures

Water supply systems can be made evident by using drawings with the input of all stakeholders. What types of sources are used, e.g. wind wheels or pumps, dug wells or bore holes. Are there different water layers or sources in use? If yes, where and what are the given properties, such as depth? Location of the public wells or taps, location of sources and pipes etc. should be identified and which citizens are dependent on which source? All the collected data and information should be summarised in a report and made available to the citizens.

Reporting, mapping wells and risks

The results of the analyses and findings of the drinking water and seasonal fluctuations should be carefully documented in the register book.

The results of the analyses of the drinking water should be carefully documented

This may include:
- The depth of the well
- The state of the well, for example is it well maintained, does it have a cover and what kind of cover, does it have a concrete enforcement around it or not
- The location and presence of possible sources of pollution in 50 m proximity around the well. Is the source of pollution e.g., in the north or in the south of the water source, uphill or downhill?
- Description of the sanitation (toilet) system-location of release of wastewater in the environments or contents of pit latrines
- Nitrate concentrations, other analytical results of the water sources such as pesticides, should be reported and/or mapped

If maps of the village exist, then those should be used. Wells or taps and the density of the population can be indicated on the map, by using different colours for the wells according to their nitrate pollution. In the absence of maps, simple maps can be drawn. The sources and dangers of pollution can be plotted manually on tracing paper and overlaid on top of the map of the village.

In EU countries, for example Romania, the data on surveillance of small, centralised supply systems are assembled by the health authority, in an Annual Country Report which is sent to the European Commission as part of the reporting obligations on the Drinking Water Directive.

Sharing information

The gathered and documented results should be made available in an understandable form to all stakeholders and to the broader public. This can be realised via Internet, public meetings, exhibitions and local/regional media. Furthermore, it is recommended to present the data in a public place, where the results of the analyses are open to the public and stakeholders.

2.8. Developing plans for the improvement of the water system

Finally, the main goal of the WSSP is to identify the weaknesses and strengths of the system, to establish an improvement and minimising the risks and hazards, which can deteriorate the water quality. After establishing a shared identification of the hazards and risks and possible improvements of the water system, joint actions on a local level could have an impact to perform a better risk management, e.g., cleaning and restoring the source or pipes, installation of closed pump systems, safe human and animal excreta management, or even lobbying for the installation of a central water supply system.

A community based WSSP developed with the involvement of all stakeholders will lead to:

- An improvement of water protection
- In minimising the health risks of water related diseases
- An adequate management of the water system
- Improvement of access to information and to safe and affordable water
- An improved ownership of the water supply and sanitation systems

3. Remarks

The given examples and suggestions are not decisive and should be adjusted and developed according to the local situation and possibilities of implementation. For example, the input and cooperation of the citizens, the local and/or regional authorities and other stakeholders, or the collaboration with schools, local health staff or NGO will have an influence on the results of the WSSP.

The Cohesion Fund is the primary EU source of investment in water infrastructure to meet the specific needs of benefiting Member States. In doing so, it helps meet their basic water needs and supports the compliance with the EU environmental acquis in the field of water. The European Regional Development Fund (ERDF) also invests in infrastructure providing basic water services to citizens. It can also support the development of regional endogenous potential through small-scale infrastructure.

Commissioner for Cohesion and Reforms, Elisa Ferreira said: "EU Cohesion policy is also about protecting and improving the quality of the most valuable good we have: water. An expanded and modernised water and wastewater infrastructure will improve access to water, reduce soil and water pollution and help protect biodiversity. By improving the security of water and contributing to a healthier population and environment, these projects will improve local population's living conditions".

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A3

WSSP FOR SMALL-SCALE PIPED WATER DISTRIBUTION SYSTEMS

Author: Margriet Samwel

SUMMARY The first part of this module provides information about some basic elements and conditions related to small-scale centralised piped water supplies. For example, for the selection of the raw water sources, several aspects have to be taken in consideration. Furthermore, the selection of water treatment processes, aspects of water storage and distribution are presented in a nutshell.
In the second part of this module some guidance is given for developing a water and sanitation safety plan (WSSP) for a small-scale piped water system. The main steps to be conducted for developing a WSSP and an overview of the typical hazards affecting the catchment, the water treatment, the distribution network and the consumer premises are given.

OBJECTIVES This module should give some understanding about the main elements of a centralised piped water supply to communities or readers. In addition, this module should make the readers aware of the basics on how to develop a WSSP for a small-scale centralised water supply and its benefits.

KEYWORDS AND TERMS Piped water, water source, catchment, water treatment, distribution, storage, consumers, developing a WSSP, hazards.

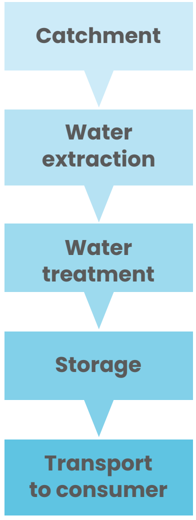
Remark: In the following modules, several aspects and elements of small-scale water supplies are presented more detailed.

Introduction

A central water supply system is characterised by its potential to satisfy the water-needs of a group of users via a pipe network. In general, small-scale supply systems are easier to manage than large systems. However, this does not imply that the quality of water in smaller systems is better. Often small-scale water supply systems lack the budget and/or the expertise for water protection measures, adequate treatment of the raw water, or for operation and maintenance of the system. Although, in general a centralised piped water system has many elements and aspects to be aware of adequately managing the supply.

A holistic approach to quality assurance of the water supply system, from the catchment area to the tap of the consumers, is important and includes:

- Assessment and control of source waters to prevent or reduce pathogen contamination
- Selection and operation of treatment processes to reduce pathogens to target levels
- Prevention of contamination by pathogens, metals or other substances in the distribution system



Basic elements of many central water supply networks

Whatever the source is, there should be enough water to provide the users all through the year. The water capacity of a source during several seasons can be estimated by observations and long-term hydrological investigations, carried out by experts.

1. Basic elements of small-scale piped water supplies

For developing and understanding a WSSP for small-scale water supplies the know-ledge of some basic elements and conditions related to piped water supply are essential. Below some information is provided, although in many cases there may be still information is lacking and an expert may be consulted.

1.1. Selection of the water source

For the selection of a source, several aspects have to be taken into consideration, such as:

Water availability and quality

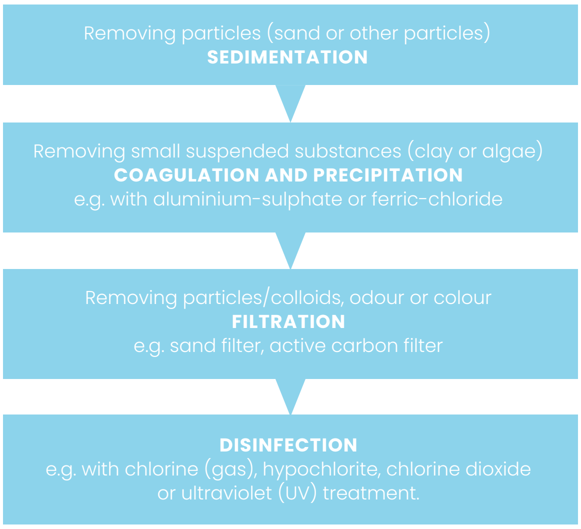
- Is there enough water available to meet the water demand of the community, including dry periods?
- Is the water abstraction in balance with the subsequence delivery of new water?
- Is the quality of the water stable and acceptable – is the water quality and q uantity vulnerable for weather events like heavy rainfall or droughts?
- Are possible contaminants removable without complicated and cost intensive treatments? (Module B2)

Type of water source

- The source of a water supply system can derive from several types of water, such as groundwater, spring or surface water (e.g., river) (module B1).
- Different sources of water have varying qualities and different needs of treatment. If groundwater is well protected against pollutants, often no treatment is needed.
- Surface waters have to be treated in any case.

Location of the water source – accessibility and protection

- Is there information about the flow direction and velocity of the water source?
- The location of the source, e.g., a well, should be chosen in an area where the risks of infiltration of contaminants, e.g. agriculture or wastewater are manageable (module B6).
- Establishment of different water protection zones should be possible, such as restrictions of human activities (module B6).
- The area should be accessible with the equipment required for operation and maintenance of the source.



Scheme of a treatment system for surface water

1.2. Selection of treatment processes

The type of the treatment depends greatly on the water source, e.g., on the water quality of the raw water. The results of laboratory tests estimate the type and the degree of intensity of the treatment (module B5). The main tasks of the treatment are to minimise the amount of microorganisms in the supply system, to eliminate particles, and to eventually remove dissolved iron and manganese or other toxic chemicals. Different treatment processes are required to remove different substances. Which kind of treatment finally is chosen depends heavily on the financial and human resources of the supplier? However, the task of the water supplier is to deliver drinking water without pathogens and health risks, and which can be consumed safely on a life-long basis to the consumer. Water should be tasty, wholesome and clean. Water, which leaves the water treatment plant, should meet the stringent criteria set by the national and/or EU directive for drinking water (module B4).

1.3. Storage and distribution of water

The conditions of the storage and distribution of water is one of the essential factors to guarantee the quality and availability of water for the consumers. During the storage and distribution, safe drinking water may get contaminated by metals or by infiltration of microorganism if the system is not well designed. A well-designed water storage and distribution system should be able to overcome high peaks in water usage during the day and night, in summer and winter time, and should avoid long retention times in the storage and distribution system.

A water tower maintaining an appropriate pressure day and night

Following elements of a drinking water storage and distribution are summarised:

- Reservoirs, where treated water is stored, allow fluctuations of the supply during the day and night, and throughout the seasons.
- Reservoirs should be ferment-proof and covered to avoid contamination from pollutants.
- When designing a piped system, sufficient pressure at the point of supply has to be ensured to provide an adequate flow to the consumer.
- For maintaining the microbial quality, it is important to minimise the transit time and to avoid low flows and pressures. The system should not have an excessive capacity resulting in long transit time.
- Low-flow, dead ends and loops should be avoided.
- The materials of the pipes and the water should not allow chemical reactions between them (module B3).
- Water should contain an estimated concentration of calcium resulting in a protection layer in metal pipes. Most countries established requirements on the quality of material in contact with drinking water e.g., using lead pipes for the construction of a new system is not allowed anymore.

Appropriate pressure and flow rate

Appropriate pressure should be maintained within a certain range in the whole system whereby the maximum pressure avoids pipe bursts, and the minimum ensures that water is supplied in an adequate flow rate to the consumer, even to consumers on the 5th floor of a building. Negative pressure should always be avoided since it can cause high risks of infiltration of contaminated water in the network. As with the pressure, flow rates are crucial. A flow rate that is too high will result in water being wasted, whereas if a flow rate is too low will mean that sanitary fixtures and other appliances in the household will not work properly. Experts should determine the suitable pressure, pipe size and the velocity of water flow within the network.

Backflow and intermittent supply

In some situations, the supply is regularly interrupted, sometimes even on a daily basis for several hours. Such a situation represents a major challenge to the water supplier to uphold water quality standards.

Backflow is an unplanned reversal of flow of water (or water and contaminants) into the supply system. Backflow is caused by a difference in pressure, for example, the supply pressure is less than the downstream pressure, allowing water to be pushed in the wrong direction. Different pressures can flow water back into the pipes, which can deteriorate the water quality. In addition, by recharging the system, surges may dislodge bio films into the pipes, leading to aesthetic problems. The control of hazards, such as stagnant water pools or drains, is important for managing the risks caused by intermittence.
If gravity is insufficient to supply water at an adequate pressure, pumps need to be installed to boost the pressure. Control valves such as pressure reducing valves,

non-return valves or throttled valves are designed to optimise the system with respect to pressure, water supply and energy costs. Regular control of pumps and valves is essential to assure the water quality.

2. Development of a Water and Sanitation Safety Plan for a centralised piped water supply system

Developing a WSSP for a centralised water supply system contains several modules or steps. The involvement of different stakeholders, e.g., the responsible institution or manager of the utility, is essential. In addition, staff for maintenance and operation, consumers or farmers having their fields in the water catchments zones, should take part in the development of an adequate WSSP.

2.1. Set up a team

A small-scale centralised water supply system has many aspects and involves many stakeholders. The establishment of a multi-disciplinary team with members like local authorities (environment, health, agriculture, etc.), water experts, farmers, citizens, schools and NGOs is advisable. As far as possible tasks, activities, and responsibilities of the team and its members should be defined together (module A1 and A2).

- Identify the required expertise and size of the team.
- Involve multi-disciplinary experts, who will contribute to success.
- Define and report the roles and responsibilities of the team and its members.

WSSP Team includes representatives of key stakeholders: Water Producer, Public Health, and Environmental Protection, supported by local and regional authorities. The water producer normally has the leading role. Cooperation and exchange of information are vital, establishing communication channels as part of the plan.

