Selecting household water filters in emergencies

a manual for field evaluation

University of Applied Sciences and Arts Northwestern Switzerland

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Selecting household water filters in emergencies

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Content

Background and target audience

Household water treatment and safe storage (HWTS) devices are an essential interventionwithin humanitarian emergencies to improve the quality of drinking water and achieve health impact. However, despite demonstrating technical efficacy under laboratory settings, evidence that HWTS products are used correctly and consistently in emergency settings and therewith perform satisfactorily is limited. To increase the ability of Humanitarian Agencies to make informed choices about the procurement and distribution of household water filters in emergencies, and motivate producers to improve the design, Humanitarian Innovation Fund (HIF) initiated the project on evaluation of household filters in emergencies in 2017. During that project, we have developed and applied an extensive field methodology for testing household filters in emergencies. The methodology developed addressed the technical performance of the filters, ease of use, acceptance and applicability aspects. The elements of the methodology proved to be essential for evaluation of the household filters in the field and have been used by other manufacturers and implementers beyond the project partners to evaluate their products. The feedback by different stakeholders showed a high need for a concise, simple and affordable methodology for evaluation of household filters in the field by the non-scientific community. The evaluation in the field is required to assure the products perform according to their specifications, are accepted, can be operated and maintained by users and can be implemented in the required context. This manual is developed based on our experiences, those of other organisations implementing household filters in the field, and published HWTS evaluation studies.

The manual is meant for a non-scientific audience interested to apply and evaluate household water filters in the field in resource-limited settings. This includes non-governmental and public implementing organisations distributing filters in emergency contexts and manufacturers developing or optimizing products. Although the manual is designed with an emergency context in mind, it can be used also in non-emergency settings. In principle, the methodology is applicable also for other HWTS interventions besides filters.

Objectives

This manual provides a modular guideline for the field evaluation of household water filters using our methodology. The methodology is based on various methods for evaluation of technical and non-technical factors including the technical performance of the filters, ease of assembly, operation and maintenance, acceptance and behavior change of users and applicability as well as feasibility for emergency response. The manual can be used for designing the studies focusing on testing of the new products or evaluating products, which have been in use during the extended time. It can be also used during the training of the team. It can support the development of a project proposal or documentation, however, it does not provide specific guidance on this. A filter can be evaluated alone, compared to another filter or to multiple products to answer the following questions:

- Which filter is suitable for our emergency context?
- Does this filter perform well and is it accepted by the users?
- How should the filter be optimized to better address the needs and context of the implementer?

Structure

The methodology is built in a modular way, allowing the implementer to design an own study by combining methods from different groups.

PART 1

introduces and describes a general study set-up. It provides an overview of the different modules and summarizes major considerations during the implementation of the study and analysis of the results. Finally, it proposes and discusses the decision process.

PART 2

- **S** Filter and context pre-evaluation
- **L** Logistics and preparation
- **D** Distribution, user information and training
- **T** Technical performance evaluation
- **U** User acceptance evaluation

Detailed protocols and questionnaires can be used directly or further adapted to fit better the local context. They are available on our homepage.

How to use the manual

Following steps are required to design the study using the manual:

- Make decisions on major questions that you need to address in your study. The decisions you take depend on i) the filter and ii) the context where you want to distribute the filter. Whether these aspects are known or not will influence your decisions. Use Information sheets in section S in Part 2 to support your decisions.
- Using the methodology template (Figure 1) presented in Part 1, consider which methods you have to, and which you would like to use. Consult information sheets for each method presented in Part 2 for more information on each method.
- Adapt the timeline, the number of monitoring campaigns etc. for your context.
- Review the protocols as well as the questionnaires. Adapt to address your needs and context if needed.
- The manual can support training the project team at the project implementation stage and be used as reference material during the study.
- Once the results are available, Part 1 further supports the data analysis as well as the decision-making process guiding the selection and applicability of the filters for specific contexts.

PART 1

Study design, planning and implementation

Part 1 provides a general overview and summarizes the considerations about the main objectives and research questions, major study phases and its implementation milestones and boundaries. The study results and results-based decision making discusses how the results can support the choice of the filters, and the final decision around their applicability in a specific context. It includes the following information sheets

Study questions	Discusses the questions the study should answer
Study phases	Provides the overview of the study design
Study implementation	Provides flowchart with major milestones and limitations during implementation
Study results and results-based decision-making	Provides suggestions on how to analyse the results and use them in decision making process

Study questions

The first step is to define which question exactly the study is meant to answer.

We define three major questions leading to potentially different study designs:

- Which filter is best adapted?
- Is the filter suitable for our context?
- Does the filter perform well and is it accepted by users?

Information sheets S1, S2 and S3 in Part 2 provide more information regarding each question and considerations. The table 1 summarizes the questions, major considerations and refers to the relevant information sheet. You can also formulate your questions and develop a process to choose the appropriate context and products for evaluation.

Table 1 – Study questions and major considerations

Study question	Is the filter defined?	Considerations	Information sheet
A. Which filter is best adapted?	**YES**	Multiple filters, already pre-selected by the implementer are to be evaluated. The feasibility of the filters for the context needs to be assessed as the first step.	S2
	NO	Filters are not yet known and need to be identified and selected. Implementer might have a preference for a certain type of filter or might have to decide to test different filters to find a product which addresses best the user needs in a specific context or setting from those available.	S1
B. Is the filter suitable for our context?	**YES**	One filter is evaluated in a specific context. The focus is on the technical performance and user acceptance in the defined settings. There are no comparative elements. The results can be used to adapt the product to the requirements of the users or support large scale implementation and development of the supply chain.	S2
	NO	The filter is not yet known and need to be identified and selected. Whenever possible, evaluating multiple filters will provide additional insights and give people a choice potentially leading to better acceptance.	S1
C. Does the filter perform well and is it accepted by users?	**YES**	The filter is evaluated in one or different contexts, which have to be chosen based on the intended use of the filter. The study can be designed as a comparative study for two or more different contexts or implemented in one context only. In the second case, the transfer of the results might be limited.	S3

The output is the final major study question, as well as the final choice of filters to be evaluated in the study as well as the choice of the context.

Study phases

Each filter evaluation study has four major phases summarized in Table 2.

Table 2 – Study phases and their considerations

Phase	Objectives and considerations	Information Sheets
Preparation phase	Defines the study objectives, as well as evaluates suitability and safety of filters, addresses logistical considerations, ethical approval and provides practical information on setting up water quality monitoring and data management processes. Define potential timeline.	L1, L2, L3, L4, L5, L6
Baseline data collection	Baseline data collection is essential for the study to evaluate the situation before the project is implemented, and to understand users' perceptions and attitudes to the products before they collected experience in using them. The questions asked during the baseline overlap with the questions asked during the final data collection to enable comparison and estimation of the effects of the study on attitudes and perceptions of users regarding filters, but also general WASH situation. If the hygienic conditions are poor and the population is likely to reject household water filtration, the RANAS approach to behaviour change can be implemented to enable evidence-based development of behavior change interventions. The questionnaires relevant for RANAS can be integrated into the Baseline questionnaire.	U1, U3
Introduction phase	Filters are distributed and introduced to users during a household visit. The introduction visit includes non-participatory observation of users installing the filters and using them the first time without training. It is directly followed by training, basic technical monitoring and first reactions regarding acceptance and use experience. The baseline data collection and introduction can be combined when the population and contexts are well known to the implementers and the risk of baseline population not being suitable for the study objectives is low. When there is an intention to sell filters to users during the scale-up or subsequent implementation phases, a willingness to pay can be evaluated. This should not be done, if the distribution of filters is and will remain free of charge, i.e. in acute emergency contexts.	D1, D2, U4, U5, T1, T2, T3, T4, T5 U8, T6
Monitoring	The monitoring includes general technical monitoring, as well as user acceptance monitoring. One or multiple monitorings can be conducted. Short studies (10-12 weeks) would imply only one monitoring. Longer studies 3-12 month would require multiple monitoring visits (at least two visits). If multiple monitorings are done, consider that always the same technical measurements/sampling, as well as the same questionnaire to the same respondents, has to be used. Follow up training might be required during the monitoring visit, especially when operation and maintenance are perceived as complex or the filter damage or drop-out rates are high. All trainings and additional information provided to users needs to be documented.	D2, U5, T1, T2, T3 ,T4, T5 T6