- **Water producers** take into account the risks within the catchment area, draw up the water supply map, identify and manage the risks from the water intake to the building socket, develop WSSP, implement and document the management and monitoring systems.
- **Public health authorities** collaborate with the water producer to identify health hazards, perform the audit of the water supply system, investigate possible water related diseases, advise the population and building administrators to maintain water safety in indoor networks, and oversee small water supply systems.
- **Environmental protection authorities** support WSSP implementation policies and development in terms of risk identification in the water catchment area, support WSSP from the point of view of risk management in the water catchment area and understand the process of WSSP's elaboration.

2.2. Describe the water system and state of management

A description of the whole water supply system is the basis for understanding the system and the field of investigation: this includes the current availability of supplies from all used sources and systems. Details about the abstraction, treatment, storage, distribution, identification of the water users, the volume of abstraction and water usage are important issues for obtaining an overall view of the system(s). Furthermore, information on the water sources, the catchment area and the land use in the catchment are indispensable for the description of the supply system. For these steps, in particular the support of the water supplier or local authorities is needed, but field visits and interviewing stakeholders (also citizens) could provide additional information.

Crucial aspects of a safe water supply are the responsibilities and tasks for the overall management, in operating and maintaining the system. How are the responsibilities and tasks for the water abstraction and protection, water treatment and distribution, water and sanitation safety, surveillance and reporting regulated? Who is responsible for which task? How and who defines the tariffs for water and sanitation services, and how is the communication with the consumers regulated and practiced.

Besides the description of the water supply system and the overall management, the visualization of the gathered information by means of maps, flow diagrams, drawings etc. is very useful for sharing information, understanding the system and for raising awareness (module A6).

Example of involved stages in a water system – from the catchment to the household level

Step	Description	Responsibility	Staff
1	Catchment	Farmer - Utility	Farmer x, y, z; Consultancy provided by utility
2	Transfer -pumping	Utility	Person A
3	Primary storage	Utility	Person A and B
4	Settling/sedimentation	Utility	Person B
5	Filtration – sand filter	Utility	Person B
6	Chlorination – Hypochlorite	Utility	Person C and Person B
7	Quality control	Utility	Person C and F
8	Water Meter	Utility	Person D
9	Distribution	Utility	Person D and E
10	Water meter	Household	Advised by utility
11	In-house network	Household	Advised by utility
12	Household use	Household	Advised by utility

2.3. Identify hazards, hazardous risks and assess the risks

Each step of the flow diagram that could go wrong, or where hazardous events could happen, has to be identified. This assessment can be done by interviewing, by collecting the experiences of stakeholders and by field visits. The causes of supply problems e.g., dry streams and wells, pipe breaks, empty dams, damaged or silted up tanks, destroyed roof catchments, etc. should be identified. Biological, chemical and physical hazards should be assessed, identifying possible points where water could be contaminated, interrupted or compromised. Used materials need to be identified, e.g., by interviews, in case there is suspicion of harmful effects e.g., lead pipes. Laboratory analyses on metals can give additional information.

The water supplier should take water samples before and after the treatment of the water. In any case, at least the quality of the water leaving the treatment system and delivered to the households should fulfil the requirements of drinking water regulated by the drinking water directive (module B4).

The causes or indicators of contamination (e.g., leaking pipes, unprotected sources, and discoloration of the water, high turbidity, unusual smell, saltiness, diarrhoea or other possible water-related illnesses within the population) should be identified and reported. The following tables give an overview of typical hazards affecting the catchment, hazards associated with the treatment, and hazards within the distribution network. Finally, hazards that could pose a threat to health risks on the long term, e.g., by chemical pollution or immediate risks by bacteriological pollution, have to be taken into consideration.

The matrix given in the table below can be used to analyse the situation for each component of the supply chain from source to consumer tap.

WSSP development matrix (source: 4th edition of the WHO Guidelines on drinking water quality)

WSSP development steps	**Main components of the drinking water supply system**			
	Water source	**Treatment station**	**Distribution network**	**Tap water**
Information gathering	Type of catchment, the water source	Charts, treatment processes, capability, control	Diagrams, flow direction, equipment, storage tanks, the status of valves	Type of premises, distribution network materials
Hazard identification in critical points	Sources of pollution, climate	Catchment area, reagents used in treatment, materials used, the ineffectiveness of treatment, power failures	External contamination, flow fluctuations, unauthorised connections, back siphonage	Siphonage, leakage from pipelines, hygiene
Risk assessment	Likelihood and consequences of pollution	Likelihood of having an ineffective treatment, the consequences of inefficiency	Likelihood of failure, consequences	Likelihood of occurrence, consequences
Control measures	Catchment and reservoir management	Treatment process, process monitoring, warning systems, shutdown of water supply to the network	Operational procedures, approved materials, valve status	Sealing elements, treatment to remove plumbosolvency, education
Monitoring of control measures	Pollutants' points of discharge, raw water quality	Raw water, treatment process, disinfected water supplied to the network (end product)	Flow, pressure, residual disinfectant concentration	Inspection of the premises
Actions in case of exceeding the Maximum Admissible Concentrations (MACs)	Stopping the takeover of water from source, adjusting the treatment process	Stopping the takeover from water source, adjust the treatment process, the treatment plant closing	Water discharge, flushing pipes, advising people to boil water	Advising consumers

Following the above matrix, the whole water supply system should be analysed at its critical points (HACCP) and risk scores should be established for each part of the chain, according to the risk matrix..

The key of establishing the scores of likelihoods is the following: **5** - almost certain, means a daily occurrence of a hazardous event; **4** – likely, is once a week; **3** – moderately likely, is once a month; **2** - unlikely, is once per year; **1** – rare, once every 5 years (WHO, 2017)

The guidance on how to set the scores for severity of the hazardous event or in other words the consequence of the impact on human health is the following: **Catastrophic** means potentially lethal to large population; **major** is for potentially lethal to small population; **moderate** means potentially harmful to large population; **minor** is potentially harmful to small population, and **insignificant** means no impact or not detectable (WHO, 2017)

Risk matrix (source: 4th edition of the WHO Guidelines on drinking water quality)

Likelihood \ Severity/Consequence's impact		Insignificant	Minor	Moderate	Major	Catastrophic
		1	2	3	4	5
Almost certain	**5**	5 (L)	10 (M)	15 (H)	20 (VH)	25 (VH)
Likely	**4**	4 (L)	8 (M)	12 (H)	16 (VH)	20 (VH)
Moderately likely	**3**	3 (L)	6 (M)	9 (M)	12 (H)	15 (H)
Unlikely	**2**	2 (L)	4 (L)	6 (M)	8 (M)	10 (M)
Rare	**1**	1 (L)	2 (L)	3 (L)	4 (L)	5 (L)

Following these criteria, the range of risk scores is between 1 and 25. After risk assessment of the drinking water supply system in critical point, various actions are recommended according to the size of the risk's scores, classified as following: low risk (score 1-5), medium risk (score 6-10), high risk (score 12-15) or very high risk (score 16-25).

Actions to be undertaken:

- **Low risk:** management will be carried out according to routine procedures that will be regularly reviewed.
- **Medium risk:** there is a need to act and plan.
- **High risk:** priority actions are needed to immediately reduce the danger.
- **Very high risk:** urgent action is needed to prevent danger, for example water supply interruption, warning people to boil water, restrictions in use, and priority actions for immediate danger reduction.

HACCP that is at its origin a food safety management system, and that was embraced for the development of WSSP, can control the microbiological, chemical and physical hazards in order to obtain a safe drinking water. Safeguarding the quality of drinking water is very important for every treatment plant, but especially for the small supply systems which are mainly community based operated.

Water Safety Plan based on risk assessment and risk management principles is a powerful and simple to use management tool for reducing risk from water supplies, emphasizing on system process control and effective management actions.

After passing kilo-metres of pipes, the water quality at household level could be decreased and is often not known

Engine room at the water supplier

2.4. Sanitary surveys and catchment mapping

It is possible to assess the likelihood of faecal or other contamination of water sources by a sanitary survey of the catchment area. This is often more valuable than bacteriological testing alone because a sanitary survey makes it possible to see what needs to be done to protect the water source. Water samples represent the quality of the water at the time it was collected. Therefore, bacteriological testing of water has to be carried out at regular intervals. The process of frequent sanitary surveys can be combined with interviewing the users of the catchment areas and bacterio-logical, physical and chemical testing to enable field teams to assess contamination and – more important – provide the basis for monitoring water supplies. Even when it is possible to carry out bacteriological and chemical quality testing, results are not instantly available and may be the water quality is not stable. Thus, the immediate assessment of contamination risk should be based on gross indicators, such as prox-imity to sources of agricultural chemicals, faecal contamination (human or animal); colour and smell; presence of dead fish or animals; presence of foreign matter, such as ashes or debris; presence of a chemical or radiation hazard, or a wastewater discharge point upstream. Catchment mapping that involves identifying sources and pathways of pollution can be important tools for assessing the likelihood of contami-nation.

Many countries developed a legislation for drinking water supply systems on the re-quirements of water sanitary zones, including allowed activities in the different zones (module B6). The implementation of the legislation is monitored, and fines are applied if it is violated.

For EU countries, the implementation of the Water Framework Directive means that state institutions have specific tasks in the field of water resource administration and regulation.

It is important to use a standard reporting format for sanitary surveys and catchment mapping, to ensure that information gathered by different staff members and infor-mation of different water sources are reliable and comparable.

2.5. Share the collected information with all stakeholders, determine and prioritise the risks

In this stage, it is important to share and discuss the collected information about the water supply system and the identified risks with all stakeholders, including water experts and citizens. Exhibitions and public meetings can be useful instruments. Risks and causes should be prioritised in terms of their likely impact on the capacity and safety of the system. In addition, the causes of identified risks and problems should be discussed, including aspects about finances and capacity of the water supplier. Is there a budget for adequate maintenance of the system or for the implementation of the requirements of sanitary zones?

2.6. Develop, implement and maintain an improved water supply and sanitation system

With the results and information of the previous steps, an action plan for short, medium and long-term actions, minimising the risks in the water supply system can be developed and implemented. In the action plan expected results of improvements and monitoring or control of the achievements should be defined. A time frame of the set targets, costs and the financial resources, tasks and responsibilities of staff and other stakeholders involved, should be defined as well. However, during and after implementing the action plans, the identification of risks and improvements of the system, communication with all stakeholders and eventual reviews of the WSSP should be a continuing process.

Overview of the hazardous events and associated hazards

Typical hazards affecting the catchment

Hazardous event	Associated hazard
Meteorology and weather event	Flooding; rapid changes in source water quality
Seasonal variations	Changes in source water quality
Geology	Arsenic, Fluoride, Uranium, Radon Shallow holes
Agriculture	Microorganisms, nitrate, pesticides, slurry spreading
Industry mining	Chemical and microbiological contamination
Transport, roads- railways	Pesticides, chemicals
Housing, septic tanks, pit latrines	Microorganisms, nitrates
Wildlife, recreational use, abattoirs	Microbiological contamination
Competing water use	Sufficiency
Unconfined aquifer	Water quality subject to unexpected change
Well/borehole not water tight	Surface water intrusion
Borehole casing corroded or incomplete	Quality and sufficiency of raw water
Raw water storage	Algae blooms and toxins, stratification

Typical hazards associated with the treatment

Hazardous event	Associated hazard
Any hazard not controlled/mitigated within the catchment	As identified in the catchment
Power supply	Interrupted treatment; loss of disinfection
Capacity of treatment works	Overloading treatment
Disinfection	Reliability, disinfection by-products
By-pass facility	Inadequate treatment
Treatment failure	Untreated water
Unapproved treatment chemicals and materials	Contamination of water supply
Contaminated treatment chemicals	Contamination of water supply
Blocked filters	Inadequate particle removal
Inadequate filter media depth	Inadequate particle removal
Security, vandalism	Contamination/ loss of supply
Instrumentation failure	Loss of control
Flooding	Loss of restriction of treatment works
Fire, explosion	Loss of restriction of treatment works
Telemetry	Communication failure

Typical hazards within the distribution network

Hazardous event	Associated hazard
Any hazard not controlled/mitigated within the treatment	As identified in the treatment
Mains burst	Ingress of contamination
Pressure fluctuations	Ingress of contamination
Intermittent supply	Ingress of contamination
Opening/closing valves	Reversed or changed flow, disturbing deposits Introduction of stale water
Use of unimproved materials	Contamination of water supply
Third party access to hydrant	Contamination of water supply/ increased flow disturbing deposits
Unauthorised connections	Contamination by backflow
Open service reservoir	Contamination by wildlife
Leaking service reservoir	Ingress of contamination
Unprotected service reservoir access	Contamination
Security, vandalism	Contamination
Contaminated land	Contamination of water supply through wrong pipe type

Typical hazards affecting consumer premises

Hazardous event	Associated hazard
Any hazard not controlled/mitigated within the distribution	As identified in the distribution
Unauthorised connections	Contamination by backflow
Lead pipes	Lead contamination
Plastic service pipes	Contamination from oil or solvent spillage

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A4

STEP-BY-STEP: 10 SUGGESTED ACTIVITIES FOR DEVELOPING A WSSP

Author: Margriet Samwel

SUMMARY This module gives some practical guidance for the step-by -step development of a water and sanitation safety plan (WSSP) for local small-scale water supply systems. The list of activities is merely a suggestion and can be extended and adopted to the local situation. The most important modules related to the activities are mentioned.