Final data collection	The final data collection is similar to the monitoring, however, an extended questionnaire list is used to collect more detailed information, as well as to repeat the questions asked during the baseline data collection and willingness to pay evaluation. Focus group discussion as well as co-design workshops could be useful tools to collect less structured and more detailed qualitative information through open-end discussions. If the results of the study are rather unexpected, Focus Group Discussions (FGDs) might help to identify the reasons. A Co-design workshop, where potential users and manufacturers discuss the design of the filter, is especially recommended when manufacturers have an intention to further optimize their products for the local context, or filters are partly produced locally (e.g. local housing is used). If this is not the case than a co-design workshop will raise expectations in users, which will not be addressed and should be skipped.	D3, U5, T1, T2, T3 ,T4, T5 T6, U6, U7, U8,

Figure 1 summarizes different study phases and methods` modules in one schema. This schema can be used as a template to draw your final study design, but placing the relevant methods` modules and adapting the timeline. The modules usually required for a filter evaluation study are summarized in the upper part, while the optional modules are shown below. The modules are structured according to their characteristics such as technical performance evaluation, user perception, training. The same structure is used in Part 2 summarizing all information sheets for each module.

	3 - 6 MONTHS BEFORE Preperation
Filter and context pre-evaluation	S1 Selecting filters
	S2 Assesing feasibility of a filter
	S3 Selecting ermergency context
Logistics and study preperation	L1 Laboratory filter evaluation
	L2 Filter logistics
	L3 Selecting locations and users
	L4 Study approvals
	L5 Data management
	L6 Field lab management
	L7 Team training

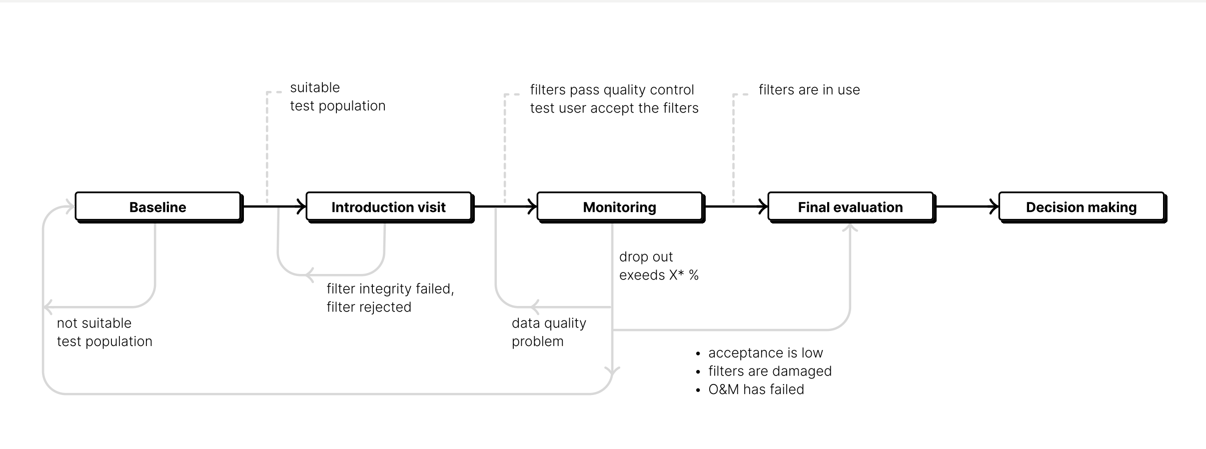
		WEEK 1 - 3 Baseline	WEEK 1 - 3 Introduction visit	WEEK 5 - 6 Monitoring	WEEK 10 - 12 Final Data collection
required	Distribution & user training		D1 Filter distribution		
			D2 User training	D2 User training	D3 Follow-up briefing
	User perceptions		U4 Non-participatory observation		
		U1 Baseline questionaire	U5 Monitoring Questionaire	U5 Monitoring Questionaire	U5 Monitoring Questionaire
					U9 Final data collection
	Technical performance		T1 Microbial water quality	T1 Microbial water quality	T1 Microbial water quality
			T2 Integrity	T2 Integrity	T2 Integrity
			T3 Flow rate	T3 Flow rate	T3 Flow rate
			T4 Use	T4 Use	T4 Use
			T5 Durability	T5 Durability	T5 Durability
optional	User perceptions	U3 RANAS	U8 Willingness to pay		U6 FDG
					U7 Co-design workshop
					U8 Willingness to pay
	Technical performance		T6 General water quality parameters	T6 General water quality parameters	T6 General water quality parameters

Study implementation

This manual does not address the project implementation steps in detail as we assume that most implementers have long experience in implementing projects, and the overall project management activities will be guided by standard organisational processes. The manual can be used for planning as supporting information to develop a budget, evaluate the needs and level of training of human resources or estimate the overall needs related to organisational logistics, etc.

Like any project, a filter evaluation study might not go as planned. It is important to set up clear “go/no go” boundaries used to define situations when certain phases need to be repeated or re-designed or the entire study has to be interrupted or even stopped before completion to avoid wasting of time and resources. Figure 2 shows the flow diagram including possible loops. Each phase can be considered as a milestone. Therefore it is important to analyse the data collected and set a milestone meeting where the decision has to be taken on continuation of the project as planned or an alternative.

Figure 2 – Decision flow during the study



* X is usually 20% or higher. This number should be agreed with partners in advance. The context leading to dropout can be taken into consideration as well.

The table 3 summairzes the study phases and the major risks which potentially affect them

Table 3 Study phases and major risks

Phase	Risk	Description and clarification	Possible actions
Preparation	Filters fail the minimal requirements for safety or do not address user needs	• Filters fail the minimal requirements for water quality or water flow. Currently, we set it at Log removal value (LRV, measure of treatment efficiency, see L1) for bacteria in an integrity test is less than 2 and the filter can provide less than 20 L per day. However, the implementer can set their minimal values before the study.	Evaluate another product or put the study on hold until manufacturer clears the problem
	Filters cannot be delivered (in time)	• Filters cannot be delivered to the location due to import bans, lack of required certificates, etc.	Select another location, delay the start or chose another produc if study objective allows it.
Baseline	The population is not suitable for the study	The population can be considered as not suitable on different occasions. Few examples: • Users refuse to participate or sign consent forms • Water is of good quality and there is no need for household filter • Another organisation is implementing a WASH project addressing water quality issue directly or indirectly	Conduct rapid needs assessments in a few other locations, and repeat the baseline in the most suitable location.
Introduction visit	Filter integrity test failed	Failed filter integrity in the field can be caused by multiple reasons and depend usually on the design of the filter. Common reasons include: • Leakage of the filter elements due to failed installation • Quality control issues at production • Damage of the filter elements during transport, storage or use	Identify and fix the problem. If possible – repeat the technical evaluation. If not – delay the filter distribution till trouble-shooting is successful or chose another filter
Introduction visit and/or Monitoring	High drop out or filters are rejected by the users	User acceptance can be low when filters do not address the needs (too small, too complex, inappropriate design) or the expectations of the users regarding the product or the project in general. There might be concerns about leaking particles, taste and odour of water, flow rate, colour, or expectation to have tap water provided instead of the filter.	Organize a Focus group discussion to find out the causes with users and decide on the next steps together with the users.

Phase	Risk	Description and clarification	Possible actions
Monitoring	Data quality is poor	Data collected is of poor quality meaning that there is missing data, water quality samples are out of range of detection (e.g. too many to count in most samples), or there is a concern regarding data fraud.	Ensure quality control procedures are in place, train staff and repeat monitoring.
	Filters are damaged or O&M is not conducted properly leading to health risks	This can happen when the filters are not robust and start to fail during the study. When more than 25 % of the filters fail for technical reasons, it might be important to evaluate the remaining regarding the risks to users, and finalize the study beforehand. If possible, provide users with alternative more robust product.	Proceed to final data collection on user acceptance and complete the study in advance
All phases	External factors	Populations evicted Deterioration of the security situation Allocation of resources into acute emergency response	Interruption or delay of the study

Study results and results-based decision-making

The results generated during the study can be used in different ways and answer the three main questions:

- → Can people who need the filter use it?
- → Does the filter work?
- → Can the filter be deployed in an emergency?

The results can be used as general evidence, to gain a better understanding of the context and user groups, and/or to further optimize the filter, training materials, or optimize the implementation strategy. The results might be used to support the decision-making process typically around three major questions summarized in section "Primary Objectives of the Study" when multiple options need to be compared:

- → Which filter should be used?
- → Is the filter suitable for our context?
- → Does the filter perform well and is it accepted by users?