This module includes an overview of the suggested activities with their input, tools that could possibly be used, results and output. The modules related to the suggested activities and issues are listed.

OBJECTIVES The leader or facilitator responsible for the WSSP project will obtain guidance and suggestions for the implementation of a WSSP for a small -scale water supply and sanitation system.

In the following section, ten suggested activities, several sub-activities and the most important related modules are presented. The suggested activities cannot necessarily be implemented or applied in all cases. The presented activity list can be extended and reduced, and should be adapted to local conditions and resources.

1. Set up a WSSP working team and identify its responsibilities and tasks. For this activity public meetings, discussions, cooperation and collaboration with local authorities, water operators and other stakeholders (e.g. citizens, schools, NGOs) should be organised and facilitated (module A1, A2 and A3). It is important to identify active members from different disciplines for the WSSP team, and to develop a step-by step program for conducting the WSSP. The tasks and responsibilities of the team should be defined, as should the requested budget and its sources.

2. Description of the local drinking water system(s) and sanitation facilities (module A1, A2, B6, B8 and B9). Information should be collected about:
- The type of water supply system(s) used; the type and abstraction of the raw water sources.
- Their eventual treatment and storage; the location of the network; and reservoirs, pumps or wells, and standpipes, etc.
- The number of connected and unconnected households/inhabitants.
- The type of distribution pipes used within the public network and in the houses (module B3).
- The identification of the size of catchment areas, water protection (sanitary) zones and related regulations (module B6).
- The identification of the most commonly used system of sanitation and of the storage, treatment and release/disposal of human excreta or wastewater; as well details about the availability of nearby hand wash equipment (water and soap), rubbish bins, and toilet paper or other cleansing materials.
- The financial aspects of the water and sanitation systems: tariffs for the consumers/water users, income and the costs of the systems etc.
- An investigation of the requirements of monitoring water quality and sanitary inspection, as well their implementation and the institutions responsible for collecting and/or registering data related to the water supply and sanitary installations. In addition, the registration practices of water, sanitation and hygiene-related diseases should also be investigated.

3. Identification of relevant stakeholders for water supply and sanitation systems: who is responsible for what and what is the level of implementation? The stakeholder investigation should cover all management steps, from the catchment area to the tap, and should include sanitary aspects. Elements to look at should include:

- Persons and institutions involved in managing, working or living in the catchment area; and persons and institutions managing the water abstraction, water treatment, storage and distribution. What is the role and type of water users?
- The identification of stakeholders dealing with sanitary facilities; the treatment, disposal and release of wastewater; or the content of the pits of latrines or septic tanks.
- The identification of the requirements and practices/ frequencies of the surveillance, operation and maintenance of water supply and sanitary facilities.

4. Obtain or draw a village map, showing the locations of the water catchment, water sources, the direction of the water flow, water networks, water reservoirs, connections with households or public buildings, location of wells, etc. (module A6). GIS mapping system should be used where this is available.

5. Conducting a hazard identification and risk assessment of the water supply and sanitation system. The assessment should ascertain the sources of pollution, the condition of the water supply and the quality of the water provided. Particularly, the results of the most relevant water analyses on microbiologic quality should be available and sanitary inspections of the whole system should be carried out. More detailed activities are listed below (modules A7, B4, B6).
- Results and reports about the quantity and quality of the locally supplied drinking water should be collected from the water provider or responsible institutions (module 7 and 8); if applicable, also from the used raw water.
- In addition, more intensive monitoring of the drinking water quality could be carried out: bacteria, nitrate (NO^3), turbidity or other parameters could be measured (module A5, B4).
- Assessment of water quality perception: interviews with the water users (module A8). Assessment of the health risks of the water supplied or used by citizens: interviews with several stakeholders.
- Risk assessment of several public and/or individual wells or springs (using the WHO form with a list of questions). Selection of some public and individual wells or springs for monitoring seasonal fluctuation of the water quality.

- Risk assessment for centralised piped water (using the WHO forms and cooperating with the supplier asking, for example, is the available water treatment appropriate or is something else needed? Are there leakages in the system, and where? Is any wastewater infiltration possible or are there unused pipelines?
- Excursions to the sanitary zones, to the locations of water extraction and treatment and to the water supplier; interviews with persons living or working in the catchment area.
- Risk assessment of the (public) sanitary facilities. Special attention should be paid to their hygiene conditions: are the toilets safe, clean and hygienic? Is there any possibility of polluting ground- or surface water in the vicinity of the toilet with excreta? (Module A7).

6. Sharing and discussing the gathered and lacking information and mobilising communities – for example by organising exhibitions, meetings, seminars or working groups, and working with the media.
- All results of the WSSP activities should be clear, well documented, well reported and accessible to all team members.
- Making the collected results and findings visible and comprehensible for the media and broader public - for example, by mapping results, making graphics, etc. A village map with indications of the water supply network; the locations of available water sources; the supplied and non-supplied households would be very useful. Points of water pollution and protection areas could also be included, as well as areas with related water quality and graphics presenting the water quality, etc.
- The implementation and results of these activities should be transparent and accountable in all aspects, including their finances.
- The documentation of meeting agendas, seminars, decisions made, the publications developed, and announcements made.

7. Development of an action plan to minimise the risks related to the water supply by consulting and involving the community and relevant stakeholders.
- Make an effort to ensure the balanced participation of men and women, experts and citizens, and the fair involvement of cultural and religious minorities.
- Identify the timeframe and the persons/institutions responsible for the actions; and estimate a budget or identify other possible financial resources.
- The planned actions for improvements will vary greatly from case to case: from covering the well with a lid, to the rehabilitation or extension of the treatment or network.
- Be realistic and do not set targets too high. It is better to plan steps and activities, which are manageable and can be financed. It may be that unaffordable investigations are needed for the requested improvements. In that case, there is the possibility of WSSP lobby work to attract external funding.

8. Report and share the action planned to improve the water quality with citizens and other stakeholders. Exchange experiences with project partners from other villages and regions. Be transparent and informative, make the plans public and inform the community about their eventual consequences, such as increased tariffs or (temporary) inconveniences.

9. Implementation of the action plan. Document in detail the plan’s implementation, progress made, failures suffered and any barriers to the planned activities and actions. Keep track of the budget, time-table and people involved.

10. Monitoring, improving or adjusting the WSSP activities should be a continuous process.
- Continue monitoring the water quality and assessing risks, reporting and communicating with all stakeholders, informing citizens about on-going activities and results, etc.
- Regularly evaluate the on-going activities and results.
- Adjust and improve the WSSP activities.

A4-a.

Scheme of conducting a WSSP step-by-step

Activities, input and output for the implementation of WSSP for small-scale water supply systems

Step	Activity	Module	Input / Tools	Output / Results
1	**Set up a WSSP working team;** identify responsibilities and tasks	A1, A2, A3	Sharing information and conducting public meetings and discussions with local authorities and school staff	Schema of team members; work plan of team, including timetable of activities
2	**Describe the water supply and sanitation system(s):** type and location of water sources, abstraction, treatment, storage and distribution	B1, B2, B3, B5	Secondary data from governmental bodies, observations, interviews with stakeholders, etc.	Description of water supply and sanitation systems, the sources and state of the water, and the maintenance and operation of systems. Visualisation by designs, maps
3	**Identify stakeholders and responsibilities**, from the catchment area up to the consumer's tap; from sanitary installations, to the storage or release of wastewater	A1, A8, B5, B7	Secondary data from: governmental bodies, water operators, responsible institutions, structured interviews with stakeholders and internet searches etc.	Scheme of responsible and involved stakeholders (stakeholder map)
4	**Village mapping:** draw the situation of the area (village map) with water points or a water network; include connected and nonconnected households, wells, taps, etc.	A6	Local maps. Secondary data from governmental bodies, local and regional water authorities, structured interviews with stakeholders and field visits	Map of village with water sources, taps, distribution network and connections if available
5	**Conduct risk/hazard assessment;** insert the location and type of risks in a village map: leakages, release of wastewater, animal or human waste, gardening etc. Collect results of water analysis. Monitor the condition of sanitation facilities	A5, A7, A8, B1, B2, B3, B4, B5, B6	Checklists and questionnaires, input from experts, field visits, secondary data from governmental bodies, structured interviews with stakeholders (water operator, authorities, experts) and the results of water analysis	Report; map of village with points of risks; knowledge of water quality (bacteria, nitrate and other parameter); water-related health risks and causes are all identified
6	**Share and discuss** the results and findings on a local and regional level.	A1	Meetings, exhibition, media; the involvement of the community and schools.	Awareness is raised on the situation; maps, posters, leaflets and articles are available.
7	**Plan actions** with stakeholders, including community and schools.	A4	Action planning with stakeholders and community mobilisation.	Description of action and actors. A timetable and financial plan is available.
8	**Report and share information** about conclusions and plans at a local and regional level.	A6	Meetings, exhibitions, media. Involvement of community and schools.	Awareness of the situation and plans is raised. Maps, poster, leaflets, articles.
9	**Implement an action plan**		Input of all stakeholders, authorities and the community.	The start of an improvement in the system.
10	**Review and adjust the WSSP**: report and share information of progress in its implementation.		Meetings, exhibition, media. Input of all stakeholders, authorities, the community and pupils. Start at step 1 and work towards step 10.	Awareness on the situation. Maps, poster, leaflets, articles. Continuation of WSSP activities.

nnabelle Avril / WECF

A5

PRACTICING SIMPLE WATER QUALITY TESTS

Author: Margriet Samwel

SUMMARY In this module, a whole range of steps concerning water quality testing is introduced: taking and managing a water sample, assessing turbidity of water, odour and colour, doing a pH test and nitrate quick test, recording the samples and measured data. Basic information is given on sampling and conducting microbiological tests.

OBJECTIVES The reader can take and label water samples, carry out some related water tests such as some quick tests, is aware of the organoleptic characteristics of water (odour, colour, taste, turbidity) and the basic requirements on microbiological analyses in drinking water. The reader will learn how to work properly and record the results adequately.

KEY WORDS AND TERMS Sampling, water analyses, microbiological tests, sterile bottles, odour, taste, turbidity, colour, pH, acidity, alkaline, nitrate quick tests, pH indicator strips, water sample, recording.

1. Taking and managing a water sample

There are certain rules that should be adhered to when sampling drinking water because the quality and reliability of drinking water analyses vary according to the way in which the sample was taken. There are many different types of contaminants and categories of sampling, yet here we concentrate on the ones appropriate for our purposes. Certain categories of analyses require special vessels or an expert to take the sample.

In many cases a mineral water bottle can be used for sampling. The bottle should be filled completely and covered with a cap, and if possible, no air should be left in the bottle.

The vessel or bottle

One of the most important parts of taking water samples is using clean tools. It is important not to touch the inner side of the vessel or cover it with your fingers. Before the vessel is filled with water to be tested, it is essential to rinse out the container once with the water you are testing. This is to reassure that you have rinsed out anything in the bottle that might cause cross-contamination. For our purposes, a plastic or glass mineral water bottle of 300 or 500 ml can be used for taking a sample.

If you want to test the water on metals, pesticides or bacteria you should contact a laboratory and ask how to take the sample (the type of bottle/vessel and who should take the sample is essential). Although not in all regions microbiological laboratories are available or not located in the vicinity, for analysing the basic bacteria, such as *Escherichia coli* or total faecal coliform, mobile kits could be an alternative for testing the microbiological quality of the drinking water. In this case the sampling bottle with a volume of at least 100 ml, should be of glass and sterile (free of microorganisms); the cap has to be sterile as well. Sometimes a local pharmacy can deliver sterile bottles, otherwise the bottle can be sterilised by boiling the cap and bottle and filled with water in a cooking pot (also filled with water) for 20 minutes. An alternative is to sterilise the empty bottle and cap in an oven during 15 minutes at 120°C. After this process, it is important to close the emptied bottle immediately with the sterile cap, without touching the bottleneck or the inside of the cap with your fingers.

When water is sampled that contains or may contain even traces of chlorine, the chlorine must be inactivated. When this is not done, microbes may be killed during transit and an erroneous result will be obtained. The bottles in which the samples are placed should therefore contain sodium thiosulfate to neutralise any chlorine present.

Taking a drinking water sample – an example

Water samples can be taken from freshly extracted water from a well, spring or the tap. If the source is a tap, it is better to take the tap which is used for drinking and cooking, e.g. in the kitchen, and to let the water run for one or two minutes. Be aware that the running water should not be wasted, because it can be used for watering the flowers or it can be given to animals.