To support decision-making for multiple options, a simplified multi-criteria decision analysis (MCDA) approach can be used. This approach uses the following six steps:

Identifying "no-go" attributes. The "no-go" attributes can be used for pre-screening and are attributes which absolutely must be fulfilled by each option. The data might show that the implementation of the filter is not feasible or even dangerous in the defined context. The check-list in table 4 summarizes the main "no-go" attributes, and corresponding data, which indicate that the filter should not be used in any or a specific context. The checklist should be adapted based on the study context and priorities.

1. Identifying attributes, which can be used to evaluate an option, or compare the options based on the results of the study. Table 5 summarizes the attributes (column 2, violet) and the related data source (column 3, light blue) and according questions derived from the provided questionnaireor technical data collected (column 4, green).

Table 4 – «No go» attributes

Filter functionality	Log removal values (LRV, measure of treatment efficiency, see L1) for integrity test are < 2 for > 60 % of all samples.	Filters are likely not to provide the required protection.
Water quality	Water quality after treatment contains > 10 CFU/100 ml of E.coli in > 60% of all samples.	Filters are likely not to provide the required protection.
User acceptance	Drop out of the study exceeds 40 %	Acceptance is low
Durability	Number of filters damaged during the study exceeds 40%	Durability is not sufficient

2. Assigning scores to attributes (column 5, orange and 6, red). This makes them comparable. In the example in table 5, scoring in the range of 0 to 4 points is applied for multiple questions for each attribute. For the questions from the monitoring questionnaire, the percentage of users who gave a specific answer defines the score (column 5). This means that if 0-20% of all users have answered this specific valid answer, assign 0 points, 21-40%= 1 point, 41-60%=2 points, 61-80%=3 points, 81-100%=4 points (column 6, red). For the attribute with multiple questions, the mean score should be calculated.

3. Assigning weights for each attribute. This is required to reflect the relative importance of each attribute to the decision. A scale of 0-100 can be used. The attributes considered most important can be assigned 100 points. The stakeholders can decide which attribute they think is the least important one and judge how much less important it is to the decision compared to the most important one. For the other attributes, the weighting is chosen in between, according to their relative importance. In the end, the weights are scaled down so that their sum equals 100%. Table 6 shows an example of weighting for the attributes summarized in table 5.

4. Calculating the weighted total score. Combine the weights and scoresto derive the overall value for each option. This can be done by multiplying scores by weights for each attribute and summing the products up for each option (table 7). Each stakeholder generates different total values according to their weighting.

5. Ranking the options according to their total values. Consider that the highest value corresponds to the best option. Different stakeholders will generate different rankings, due to different weighing. At this point, it is important to compare and discuss the ranking of options by different stakeholders and their different weightings, discuss any doubts and disagreement, explore how sensitive the results are to the weighing of different stakeholders. When the results are not clear or contradictory, it might be needed to reconsider the attributes, adding additional questions, or scoring and weighing each question separately, and not aggregated for each attribute. The scoring proposed in table 5 might be reconsidered as well.

The method proposed does not take into consideration more subjective data or results of the Focus group discussion. Thus, it should be considered as an aid tool for decision making.

Table 5 – Questions, attributes, data and valid answers for multicriteria decision analysis. Answers are transferred directly from the surveys for each question.

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7
Question	**Attribute**	**Data source**	**Questionnaire item / Question**	**Valid answer(s)** (if 0-20% answered this valid answer(s) assign 0 points, 21-40%= 1, 41-60%=2, 61-80%=3, 81-100%=4 points)	**Assigned points (0-4)**	**Mean point for attribute**
1. Ease of use Can people who need filter use it?	Assembly	Observation checklist	OB4: Has filter been installed correctly?	Answer 3 and 4		
			OB6: Is the tap installed correctly?	Answer 3		
			OB7: Has the filter element been contaminated during installation on the clean side?	Answer 0		
			OB8: Was the storage tank contaminated?	Answer 2 (if 77: not applicable)		
	Operation and maintenance	Observation checklist Monitoring	OC4: Does the user easily understand how to use the filter?	Answer 2 and 3		
			OE1: Does the user understand how the maintenance should be done?	Answer 3 and 4		
			OE3: Can the user do the cleaning properly?	Answer 1		
			MB2: Is the filter functional?	Answer 1		
			MB8: Is the filter visibly clean?	Answer 1		
			MB9: Is a container for storing water visibly clean?	Answer 1		
			MB9: Is a container for storing water visibly clean?	Answer 0		
			MB3: Does the filter have any damages?	Answer 3 and 4		

Question	Attribute	Data source	Questionnaire item / Question	Valid answer(s)	Assigned points (0-4)	Mean point for attribute
1. Ease of use Can people who need filter use it?	Operation and maintenance	Observation checklist Monitoring	MC3: How easy is it for you to use the filter?	Answer 3 and 4		
			MC5: How easy is it to clean the filter?			
	Acceptability	Extended list (final data collection)	FG23: Look of water	Answer 3 and 4		
			FG24: Cleaning of the filter element	Answer 3 and 4		
			FG25: Cleaning of the filter housing	Answer 3 and 4		
			FG26: Perceived safety of water	Answer 3 and 4		
2. Performance Does it work?	Protection levels	Monitoring	Does the filter reduce bacteria in the water?	LRV in integrity test is ≥2		
			Does filter improve water quality at a household level?	Samples with 0 CFU/100 ml for E.coli in treated water		
			Does the re-contamination of treated water occur?	Samples with 0 CFU/100 ml E.coi in stored water		
			Does microbial regrowth in filter occur?	Samples with ≤ 10 CFU/100 ml in treated water		
	Treatment capacity and flow rate	Monitoring	MC9: Do you have enough filtered water?	Answer 1		
			MC10: Should the filter treat more water?	Answer 1		
			MC16: Is the water filtered fast enough?	Answer 1		
			What is the measured flow rate of the filter?	Samples with Flowrate ≥ 1 L/h		

Question	Attribute	Data source	Questionnaire item / Question	Valid answer(s)	Assigned points (0-4)	Mean point for attribute
2. Performance Does it work?	Treatment capacity and flow rate	Monitoring	MB6: Does the filtered water storage have water inside?	Answer 3 and 4		
			Are filters robust enough to be deployed in an emergency? (Indicator: dispersion of all integrity tests values measured in the field)	Interquartile range (the middle 50% of all data values for LRV for integrity test) ≤ 1		
3. Logistics Can it be deployed in an emergency?	Filter costs	Preparation L2	What does the filter costs (Filter cost / expected filter lifespan: Euro/year)	> 60 Euro/year – 0 points 41-60 Euro/year – 1 point 21-40 Euro/year – 2 points 11-20 Euro/year – 3 points ≤ 10 Euro /year – 4 points		
			Investment filter costs including logistics until country office for 1 filter	> 110 Euro/year – 0 points 81-110 Euro/year – 1 point 51-80 Euro/year – 2 points 21-50 Euro/year – 3 points ≤ 20 Euro – 4 points		
	Logistical footprint	Preparation	Shipping volume for 40 filters, m3	> 2.5 m3 – 0 points 1.5-2.5 m3 – 1 point 0.8-1.49 m3 – 2 points 0.3-0.79 m3 – 3 points < 0.3 m3 – 4 points		
	Durability	Monitoring	Are the filters durable in the study context? (Indicator: number of damaged filters)	Number of filters which never get damaged during the study		
	Quality control of the products before deployment		What is the production quality of the products? Indicator: integrity test in the lab for at least five filters	LRV in integrity test is ≥ 4 (or value provided by manufacturer if LRV is expected to be in the range of 2-4).		

Table 6 – Example: Weighing - Assigning weights for each attribute to reflect their relative importance to the decision

	Assembly	O&M	Acceptability	Protection levels	Treatment capacity/ flowrate	Filter use	Robustness	Filter costs	Logistical footprint	Durability	Quality control	Total
Weighting stakeholder A	50	70	100	100	70	100	30	50	10	40	40	680
Weighing, %	7.6%	10.6%	15.2%	15.2%	10.6%	15.2%	4.5%	7.6%	1.5%	6.1%	6.1%	100%

Table 7 – Example: Weighed total score - combining the weights and scorers for each attribute and option

	Assembly	O&M	Acceptability	Protection levels	Treatment capacity/ flowrate	Filter use	Robustness	Filter costs	Logistical footprint	Durability	Quality control	Total
Weighting stakeholder A	50	70	100	100	70	100	30	50	10	40	40	680
Weighing, %	7.6%	10.6%	15.2%	15.2%	10.6%	15.2%	4.5%	7.6%	1.5%	6.1%	6.1%	100%
Option 1, scores	0.75	3.38	3.18	2.75	3.75	3	3	2	3	4	3	2.93*
Option 2, scores	0	4	3.6	1.5	4	2	1	1	0	3	2	2.35*