For taking a water sample for microbiological tests from a tap, the end of the tap should be sterilised by flambé some seconds with for example a pocket lighter.

Labelling and recording

Write on a water-resistant label and fix the label on the bottle:
- Name of the water sampler.
- Date and time of sampling.
- Name of the water user.
- Location: complete address.
- Type of source: e.g., tap in kitchen, dug well in yard, rainwater etc.
- Purpose of water: e.g., drinking water, irrigation.

Besides labelling the bottle, it is very useful to keep records of the samples that have been taken and analysed in a "laboratory book". Remarks on the well's surrounding, leakages in the pipes or other relevant findings and observations should be written down. Finally, the results of the analyses and tests should be recorded in a book. See also the example form at the end of this module.

Storage of water samples

In general water samples should be stored in a cool and dark place. If several hours pass between sampling and analysing, the sample should be stored in the fridge or in some other cool and dark room (cupboard).

Samples for microbiological analyses should always be stored cool and analysed as soon as possible. Be aware that within 20 minutes bacteria grow very fast and even duplicate themselves at a temperature of 37 °C.

After sampling water for microbiological tests, the samples should immediately be stored in dark and a cool place or in a cool box, e.g. filled with ice packs. It is presumed that if no cool place or box is available, the transportation time should not exceed 2 hours.

Location and time of carrying out water tests

It is wise to take the samples into the laboratory of a dispensary or school, the classroom, or the kitchen to do the tests properly. However, if the weather is suitable (no rain, the weather not below approx. 15 °C), some physical or chemical tests can be performed outside directly at the water source. Nevertheless, since chemical analyses means working in a very precise way, it is advisable to do it indoors.

Have in mind that some tests need to be done soon after taking the sample. Water is a liquid with several compounds, which can react and change, for example the pH. If the sample is not tested soon, inevitable present volatile chemicals could evaporate or the odour may change, therefore tests on pH, odour and colour should be done straight away. Nitrate and several other chemical components such as fluoride or arsenic could be tested within 48 hours. Nitrate is a rather stable compound, however, if the sample is contaminated with bacteria the concentration can change.

Microbiologic test should be carried out as soon as possible samples should be stored in a fridge or in a cool box and not exceed a storage time of 6 hours.

Hygienic rules

Working tables should be clean and can be covered with a fresh and clean towel.

- Wash your hands before doing the tests.
- Never touch the chemicals on the test strip or other chemicals with your fingers.
- Never lay down test strips on the table or on the towel. The chemicals on the strip will react also with chemical traces on the table or towel.

2. How to assess turbidity of water

Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in the air. The measurement of turbidity is a key test of water quality. Fluids can contain sus-

Samples of water turbidity standards with 5, 50 and 500 NTU.

pended solid matter consisting of many different sized particles. While some suspended materials are large and heavy enough to settle rapidly to the bottom of the container, if a liquid sample is left to stand (the settable solids), very small particles settle only very slowly or not at all. Small solid particles cause the liquid to appear turbid.

The turbidity of drinking water can be assessed visually in the field. A glass with 0.3 l volume is filled with water. It is held against the light. Turbidity is assigned to the categories: clear, weak turbid, medium turbid or strong turbid. Note if after some time the suspended solids precipitate at the bottom of the glass.

A more accurate measure of turbidity is based on the property that particles scatter light when a light beam is focussed on them. Turbidity measured this way uses an instrument called a nephelometer with a detector set up to the side of the light beam. More light reaches the detector if there are lots of small particles scattering the source beam than if there were few. The units of turbidity from a calibrated nephelometer are called Nephelometric Turbidity Units (NTU).

The Drinking Water Directive of the European Union (2020/2184/EU) stipulates that the turbidity of water should be acceptable to consumers and should not show any abnormal change. In the case of surface water treatment, EU Member States should strive for a parametric value not exceeding 1.0 NTU in the water ex treatment works, because a higher value of turbidity will compromise the disinfection efficiency.

3. How to assess taste, odour and colour

All water sources contain a number of naturally occurring minerals such as calcium, magnesium and iron. The varying concentrations of these minerals in water give rise to slightly different colours and tastes that can be detected easily. People, travelling to different parts of the country will be able to notice differences. Water also contains dissolved gases, such as oxygen and carbon dioxide that can give tap water a distinctive taste. Without these elements, water would taste flat and unappealing.

While relatively small quantities of water are colourless when observed by humans, pure water has a slight blue colour that becomes a deeper blue as the thickness of the observed sample increases. The blue tint of water is an intrinsic property and is caused by selective absorption and scattering of white light. Impurities dissolved or suspended in water may give water different coloured appearances. The presence of colour in water does not necessarily indicate that the water is not potable. Colour-causing substances, such as tannins, may be harmless. Qualitative visual assessment of the watercolour can be carried out in the field by filling a 0.3 litre volume drinking glass and holding it in front of white paper.

Different tastes and odours

The odour of drinking water samples can be determined by the olfactory sense of the sampler in the field, or the well-covered sample can also be taken indoors for testing.

For the field test, a 0.3l glass is filled with water and the odour is determined by smelling. The intensity of the smell can be categorised as weak, medium or strong. The type of odour can be attributed to no odour, faecal, soil, chlorine and others.

In many centralised water supply systems, chlorine gas is added to drinking water during the final stages of treatment to kill any harmful germs that may be present. A small amount of chlorine remains in the water as it makes its way to customers' taps and gives the water a chlorine taste.

Water that passes through peaty land can have an earthy or musty taste and/or odour. Rubber and plastic hoses used to fill drinking water tanks or vending machines and hoses of washing machines and dishwashers can give rise to a rubbery or plastic taste. Copper, iron or galvanised pipes can cause a metallic or bitter taste.

Spilled heating or motor oil or petrol on driveways and gardens can adversely affect the groundwater. A plastic service pipe located in this area can also adversely affect water. If petrol or a chemical taste or odour is detected in the drinking water, the customers should contact the water supplier.

4. How to do a pH test

pH is the unit of the acidity or alkalinity of a solution. Pure distilled water at 25 °C has a pH level of 7 and is called neutral (the measurement scale ranges from 0-14). Acids are defined as solutions that have a pH less than 7, while bases (alkaline) are defined as solutions that have a pH more than 7. The normal range for pH in surface water systems is 6.5 to 8.5, and the pH range for groundwater systems is between 6 and 8.5.

The drinking water directive of the European Union indicates the pH units in drinking water should not be aggressive which means not less than 6.5 and not exceed 9.5 pH units.

How to use the pH indicator test strips:
- Water temperature should be about 20 °C when it is measured because the pH level depends on the temperature as well.
- Dip the strip for 1 to 3 seconds for reaction to take place and compare strip to colour chart.

Litmus tests can be applied to indicate if a liquid is acid or alkaline. Litmus strips are cheaper than pH indicator test strips, however they are not as precise. A much more advanced and precise method is to use a digital pH meter, which nevertheless should be properly calibrated.

ph		
1	Gastric acid	Acid
2	Lemon juice	
3	Vinegar	
4	Tomato juice	
5	Black coffee, bananas	
6	Milk, Urine	
7	Distilled water	Neutral
8	Sea water, eggs, blood	Alkaline
9	Baking soda	
10	Soap	
11	Ammonia solution	
12	Bleach	
13	Drain or oven cleaner	
14	Sodium hydroxide (NaOH)	

Examples of some liquids and their pH (acidity/alkalinity; source: https://www.bbc.co.uk/bitesize/topics/zn6hvcw/articles/z38bbqt)

Handwashing is essential for proper hygiene

Nitrate testing tube containing test strips, measuring the nitrate concentration of water with a range from 0 – 10 – 25 – 50 – 100 – 250 – 500 mg/litre are very suitable.

5. How to do quick nitrate tests

Nitrate in water is undetectable without testing because it is colourless, odourless, and tasteless. Nitrate in drinking water can be a problem, especially for newborn babies. A water test is the only way to determine the nitrate concentration and ascertain whether it is under the acceptable EU standard of 50 mg/l.

A quantitative nitrate test is usually done in a laboratory, but with nitrate quick tests strips, a very good and reliable impression on the rate of the nitrate concentration in water can be gained. Nitrate test strips give a semi quantitative result, and fulfil the purpose of detecting a nitrate contamination or not.

Although the tests are easy to carry out, some rules and regulations have to be followed:

- Read the instructions of the package carefully. Assure a clean and proper working place.
- For testing the nitrate concentration in water, keep the strip just one second in the water sample and shake excess water from the strip very gently.
- Wait one minute and compare the developed colour with the colour scale on the tube.
- Do not test nitrate in an area with a temperature below 15 °C. During times with cold temperatures the chemical reaction of test strips is decreased. Therefore, please take the sample to a warm location for testing.
- In case of unexpected results, it is necessary to repeat the analysis. For this reason, pour a new sample into a clean glass and repeat the procedure as described above.
- Please be aware that the test strips are not suitable for chlorinated drinking water.
- If no tests are carried out between testing phases, please cover the test strip tube with the lid.
- Store the well-closed tube in a cool place. The fridge is the best place.

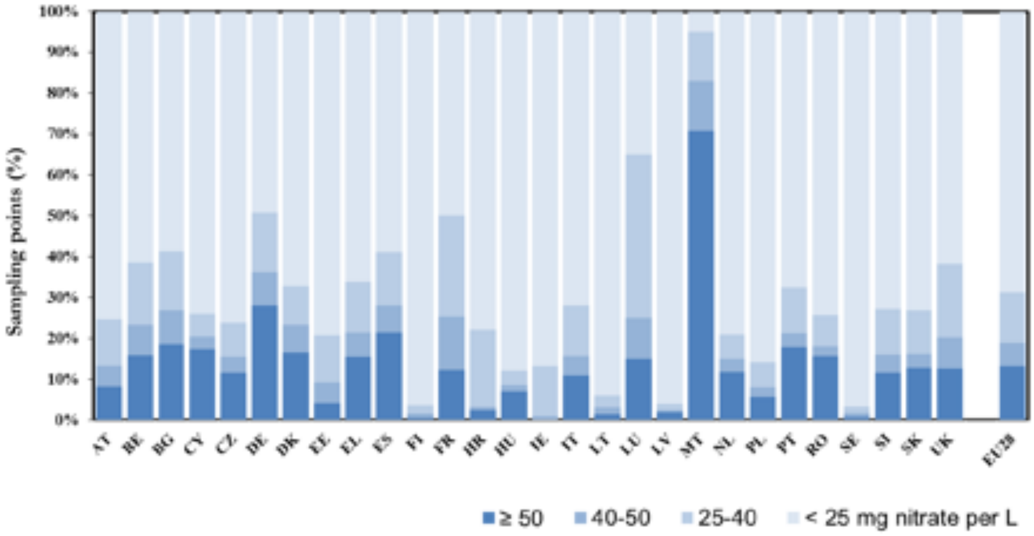
It is possible to cut the test strip lengthways and make two strips from one strip. Please work very clean and hygienically and use very clean scissors. Never touch the nitrate indicator with your fingers and do not lay the strips down anywhere, like on the table.

For the European region, the Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (the Nitrates Directive) was adopted on 12. December 1991. It aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices. The Nitrates Directive forms an integral part of the Water Framework Directive and is one of the key instruments in the protection of waters against agricultural pressures. According with the requirements of the Directive, member states shall designated nitrate vulnerable zones. The maps of these zones across Europe, can be found at the following link:
Nitrate Vulnerable Zones

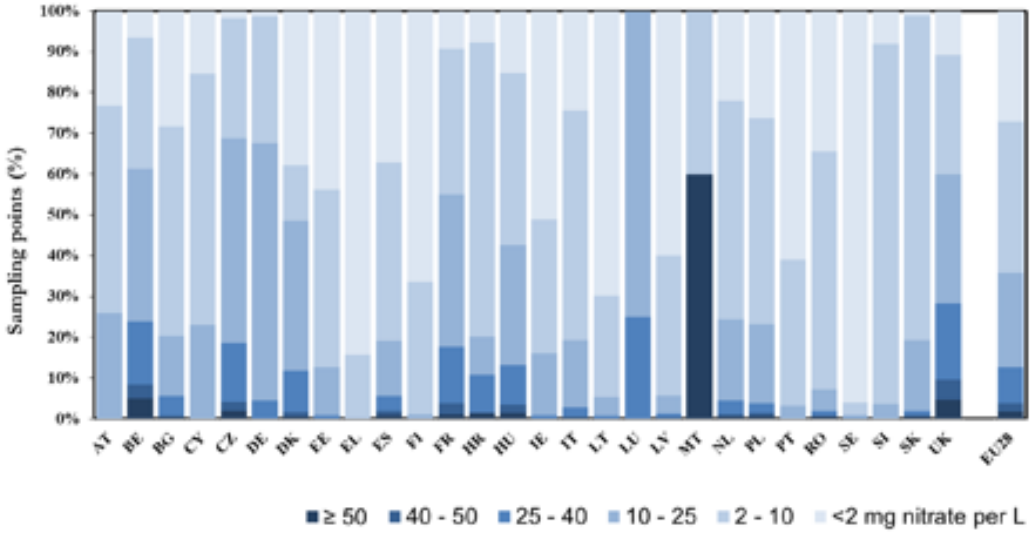
The Report from the Commission to the Council and the European Parliament on the implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources based on Member

State reports for the period 2012–2015 shows the following range of concentrations of nitrates in ground and surface waters by countries (European Commission, 2018)

Frequency diagram of annual average nitrate concentrations in groundwater. Results are presented for all groundwater stations at different depth (source: European Commission, 2018)



Frequency diagram of annual average nitrate concentration in fresh surface waters (rivers and lakes, source: European Commission, 2018)



6. Recording the results

Recording and reporting the sample type, tests carried out, results and observations are the basis for communication and keeping track of developments. Recorded results should be readable, understandable and transparent to all concerned stakeholders. Please record at least the following information of sampling: date and location (street, house number, village), source of water, information about the environment of the water source, date of analyses and the results. See model sample forms at the end of this module and in module A6.