* The total weighted score is calculated as a sum of the score and weigh for all attributes

PART 2 Information sheets

Part 2 – Information sheets consist of five main sections, based on Figure 1 of this manual and include:

- **S** Filter and context pre-evaluation
- **L** Logistics and preparation
- **D** Distribution, user information and training
- **T** Technical performance evaluation
- **U** User acceptance evaluation

S Filter and context pre-evaluation

Section S summarizes the information sheets focusing on the selection and pre-assessment of filters for the field study as well as understanding the emergency contexts and suitability of the filters in different contexts. It includes three sheets. S1 is meant to support the studies, which require pre-selection of filters out of certain production or the entire market. S2 lists major considerations for pre-assessment of the filters for specific contexts and S3 discusses different emergency contexts.

S1	Selecting filters
S2	Assessing the feasibility of a certain filter
S3	Selecting emergency context

S.1 Selecting filters

Required	Optional	Group	Detailed protocol/questionnaire	
	x	Filter and context pre-evaluation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x				

Background

The number of products available on the market is huge and selecting filters for further evaluation during the study is difficult and will be subjected to personal preferences and probably bias. Before the selection process is started, it is important to understand the variety of filters and their features. Some of the major filter features are summarized in the table 8. However, the filters in each category vary depending on the design and manufacturer and the summary is not exhaustive and does not cover all possible options or their combinations.

Table 8 – Overview of filter types and typical filter features

	Ceramic filters	Membrane filters	Biosand filters	Multistage filters
Filter elements	Ceramic candles, disks, candles produced out of compressed activated carbon	MF and UF filter modules in hollow fibres and flat sheet configuration	Household sand filters	Combination of technologies, usually ceramics followed by slow release disinfection technologies or activated carbon
Pressure generation	Gravity	Gravity and manual pumping	Gravity	Gravity
Typical designs	Pot filter Two containers on top of each other Syphon filters	Filters with a manual pump to be installed in jerry cans or buckets Standalone filters with manual pump and container integrated Gravity filters with two containers on top of each other Gravity filters with one source container only	Housing is locally constructed out of concrete, plastic, metal. Water can be abstracted directly or stored in a safe water storage container under the filter	Gravity filters with two containers on top or next to each other. Often aspirational designs
Locally used supplies	Locally available buckets might be used as housing. Local production is possible	Locally available buckets might be used as housing. Membranes are imported	Local production	
Flowrate	Approx.. 0.5-1L/hour, 15-20 L/day	Varies between 2-10 L/hour – 40-240 L/day	10-20 L/h, 100-200 L/day	Approx.. 0.5-2L/hour, 15-20 L/day
Logistical footprint	Depends on design	Depends on design	High, the filter is not transportable easily	Depends on design
Transportability	yes	yes	no	yes
Pathogen removal	Protozoa and Bacteria, limited removal for viruses. Protection varies depending on production quality/pore size	Depending on the type of the membrane used, high removal for bacteria and protozoa, and in some cases for viruses. Protection varies depending on product quality and quality control.	Highly variable depending on O&M	Limited data, in principle high pathogen removal should be expected for new systems but fouling and reduction of removal in time are likely
Clogging	Mechanical cleaning of the ceramic elements	Automatic backflushing for manual pump systems, no backflushing or manual backflushing required for some gravity-driven systems	Removal of the schmutzdecke (upper layer of sand)	Mechanical cleaning of the ceramic elements, replacement of cartridges
Consumables	no	no	no	Yes – cartridges containing disinfectant or activated carbon

Regrowth and recontamination	Depends on design, silver-containing systems have some bacteriostatic properties reducing microbial regrowth	Microbial regrowth is likely in warm climates, membrane preservatives might support this process Recontamination depends on the design	Microbial regrowth is unlikely, as biosand filtration improves biostability of water, recontamination depends on handling water after filtration	Disinfectants protect water from regrowth and reduce recontamination. Efficiency depends on the technology used and fouling properties of water
Life span of filter elements	6-12 month	1-5 years	Depends on O&M	6-12 month

Based on the overview of the typical characteristics of filters, certain types of technologies can be excluded. For example low transportability of the BSF filters, the low flow rate observd for some ceramic syphon filters can and should lead to exclusion of this technologies for certain contexts.