7. WSSP related activities, output and results

WSSP activities	Output and results
Ask the water supplier or other responsible authorities for analyses results of the water supply system(s): • What is the frequency of the analyses? • Is the water quality of all relevant water points or sources analysed? • Are the most relevant water analyses carried out (i.e. bacteria)? • Are the analysed parameter complying with the established maximal values?	Insight is obtained on the results and frequency of carried out water analyses.
Discus the available analyses results and take decisions on additional monitoring activities to be carried out by a certified laboratory or by mobile test kits.	Decisions are taken on additional required analyses and the method on performing the analyses.

Water Safety Plan is a tool that allows the users to consistently establish the parameters characterising drinking water quality, based on the hazards identification and associated health risks for consumers in the critical points of the supply system.

8. Text sources and further reading

European Commission (2022). Nitrate Vulnerable Zones. Available online: https://water.jrc.ec.europa.eu/portal/apps/webappviewer/index.html?id=d651ecd9f5774080aad738958906b51b

European Commission (2018). Report from the commission to the council and the European parliament on the implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources based on Member State reports for the period 2012–2015. Available online: https://ec.europa.eu/environment/water/water-nitrates/pdf/nitrates_directive_implementation_report.pdf

Ministry of Health, Wellington New Zealand (2007). Monitoring and Sampling for Small Supplies: Resources for the Drinking-water Assistance Programme.

WHO, UNICEF (2012). Rapid assessment of drinking-water quality: A handbook for implementation. Available online: https://www.who.int/publications/i/item/789241504683

WHO (2017). Guidelines for Drinking-water Quality, 4th edition. Available online: https://www.who.int/publications/i/item/9789241549950

source:
Vladimir Munitlak

Example form for sampling and analysing microbiological contaminants and residual and bound chlorine

Bacteriological Analyses	**Residual and Bound Chlorine**
Name of body or person responsible for the supply Name of sampler Type of water supply Locality Sample site Source Sender or user Date and time of sampling Date and time of analysis Remarks	Name of sampler Type of water supply Locality Sample site Source Sender or user Date and time of sampling Date and time of analysis Residual chlorine mg/l Bound chlorine mg/l Residual chlorine inactivated? Yes / No

Bacterium	**Result**	**Maximal allowed contaminant level: /100 ml**
Total coliforms	/100 ml	0 /100 ml
Enterococci	/100 ml	0 /100 ml
Escherichia coli	/100 ml	0 /100 ml
Other	/100 ml	/100 ml

Summary: Bacteriological quality of the sample:
good / bad

Analysis carried out by
Date
Signature

A6

MAPPING THE VILLAGE / VISUALISATION OF ANALYSIS RESULTS

Authors: Doris Möller, Margriet Samwel

SUMMARY A village map with the location of the water sources (wells or springs) and their related nitrate concentrations gives an indication of the "hot spots" of polluted water sources, and the areas with little or no nitrate pollution. A similar map can be produced with the locations of pollution sources. Long-term monitoring of the nitrate concentrations of different local water sources gives an insight into the level of water pollution during the different seasons.
Forms for recording the monitoring results, examples of village maps with locations of the monitored wells or distribution system and graphics of long-term nitrate monitoring results are found in this module:

A6-a Form for collecting monitoring results of water sources in and around the village
A6-b Form for reporting results of the long-term (seasonal) monitoring of 2 water sources
A6-c Example of mapping a village in Uzbekistan
A6-d Example of mapping water sources in a village and the related nitrate concentrations in Belarus
A6-e Example of visualisation of the seasonal fluctuation of nitrate concentration in 5 different wells and 2 different regions in Romania
A6-d Example of a water network diagram.

OBJECTIVES The reader is able to register analytical results, to visualise the water supply system and available water sources in a village map and to process long-term nitrate monitoring results of selected wells in a graphic. By this activity a better understanding of the sensibility of the groundwater pollution and its causes will be reached. The maps and graphics contribute to the identification of strategies for providing safe water to the citizens.

KEY WORDS AND TERMS Mapping, visualisation, monitoring, graphics, reporting, sharing information

Introduction

For the implementation of a Water Safety Plan, a lot of data is produced and collected. One way to get a better overview of the collected data about water sources and their locations, or about the area with potential contaminants is by making the data visible in maps and/or graphics. An advantage of producing maps and graphics (visualisation) is that the results are easier accessible and understandable to a broader public.

Nowadays, the mobile phones allow precise geographical location with GPS coordinates and digitization of information. This means that they can be easily used as a valuable tool for mapping the results of water quality and establish the location of the wells having construction or water quality problems. This approach can be used as an analysis tool in designating the areas with problems (hot spots), in order to take decisions about interventions, and to improve the situation.

To another level of complexity, where the responsible institutions are involved in generating data with geographical location, and in establishing a GIS (Geographic Information System), they have to keep in mind the requirements of INSPIRE Directive 2007/2/EC establishing an infrastructure for spatial information in Europe to support Community environmental policies, and/ or activities which may have an impact on the environment. The Directive addresses 34 spatial data themes needed for environmental applications, water included, with key components specified through technical implementing rules. This makes INSPIRE a unique example of a legislative “regional” approach.

1. Mapping the village and its water sources / distribution network

If possible, use an existing map of the village. If the village is served with a centralised piped water system, probably the local administration or the water supplier will have at its disposal a village map, showing the distribution pipes, water reservoirs, abstraction points and the houses connected to the network. If no map is available, a village map should be drawn (see example A6-c). First draw a draft to find out what has to be included, how big the scale will be, and of which size the map will be drawn. Alternatively maps of the different areas of the community could be drawn. Use the water supply (the well, where the drinking water is taken from) as the centre of the map and include the near surroundings. Place the maps together to get a bigger picture of the village. If there are still unmapped parts of the settlement, the basic elements should be added. Drafts are sufficient here. If the individual maps overlap, compare the results. The more accurate version will be placed on top.

The following basic elements should be found:

- Distinctive landmarks and institutions such as schools, churches, town hall, dispensary
- Heights (hills, valleys, etc.)
- Rivers, waterways etc.
- Streets and houses
- North/South/East/West
- Direction of the water flow of the groundwater and/or rivers
- Scale

Then include the following elements:

- Water supply: wells, public tabs, water points, springs, network of pipes, etc.
- Land use, such as grazing land, landfill (dump), industry or small businesses (garages, fuel stations, workshops etc.)
- (Pit/school) latrines, disposal of wastewater
- Pig/cow stables

After testing the nitrate concentration of the different water sources, think about using colours to mark the quality of each water supply (see also module B4 and A5). Different symbols can be used to distinguish the various types of water supplies. Insert the nitrate monitoring or other monitoring results into the related water sources. In addition, the possible identified sources of water pollution could be included in the same map. For a village served with a water supply network, the map can clarify which houses are connected to the supply, the location of the water abstraction and the catchment area with the different protection zones. On the map, the land-use or human activities within the catchment zones could be distinguished and critical circumstances could be identified (see also module B9).

For the European region, where the regionalization of water utilities is encouraged, including by the use of economic tools of loans and grants for infrastructure in rural areas, often the regional operators extended the drinking water and sewage networks to the neighbouring villages, and these water operators have a SCADA System implemented. SCADA System means Supervisory Control and Data Acquisition and it is used for controlling, monitoring, and analysing industrial devices and processes, and it is very popular for drinking water management. It means that the water operator has a precise map of the whole supply system and can make it available to the community that is interested in the surveillance of its water quality, for educational and awareness activities.

2. Visualisation of the fluctuation of nitrate results

The quality of water sources are influenced by geographical and geological conditions, environmental events and circumstances, as well as by human activities, including management of animal and human excreta manure or gardening. Therefore, many water sources do not have stable quality and parameters such as microorganism or nitrates can fluctuate more or less throughout the year. However, in case of deep and/or impermeable soil layers a contamination of the groundwater can take dozens of years. To understand the sensitivity of water sources to man-made (anthropogenic) contaminants, it is very useful to select some water sources in different locations within or around the village and monitor the nitrate concentration of the sources on a regular basis (form A6-b can be used for recording the results). If possible, monitor the sources during one year every 2 or 3 weeks (long-term or seasonal monitoring). To investigate the influence of precipitation on the nitrate concentration in the water source, the weather events should be recorded. A precipitation measure beaker in a yard could be used for this task, or it could be recorded by simple observation. The monitoring results can be collected in a form and finally processed/visualised in graphics (see example in this module). Graphics can be made by hand or with a computer programme. The recorded levels of precipitation and the long-term nitrate monitoring results should be processed in a graphic, and the two recording's data should parallel by having the same time frame. In the graphic, it is extremely important to mention: the used units, the related parameter, date of sampling, type of water source or sample, etc., and to give a clear subtitle of the visualised results of the investigation. Finally, an outsider should be able to understand the presented data.

3. Sharing information

It is recommended to prepare a poster of the maps and graphics, and hang this in a public place, a school corridor or in another public place, where the results of the findings are open to the WSSP team, broader public and school. Discuss the results with the water authorities and other stakeholders and try to correlate the ultimate observed fluctuation with special events, which could be for example application of fertilizer and/or manure of the fields, leakages of nitrates from the soil into the groundwater after heavy rainfall. Please be aware that a low nitrate concentration in the water source is no guarantee for safe drinking water.

4. WSSP related activities, outputs and results

WSSP related activities	Outputs and results
Obtain or draw a map of the community indicating the water sources, wells etc., if applicable the water network, the sewage system and the connected and noncon-nected households and public institutions.	A map indicating the infrastructure related to water and sanitation within the community is available.
Insert in the map the collected data on sources of possible pollution, such as manure heaps, agricultural fields, pit latrines, leakages within the network etc.	A map indicating the infrastructure related to water and sanitation within the community and the locations with possible water pollutants is available.
Insert in the map the results of the water quality analyses.	A map indicating the water quality of the present and used water sources and/or network branches is available.
Make the trend of a possible change of the water quality visible by graphics (seasonal monitoring results or for years collected data.	Possible long-term trends on the water quality are made visible.
Make the results accessible to stakeholders and community via local exhibitions or media etc. Discuss and document the findings, the possible trends of water quality and causes.	The results are presented and discussed with stakeholders and the community, conclusions and recommendations are formulated and documented.

5. Text sources and further reading

WaterAid (2007). WaterAid learning for advocacy and good practice. Water and sanitation mapping: a synthesis of findings. Available online: http://www.odi.org.uk/resources/docs/3838.pdf

source:
Vladimir Munitlak

A6-a

Form to register nitrate monitoring results of water sources

The analysis results and the location of the related water sources can be inserted in a village map.

Date of sampling	**Type of water source** (centralised piped water, well, spring or river, etc.)	**Location of sam-pling**	**Depth of well/ groundwater**	**Nitrate [mg/l]**	**Remarks**

A6-b

Form to seasonal (long-term) nitrate monitoring results of a selected water source

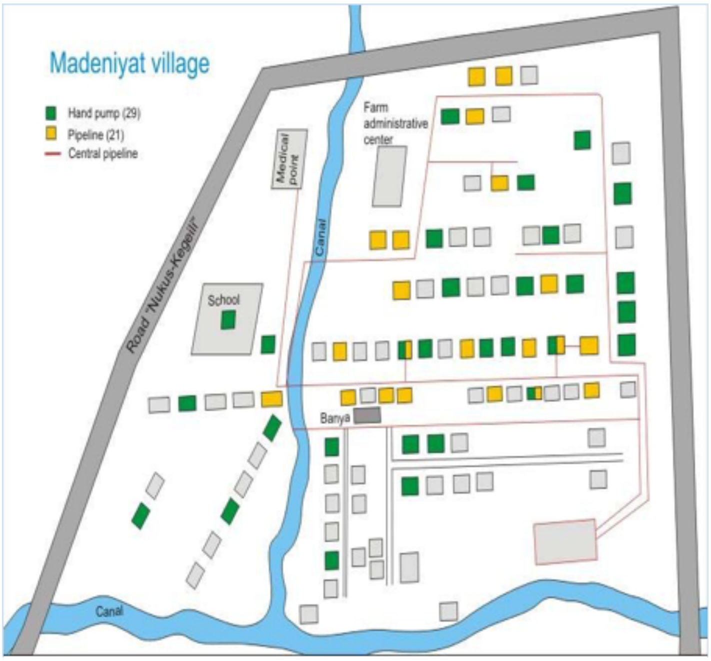
For the seasonal fluctuation of the water quality nitrate tests of some selected water sources can be carried out every 2 or 3 weeks during one year. Parallel to the monitoring the level of precipitation is measured with a precipitation measure beaker or observed and recorded. The results should be processed in a graphic.

Responsible person or institution or school:			
Name and address of the monitored water source:			**Remarks**
Type of water (individual or public well, public tap or centralised piped supply):			
Used waters source (groundwater, river spring or others): If applicable depth of used groundwater:			
State of water source:			
Date of sampling	Nitrate mg/l	Are particles or others visible?	Weather events during during/ between the sampling periods (rainfall or droughts)

A6-c

Example of mapping a village in Uzbekistan

A village map with the locations and types of the water sources increases the understanding of the local water system. If applicable, the water and sewage network and house-connections should also be included.



Map of a village in Uzbekistan with the locations and types of the water sources (source: WECF/Mehriban, 2007, TMF Project)

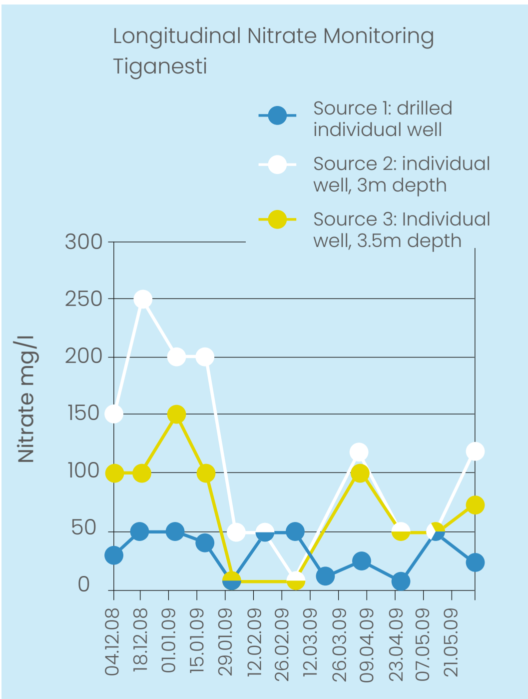
A6-d

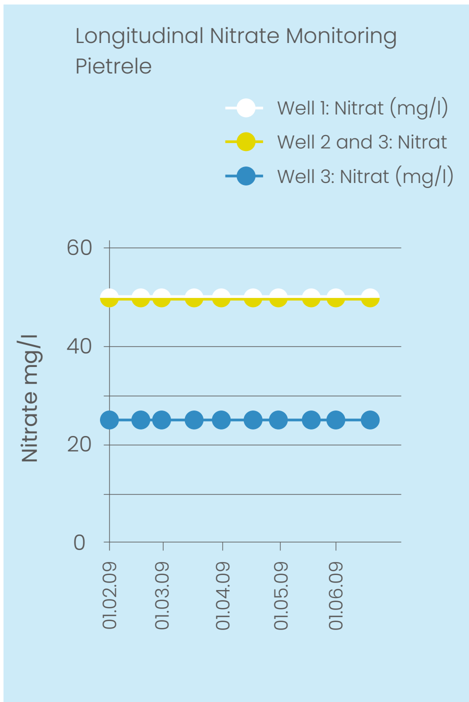
Examples of visualisation of the seasonal fluctuation of nitrate concentration in 6 different wells and 2 different regions, Romania

Nitrate concentrations in groundwater (but also the contamination with microorganism) can more or less fluctuate during the year and season. The fluctuations depend on e.g. human activities, the type of soil layers and amount of precipitation, the velocity and the depth of the groundwater. Long-term monitoring of nitrate concentrations of water sources can give some information about the sensibility of the water for pollution caused by for example the level of precipitation or snow melting or human activities such as fertilising the fields, lack of safe management of pit latrines or manure. Answers on questions such as "why are some wells severely polluted, why is the nitrate concentration increasing in springtime" should be found by conducting a hazard assessment. Please see module A7.

The graph on the right shows the monitoring results of three wells from a groundwater layer of 60 m depth. They don´t show any fluctuation in the nitrate concentration, indicating that the aquifer is not sensible to seasonal fluctuations. However, a nitrate concentration of 50 mg/l indicates that the aquifer is influenced by man-made pollution.

The water samples in Tiganesti (at the left), from a groundwater layer of 8 m depth, partly show an enormous nitrate decrease in the months of December and January. This is the season when the pigs, mostly located in the backyards of the households, are slaughtered. The graphic also shows that the groundwater is very sensitive to the infiltration of contaminants.





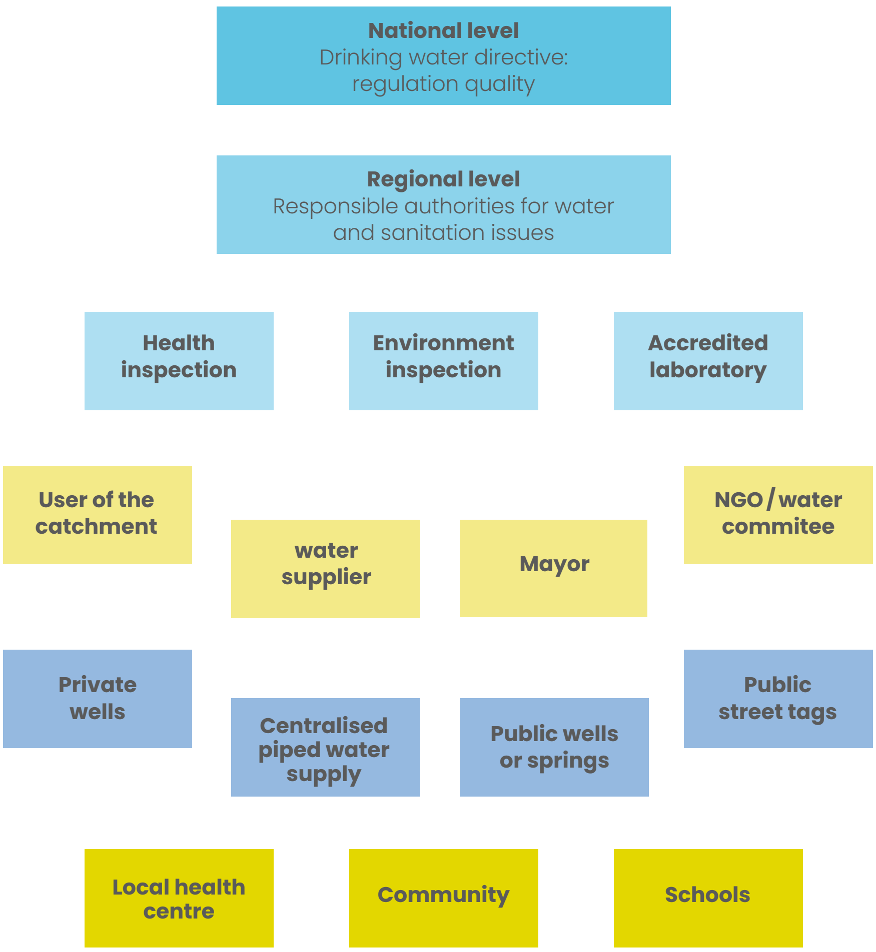
Seasonal nitrate monitoring results of different wells in the villages Ţigăneşti (Teleorman county) and Pietrele (Giurgiu county), Romania, carried out by the local schools (source: WECF/EuroTeleorman, 2009, Fondation Ensemble project)

A6-e

Water network diagram
Identifying stakeholders of the water supply system

Key stakeholders involved in a water supply system should be identified and recorded. Of course, other stakeholders, such as school or farmers, can be added. Please set the relevant stakeholders into the right boxes and visualise their relationships and interactions by lines and arrows.

The network diagram clarifies the main responsibilities and connections of the different stakeholders for the provision of a safe water supply in a community. In the diagram below, possible stakeholders at different levels and/or positions are presented in different colours. However, their relationships and interactions are not (yet) made visible.



Water network diagram


НАЛОГ
СОЦФОНД

A7

RISK ASSESSMENT OF SMALL-SCALE WATER SUPPLY AND SANITATION SYSTEMS

Authors: Margriet Samwel, Claudia Wendland

SUMMARY – USING SANITARY INSPECTION FORMS
The following represents a basic guidance for assessing risks of a range of small-scale water supply systems such as point sources like boreholes, springs, dug wells and centralised piped water supplies, furthermore for sanitary facilities such as a school or other public toilets.

A range of checklists for the sanitary inspection of several water supply and sanitation systems are presented. In this module the use of the forms and the valuation of the assessed risks are explained.

Risk assessment forms are provided for:

a) Dug well or borehole
b) Public tap of piped water
c) Piped water with service reservoir
d) Gravity-fed piped water
e) River-water-fed piped water
f) Deep borehole with mechanised pumping
g) Protected spring
h) Sanitation facility in the school (or other public places)
i) Hand wash facility in the school

OBJECTIVES The reader can carry out a basic sanitary inspection of small-scale water supply and sanitation systems and identify the level of risks for the assessed systems.

Introduction

Having explained and in understanding the water supply system technically and/or the sanitary systems such as toilets, the next step is to conduct a risk assessment – hazard analysis of the system. Hazards may occur throughout the whole system, from the water catchment to the point of consumption, but can also occur while toilets are unhygienic, or the faecal matter is managed unsafely. One of the most critical hazards within a water supply system is caused by infiltration and contamination of the drinking water with microorganisms (pathogens). Pathogens generally originate from human or animal faecal material, contaminating raw water and finding their way into the water delivery system. Common sources of faeces include: wildlife such as birds, grazing animals and vermin in and around reservoirs, backflow from unprotected connections and sewer cross connections.

One way to identify hazards is through conducting water analysis (see module A5). However, water analyses illustrate the presence or absence of a contaminant in a certain moment. Therefore, possible factors that could cause contamination at all possible times must be considered. For example, the application of human or animal manure, or an accident with a sewage line in a catchment area, can be a temporary hazard of the supply system and not necessarily affect it indefinitely (see module B6). Besides the required water analyses, visual surveys and interviews are extremely important for the overall assessment of a drinking water system.

Sanitation and hygiene are two essential pillars for public health, which are assessed within this module as well. The schools and public places are locations where parts of the community meet and are in close contact. Unsafe sanitation and hygiene here are major causes for diseases. Hygiene education and behaviour play of course a major role in prevention and has to be assessed in separate interviews in addition to these inspections.

1. Sanitary inspection forms

The World Health Organization (WHO) developed sanitary inspection forms for conducting a sanitary inspection (risk assessment) of small-scale water systems. For different distribution systems the situation and risks can be different and therefore, also different aspects have to be considered and surveyed. For the most relevant small-scale water supply systems, sanitary inspection forms were developed, presenting a checklist for the basic and most general hazards.

In addition to the drinking water aspects, this module recommends sanitary inspection of the risk assessment of sanitation and hand wash facilities in schools and other public places. The situation of sanitation and hygiene in schools is of importance for public health also in small communities as water and excreta related diseases easily spread in the school environment and public places, thus affecting the whole community. To assess the health risk of unsafe sanitation and inadequate handwashing facilities, the sanitary inspection forms were developed by WECF. The checklists contain a list of questions, which should be answered by having a look at the system and the surroundings, and may be by interviewing relevant persons (see module A8). The question of the checklist must be answered with “yes” or “no”.

The forms presented in this module were partly adjusted to the local requirements or extended to other relevant possible hazards. The sanitary inspection forms enable the user to conduct a basic and simple sanitary survey of the water sources, contributing to the identification and understanding of the hazards in a system. The sanitary inspection is an important part of a WSSP, although it is not a stand-alone activity for the implementation of a WSSP. The risk assessment is like a piece of the whole “WSSP puzzle", and the challenge will be to gather and interpret the correct information.

In this module, the following risk assessment forms are provided for assessment:

a) Dug well or borehole
b) Public tap of piped water
c) Piped water with service reservoir
d) Gravity-fed piped water
e) River-water-fed piped water
f) Deep borehole with mechanised pumping
g) Protected spring
h) Sanitation facility in the school (or other public places)
i) Hand wash facility in the school

The WSSP team should discuss and decide which form should be used, and which questions of the sanitary inspection are lacking and should be added. Depending on the water system, several systems, such as centralised piped water supply, can only be assessed in cooperation with the responsible person or team of the water supply system. In case of an individual or public dug well or borehole, the assessment can be carried out mainly by observation. In EU countries, the public wells are surveyed by the local health authority and the community is advised what to do in order to remediate the problem and protect the public health.

2. The results

After the "yes" and "no" answers of the related form are identified, the "yes" answers are counted, one "yes" equals to one point. The total score of "yes" answers are summed up at the bottom of the form and give the related level of risks of the water or the sanitation system. However, positive results of a sanitary inspection are no guarantee for protecting public health or safe drinking water. Groundwater and spring sources can be influenced by contaminants, which infiltrated the source many kilometres away from the point of abstraction (see also module B6). Also water from mountainous areas with karst formations in particular can be sensible for contaminants. A challenge in identifying the risks of water sources is the amount of knowledge there is regarding the hydrological and geological conditions of the sources. Unfortunately, this knowledge is not always available.

From case to case, it may be concluded that not all the questions of the form have the same level of risks. For example, in Form a. "risk assessment of dug well or borehole", questions 1 and 2 (Is there a latrine, animal breeding etc. within 30 m of the well or borehole?) could be more important than question 6 (Is the fence missing or faulty?).

Furthermore, possible risks of water contamination related to, for example, the mining of minerals or oil are not considered in the offered sanitary inspection forms. Industry and geological conditions are also not included. For more information on WSSP risk assessments with typical hazards on several stages of a piped water distribution system, refer to the information presented in module A3. Nevertheless, carrying out a risk assessment by using the sanitary inspection forms is an excellent tool for learning more about the possible risks of the water system and raising awareness on possible sources of pollution.

A sanitary surveillance of a drinking water facility means according to the WHO views, a field inspection based on the form mentioned above, and laboratory analysis of water quality. The recommendation for the community is to closely work with health authority, and a specialised and accredited analysis laboratory, when the risk score based on the field inspection forms is higher than 6 points. Usually, an inspection

source:
Vladimir Munitlak

form has a legend explaining what is the mean of the risk score and what are the actions associated with each range of risk. E.G. Risk score: 9-11 = Very high risk; 6-8 = High risk; 3-5 = Medium risk; 0-3 = Low risk. Actions: **Low risk** – water is good; **Medium risk** – water is acceptable; **High risk** – test water, seek specialist advice, temporarily use another source of water; **Very high risk** – do not drink water until you eliminate the causes of contamination.

A "Guideline for small communities on risk based drinking water management in Romania" is available online in English and Romanian.
The Guideline presents a study case from Romania, but the general principles are applicable globally.

3. Text sources and further reading

WHO (2001). Water quality: guidelines, standards and health: assessment of risk and risk management for water-related infectious diseases.
Available online: https://apps.who.int/iris/handle/10665/42442

WHO (2009). Water, sanitation and hygiene standards for schools in low-cost settings.
Available online: https://apps.who.int/iris/handle/10665/44159

Aquademica (2018). Guideline for small communities on risk-based drinking water management in Romania. Available online: https://aquademica.ro/guideline-for-small-communities-on-risk-based-drinking-water-management-in-romania/

A7-a

Risk assessment of dug well or borehole

Village:
Location:
Depth of well/borehole: m
Nitrate (quick test) concentration of the water: mg/l
Date of visit:
Assessment was carried out by:

	Specific Diagnostic Information for Assessment Risk	Yes	No	Remarks
1	Is there a latrine within 30 m of the well or borehole?			
2	Is there animal breeding of pigs, cows, goats or others within 30 m of the well or borehole?			
3	Is there any cultivation (use of manure or fertiliser) within 30 m of the well or borehole?			
4	Is the drainage faulty, allowing ponding within 2 m of the well or borehole?			
5	Is the drainage channel cracked, broken or needs cleaning?			
6	Is the fence missing or faulty?			
7	Is the apron less than 1 m in radius?			
8	Does spilt water collect in the apron area?			
9	Is the apron cracked or damaged?			
10	Is the hand pump loose at the point of attachment?			
11	Is the well-cover unsanitary?			

Source: WHO Guidelines for drinking water quality, 4th ed., modified by WECF

Total Score of Risks: 10 for dug well; 11 for borehole Risk score:

Very high risk	High risk	Medium risk	Low risk
11-9	8-6	5-3	2-0

Results and Recommendations:

The following important points of risk were noted (list 1-11):

Comments:

A7-b

Risk assessment of public tap of piped water

Village:
Location:
Nitrate (quick test) concentration of the water: mg/l
Date of visit:
Inspection was carried out by:

	Specific Diagnostic Information for Assessment Risk	Yes	No	Remarks
1	Does any tap stand leak?			
2	Does surface water collect around any tap stand?			
3	Is the area uphill of any tap stand eroded?			
4	Are pipes exposed close to any tap stand?			
5	Is human excreta on the ground or latrine within 30 m of any tap stand?			
6	Is animal manure on the ground within 30 m of any tap stand?			
7	Is there any fertilising with manure or chemicals within 30 m of any tap stand?			
8	Is there a sewer within 30 m of any tap stand?			
9	Is there a sewer or any fertilising with manure or chemicals within 30 m of any extraction point?			
10	Has there been discontinuity in the last weeks at any tap stand?			
11	Are there signs of leaks in the mains pipes in the parish?			
12	Did the community report any pipe breaks in the last weeks?			
13	Are the mains pipes exposed anywhere in the parish?			

Source: WHO Guidelines for drinking water quality, 4th ed., modified by WECF

Total Score of Risks: 13
Risk score:

Very high risk	High risk	Medium risk	Low risk
13-10	9-7	6-4	3-0

Results and Recommendations:

The following important points of risk were noted (list 1-13):

Comments:

A7-c

Risk assessment of piped water with service reservoir

Village:
Location:
Nitrate (quick test) concentration of the water: mg/l
Date of visit:
Inspection was carried out by:

	Specific Diagnostic Information for Assessment Risk	Yes	No	Remarks
1	Does any standpipe leak at sample sites?			
2	Does water collect around any sample site?			
3	Is the area uphill of any tap stand eroded?			
4	Are pipes exposed close to any sample site?			
5	Is human excreta on the ground within 30 m of any tap stand?			
6	Is a sewer or latrine within 30 m of any sample site?			
7	Is animal manure on the ground within 30 m of any tap stand?			
8	Is there any fertilising with manure or chemicals within 20 m of any sample site?			
9	Has there been discontinuity in the last weeks at any sample-site?			
10	Are there signs of leaks in the sampling area?			
11	Did the community report any pipe breaks in the last weeks?			
12	Is the main supply exposed in sampling area?			
13	Is the service reservoir cracked or leaking?			
14	Is the inside of the service reservoir clean?			
15	Are the air vents or inspection cover unsanitary?			

Source: WHO Guidelines for drinking water quality, 4th ed.; modified by WECF

Total Score of Risks: 15
Risk score:

Very high risk	High risk	Medium risk	Low risk
15-12	11-8	7-5	4-0

Results and Recommendations:

The following important points of risk were noted (list 1-15):

Comments:

A7-d

Risk assessment of gravity-fed piped water

Village:
Location:
Nitrate (quick test) concentration of the water: mg/l
Date of visit:
Inspection was carried out by:

	Specific Diagnostic Information for Assessment Risk	Yes	No	Remarks
1	Does the pipe leak between the source and storage tank?			
2	Is the storage tank cracked, damaged or leaking?			
3	Are the vents and covers on the tank vermin-proof?			
4	Is the storage tank clean?			
5	Does any tap stand leak?			
6	Does surface water collect around any tap stand?			
7	Is the area uphill of any tap stand eroded?			
8	Are human excreta on the ground or a latrine within 30 m of any tap stand?			
9	Is there any fertilising with manure or chemicals within 30 m of any tap stand?			
10	Is there a sewer within 30 m of any tap stand?			
11	Is there a sewer or any fertilising with manure or chemicals within 30 m of any extraction point?			
12	Has there been discontinuity in the last weeks at any tap stand?			
13	Are there signs of leaks in the mains pipes in the system?			
14	Did the community report any pipe breaks in the last weeks?			
15	Are the main pipes exposed anywhere in the system?			

Source: WHO Guidelines for drinking water quality, 4th ed., modified by WECF

Total Score of Risks: 15
Risk score:

Very high risk	High risk	Medium risk	Low risk
15-11	10-7	6-4	3-0

Results and Recommendations:

The following important points of risk were noted (list nos. 1-15):

Comments:

A7-e

Risk assessment of river water-fed piped water

Village:
Location:
Name of river:
Depth, width and length of the river: m, m, m
Date of visit:
Inspection was carried out by:

	Specific Diagnostic Information for Assessment Risk	Yes	No	Remarks
1	Is the area upstream eroded?			
2	Is there ground cover (meadow or forest) within 100 m from the riverbank to the extraction point?			
3	Have grazing animals access to the river within 100 m from the riverbanks to the extraction point?			
4	Is there any fertilising with manure 100 m from the riverbanks to the extraction point?			
5	Is there any waste dumping place within 100 m from the riverbanks to the extraction point?			
6	Is there any communal or industrial wastewater discharge into the river upstream?			
7	Are particles in the water removed by sedimentation/filtration?			
8	Is the treated water disinfected?			
9	Is the storage tank cracked, damaged or leaky?			
10	Are the vents and covers on the tank vermin-proof?			
11	Is the storage tank clean?			
12	Does any tap stand leak?			
13	Has there been discontinuity in the last weeks at any tap?			
14	Are there signs of leaks in the main pipes of the system?			
15	Did the community report pipe breaks in the last weeks?			

Source: WHO Guidelines for drinking water quality, 4th ed. and DVGW Arbeitsblatt W102, modified by WECF

Total Score of Risks: 15
Risk score:

Very high risk	High risk	Medium risk	Low risk
15-11	10-7	6-4	3-0

Results and Recommendations:

The following important points of risk were noted (list 1-15):

Comments:

A7-f

Risk assessment of deep borehole with mechanised pumping

Village:
Location:
Depth of borehole: m
Nitrate (quick test) concentration of the water: mg/l
Date of visit:
Assessment was carried out by:

	Specific Diagnostic Information for Risk Assessment	Yes	No	Remarks
1	Is there a latrine or sewer or animal manure 100 m from the pump house?			
2	Is there any source of other pollution within 100 m?			
3	Is there an uncapped well within 100 m?			
4	Is the drainage around the pump house faulty?			
5	Does damaged fencing allow animal entry?			
6	Is the floor of the pump house permeable to water?			
7	Does water form pools in the pump house?			
8	Is the well seal unsanitary?			
9	Is the well-cover unsanitary?			

Source: WHO Guidelines for drinking water quality, 4th ed., modified by WECF

Total Score of Risks: 9
Risk score:

Very high risk	High risk	Medium risk	Low risk
8–9	6-7	4-5	0-3

Results and Recommendations:

The following important points of risk were noted (list 1-9):

Comments:

A7-g

Risk assessment of a spring

Village:
Location:
Depth of borehole: m
Nitrate (quick test) concentration of the water: mg/l
Date of visit:
Inspection was carried out by:

	Specific Diagnostic Information for Risk Assessment	Yes	No	Remarks
1	Is the spring unprotected?			
2	Is there a latrine or sewer uphill and/or within 30 m of the spring?			
3	Is there any fertilising with manure or agricultural chemicals uphill or within 30 m of the spring?			
4	Is there any other source of pollution uphill and/or within 30 m of spring? (i.e. waste disposal, manure or compost heaps, pesticides)			
5	Can animals have access within 30 m of the spring?			
6	Is the masonry of the spring (basin or reservoir) faulty?			
7	Is the backfill area behind the retaining wall eroded?			
8	Is the fence absent or faulty?			
9	Does surface water collect uphill of the spring?			
10	Is the diversion ditch above the spring absent or non-functional?			

Source: WHO Guidelines for drinking water quality, 4th ed., modified by WECF

Total Score of Risks: 10
Risk score:

Very high risk	High risk	Medium risk	Low risk
9–10	6-8	3-5	0-2

Results and Recommendations:

The following important points of risk were noted (list 1-10):

Comments:

A7-h

Risk assessment of a school or public toilet

Village:

Name of the school/location:

Type of toilet:	Flushed toilet & sewerage	O
	Flushed toilet & septic tank	O
	Pit latrine	O
	Any other toilet	O, please specify:

Date of visit:

Inspection was carried out by:

	Specific Diagnostic Information for Risk Assessment	Yes	No	Remarks
1	Is the spring unprotected?			
2	Is there a latrine or sewer uphill and/or within 30 m of the spring?			
3	Is there any fertilising with manure or agricultural chemicals uphill or within 30 m of the spring?			
4	Is there any other source of pollution uphill and/or within 30 m of spring? (i.e. waste disposal, manure or compost heaps, pesticides)			
5	Can animals have access within 30 m of the spring?			
6	Is the masonry of the spring (basin or reservoir) faulty?			
7	Is the backfill area behind the retaining wall eroded?			
8	Is the fence absent or faulty?			
9	Does surface water collect uphill of the spring?			
10	Is the diversion ditch above the spring absent or non-functional?			

Total Score: 10

Risk score:

Low Risk	Medium Risk	High Risk	Very High Risk
9–10	6-8	3-5	0-2

Results and Recommendations:

Comments:

A7-i

Risk assessment of hand wash facilities in the school

Village:
Name of the school/location:
Type of hand wash facility: Piped water O
Handwash stand O
Date of visit:
Inspection was carried out by:

	Specific Diagnostic Information for Risk Assessment	Yes	No	Remarks
1	Is there hand wash facility close to the toilet?			
2	Is there a hand wash facility close to the kitchen?			
3	Are all hand wash facilities functional?			
4	Is there sufficient water quantity available?			
5	Is the water quality suitable for handwashing?			
6	Is soap available either liquid or bars?			
7	Are hand dryers or paper towels available?			
8	Are there no leakages from pipes?			
9	Is the facility clean and free of litter?			
10	Are there no flies?			

Total Score: 10
Risk score:

Low Risk	Medium Risk	High Risk	Very High Risk
9–10	6-8	3-5	0-3

Results and Recommendations:

Comments:


DIAMOND

CONDUCTING INTERVIEWS

A8

Authors: Margriet Samwel, Claudia Wendland

SUMMARY The development of a Water and Sanitation Safety Plan (WSSP) requires information from several stakeholders. A very useful and rather easy way to collect information about several aspects of a water supply and sanitary systems is by conducting interviews with the relevant stakeholders. The type of stakeholders and the posed questions vary from the water operator or to the consumers and require may be different approaches and questions. Some basic knowledge and approaches on conducting interviews and on the selection of responders is provided in this module. Also, examples of questionnaires targeting different responders are presented in this module.

This module provides example questionnaires for:

A8-a Questionnaire for citizens
A8-b Questionnaire for doctors and health professionals
A8-c Questionnaire for water operators and water professionals
A8-d Questionnaire for users (pupils) of school sanitation and hand wash facilities
A8-e Questionnaire for responsible authority for the operation of public sanitation and hand wash facilities (school director, administration)

OBJECTIVES The readers or pupils are able to conduct interviews with several types of stakeholders. They collect and process useful information from the water operator, local authorities, consumers and pupils.

KEY WORDS AND TERMS Conducting interviews, Interviewer, interviewee, responder, randomly selection, preparation of questionnaires.

Introduction

For conducting interviews, some understanding of the respondent is needed. The respondents/interviewees may be reluctant and hesitant to communicate with the interviewer and/or to answer the posed questions. Before you start to design your interview questions and process, clearly define which information should be gathered and identify the target groups of respondents.

Before the start, practical logistics and processing of the gathered information should be discussed and clarified

Often, respondents may feel more comfortable at their own places of work or homes. Make sure that the respondent is comfortable.

Also, thoughts should be made or the interviewer should be instructed on how to approach the interviewees. This helps to keep a clear focus on the intent of each question and to obtain reliable information. Also, the interviewer should think about how to approach the respondent and may need some instructions on this.

1. Interviews can be conducted in several ways

- The interview can be conducted in an informal and conversational way: no determined questions are asked.
- A guided interview approach ensures that the required information is collected, yet in a more structured way (the conversational way generally allows a certain degree of freedom in talking).
- With a standardised, open-ended interview the same open-ended questions are asked to all respondents, but the respondents are free to choose how to answer the question.
- With a closed, fixed-response interview all respondents are asked the same questions and are asked to answer from among the same set of alternatives.

For our purpose to enable non-experts to conduct interviews, questionnaires with standardised questions are prepared; answers can be a combination of free choice and a choice of given answers. Of course, the users can adapt questions according to the local relevance and interests.

1.1. Interview logistics

Selection of persons to be interviewed

Interviewing the local water supply and health authorities in a small village involves a restricted number of respondents of 3 to 6 persons. Whereas interviewing citizens, a strategy for a broad variety of samples respondents and locations has to be developed. Considering restricted possibilities, such as the availability of interviewers and respondents, the number of wished respondents could be minimised. A minimum of 20 persons should be interviewed to get an impression on the citizen's experiences living in the village. Attention should be paid to have an equal amount of male and female and a variety of ages and social/economic conditions among the respondents.

One way is to randomly select the respondents in a community. The locations should be equally spread out over the community by using a map for identifying the locations of respondents. Another possibility is to ask pupils to interview their parents/ relatives and neighbours. The advantage of this is that more interviews can be conducted. However, the location of the respondents should not be in one area of the village but spread out over the whole village like in the random approach.

Preparing the questionnaires

The questions of the questionnaires provided in this module should be checked together with the WSSP team on their relevance, completeness and comprehension. If pupils are conducting the interviews, they should understand the relevance and the text of the question and be well prepared by their teacher. Interviewers should be provided with enough copies of the questionnaires, pens and instructions for doing the interviews.

1.2. Preparation of the interview before questioning

1. Choose a setting with some discretion. Avoid loud lights or noises and ensure that the respondent is comfortable. Often, the respondent may feel more comfortable at his / her own place of work or home.
2. Introduce yourself and explain the purpose of the interview.
3. Address terms of confidentiality. Writing down the respondents name or age is not necessary; the results will be handled anonymously. Explain who will get access to their answers; write down time and locality.
4. Explain the format of the interview you are conducting and its nature.
5. Indicate how long the interview will approximately take.
6. Tell them how to get in touch with you later if they want to.
7. Ask them if they have any questions before you both get started with the interview.
8. Do not count on your memory to recall their answers and write down the answers of the respondent straight away.

1.3. Conducting the interview

Obtaining reliable information from the respondents is not always easy. For conducting an interview, some basic rules should be taken in consideration. For example:

1. Ask one question at a time.
2. Attempt to remain as neutral as possible. That is, do not show strong emotional reactions to the responses.
3. Encourage responses with occasional nods of the head, etc.
4. Be careful about your behaviour when taking notes and how it may influence the further course of the interview. For example, if you jump to take a note, it may appear as if you are surprised or very pleased about an answer, which may unconsciously influence further answers.
5. Be careful with "why" questions; these questions may cause respondents to react defensive, e.g., that they feel they have to justify their response, which may inhibit their responses to this and future questions.
6. Provide transitions between major topics, e.g., "we have been talking about (some topic) and now I'd like to move on to another topic".
7. Do not lose control of the interview. This can occur when respondents stray to another topic, taking too much time to answer a question reducing the interviewing time; another possibility is that the respondent may start posing questions to the interviewer.

After the interview

Make sure that the respondent is allowed to look at your written notes after the interview in order to clarify any scratches, ensure pages are numbered, search out any notes that do not make sense etc. Write down any observations you made during the interview. For example, if there were any surprise reactions during the interview.

After the responses of all respondents are collected, the data have to be processed. Pooling similar answers and/or making graphics of the pooled answers can be used as a summary of the findings. Percentages of the positive and negative perceptions or knowledge can be calculated for example.

2. Remarks

- Questionnaire forms can be discussed with the WSSP team and/ or pupils focussing on its relevance for the community, the water supply and sanitary installations and the clearness of the questions.
- Doing interviews and testing the clarity of the questionnaires should be practised before the real interviews are started. The interviewer could practice with a colleague. A third person watching the interview can act as the observer, giving feedback after the interview.

3. Text sources and further reading

Management Library (2022). General Guidelines for Conducting Research Interviews. Available online: http://managementhelp.org/businessresearch/interviews.htm#anchor140495

Math is fun (2012). How to do a Survey. Available online: http://www.mathsisfun.com/data/survey-conducting.html

A8-a

Questionnaire for citizens: Experiences, problems and perceptions

Name of interviewer:
School or WSSP team:
Date:

	Information about the responder: Age:	Male ☐	Female ☐	Other ☐	
	No. of persons in the household:				
	Street:				
	Target village/community:				
	Number of inhabitants:				
		Yes	**No**	**Other answer**	**Remarks**
1	Do you have centralised piped water in your house?				
2	Which other water source do you use?				
3	How much water do you need daily for your household?				
4	Is there always enough water available?				
5	Is the water quality good?				
6	If not, please explain why not				
7	Do you treat or boil the water for drinking?				
8	Were you or your family ever sick due to the water? If yes, when and how?				
9	Do you use bottled water? If yes, how many litres daily?				
10	Do you have a water meter				
11	How much do you pay monthly for the water supply?				
12	What kind of toilet do you have? (pit latrine or flush toilet)				
13	Is the wastewater of your house or toilet treated?				
14	What are your suggestions concerning the drinking water supply for your household?				

Source: WHO Guidelines for drinking water quality, 4th ed., modified by WECF

Total Score of Risks: 10
Risk score:

Very high risk	High risk	Medium risk	Low risk
9–10	6-8	3-5	0-2

Results and Recommendations:

The following important points of risk were noted (list 1-10):

Comments:

A8-b

Questionnaire for doctors and health professionals: Water and related diseases

Name of interviewer:
School or WSSP team:
Date:

	Information about the responder: **Male** ☐ **Female** ☐ **Other** ☐ **Function:** **Target village/community:** **Number of inhabitants:**				
		Yes	**No**	**Other answer**	**Remarks**
1	Do you have any complains about the water quality in your community?				
2	If yes, please explain				
3	Do you have the analysis results of the drinking water				
4	Do you have in your praxis access to adequate wash and sanitary facilities?				
5	Do in your village occur any water related diseases?				
6	If yes, please explain.				
7	Do in your village occur any hygiene or sanitary related diseases?				
8	If yes, please explain.				
9	Is the served water in your village suitable for babies?				
10	Do you have any advises for the villagers on how to use the water?				
11	Do you have any suggestions concerning the drinking water supply in your village?				

A8-c

Questionnaire for water operator or person in charge: Water and management

Name of interviewer:
School or WSSP team:
Date:

	Information about the responder: Male ☐ Female ☐ Other ☐ **Function:** **Target village/community:** **Number of inhabitants:**				
		Yes	**No**	**Other answer**	**Remarks**
1	How many households are served in your community by centralised piped water?				
2	How many households use individual wells or springs?				
3	Which water sources are used for the water supply?				
4	What is the main risk for the water supply? (i.e. interruptions or leakages or others)				
5	If there are, what are the main pollutants or contaminants in the village water sources?				
6	Is the water treated? If yes, please explain how.				
7	How often is the water of the public supply analysed?				
8	Which bacteria or chemical substances are analysed?				
9	Is there any substance not in compliance with the standards? If yes, which?				
10	Are the analysis results of the public supply accessible for the citizens?				
11	Is there qualified staff for operation and maintenance of the public supplies?				
12	Are there sufficient financial resources for operation and maintenance of the public supplies?				
13	What are the sources of the financial means: tariffs, tax or other?				
14	Do you have any suggestions concerning the drinking water supply in your village?				

A8-d

Questionnaire for users (pupils) of school sanitation and hand wash facilities

Name of interviewer:
School or WSSP team:
Date:

	Information about the responder: Age: **School:** **Target village/community:** **Number of pupils:**	**Male ☐**		**Female ☐**	**Other ☐**
		Yes	**No**	**Other answer**	**Remarks**
1	Are you satisfied with the school toilet?				
2	Are you satisfied with the hand wash facility in the school?				
3	Do you use the school toilet?				
4	If not, why not?				
5	Do you use the hand wash facility?				
6	If not, why not?				
7	Are toilets easily accessible?				
8	Is there a sufficient number of toilets in the school?				
9	Are there sufficient hand wash facilities in the school?				
10	Are the hand wash facilities close to the toilets?				
11	Do you think that there is enough privacy in the toilet cabins/in front of the urinals?				
12	Is toilet paper available all the time?				
13	Is soap for handwashing available all the time?				
14	Is there always sufficient water available for washing hands?				
15	Are the toilet rooms clean?				
16	Do you know who is responsible for cleaning the toilets and washrooms?				
17	Can pupils complain to school staff about a bad situation in the school toilet?				
18	Do they teach proper hygiene practices at school?				

A8-e

Questionnaire for responsible authority for the operation of public sanitation and hand wash facilities (school director, administration)

Name of interviewer:
School or WSSP team:
Date:

	Information about the responder: Age: **School:** **Target village/community:** **Number of pupils or user of the facility:**	**Male ☐**		**Female ☐**	**Other ☐**
		Yes	**No**	**Other answer**	**Remarks**
1	Are sufficient toilets and hand wash facilities for the users?				
2	Is there an operation and maintenance plan for the facilities?				
3	Is there enough staff for operation and maintenance of the facilities?				
4	Do you have a separate budget for operation and maintenance of the facilities?				
5	Are there sufficient financial resources for operation and maintenance of the facilities?				
6	How is the wastewater from toilets and hand wash facilities treated?				
7	Who takes care that toilet paper and soap are available in the facilities?				
8	Is there always sufficient water available for washing hands?				
9	Can pupils or users complain to school staff about a bad situation in the school toilet?				
10	Do you have many complaints related to the toilets or hand wash facilities?				
11	If yes, why?				
12	Is hygiene education part of the curriculum?				

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