The table 9 rates four specific types of filters based on the list of proposed criteria (subjective rating, without weighting). Once the types of filters are identified (in the proposed example, both membrane systems are preferred technologies), specific products can be evaluated. Adding weights to filter features reflects needs and priorities for a specific context and might simplify the choice. Exclusion criteria are marked with *

Description

Table 9 – Possible (subjective) filter type rating based on the set of defined criteria

	Ceramic two bucket filter, locally assembled	Ceramic syphon filter	Membrane gravity-driven filter	Membrane filter for jerry can with a manual pump
Flow rate *	1	0	2	3
Virus removal *	1	0	2	3
The simplicity of operation and maintenance	2	2	3	2
Simplicity of assembly	0	2	0	2
Compatibility with locally available jerry cans and bucket	2	3	2	3
Aspirational design	1	0	1	1
Integrated water storage	3	0	3	0
Design features incl. availability of lid, stand, tap quality	1	0	1	1
Costs	3	3	2	1
Logistical footprint	1	3	1	2
The local assembly is not required	0	3	1	3
Need for local container procurement	3	3	3	3
Design flexibility	2	3	2	2
Lifespan, durability and robustness	1	0	3	2
Availability of third-party certification, field evaluation data or WHO HWTS scheme evaluation results	2	2	1	1

Considerations

Filter selection is a subjective process and different members of the team might have different views and interpret the available data in different ways. The results of the filter evaluation would provide more clarity on the choice and suitability of the evaluated product. Thus, it might be helpful to select and compare filters from different categories (e.g. gravity-driven against a product with a manual pump, filter with integrated storage against one without).

S.2 Assessing the feasibility of a certain filter

Required	Optional	Group	Detailed protocol/questionnaire	
	x	Filter and context pre-evaluation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x				

Background

When the filters are pre-selected by implementers, or when a defined product needs to be evaluated in a certain context, pre-assessment of the filter regarding applicability to the local context, expectations of the implementing team and credibility of the available data is useful. Pre-assessment will help identify potential problems or challenges beforehand and discuss options to address them with manufacturers and implementers.

Description

Table 10 summarizes the major filter features and their meaning for local context, as well as expectations and feasibility for implementation. The table can be used as a checklist. It is not complete and can be further elaborated depending on the specific filter design.

Table 10 – Filter features and related information and context related considerations

Filter feature	The information available for the filter	Context and implementer`s requirements and expectations
Capacity and flow rate	Daily and immediately capacity of the filter	Size of the households and minimal requirement for drinking water based on the needs assessment or sphere standards
Microbial removal performance	Data/certificates available on the removal of protozoa, bacteria and viruses and its credibility (third party or not, WHO evaluation results, etc)	The desired level of protection according to WHO HWTS evaluation scheme, source water quality and related health risk
Water storage	Availability of water storage container	Hygienic conditions in households and the need for external storage
Protection from contamination	Design features or post-treatment protecting produced water from re-contamination	Expectations to design as well as knowledge and attitude regarding specific technologies (silver, bromine, chlorine, activated carbon)
Type of technology used	Filtration element used in the filter	Expectations and preferences regarding the potential for local production
Lifespan	Predicted or known filter lifespan	Minimal required lifespan
Source water quality	Limitations regarding water turbidity or organic matter content	Source water quality and expectations regarding filter performance
Local assembly	Need for using local containers, drilling holes and any other steps required for local assembly. Overall perceived simplicity of the assembly.	Feasibility of the local assembly in the context of the study, the decision on who and where the assembly should be done
Design features	Appearance and filter design, number of small parts, moving parts or parts which appear to be fragile and can be easily damaged	Requirements regarding the robustness of the filter as well as ease of operation, maintenance and use
O&M	Description of the operation and maintenance requirements for the filter	Are O&M procedures easily understood and can they be implemented by the members of the team?
Instructions	Printed instructions	Are printed instructions clear? Can they be used directly or require translation?
Costs	Actual costs of the filter including packaging, shipment, taxes, certification	Willingness to pay for the filter by implementing, value for money
Logistical footprint	Size of the filter, packaging	International and local logistics and suitability for local transport and distribution

S.3 Pre-assessing the emergency context

Required	Optional	Group	Detailed protocol/questionnaire	
	x	Filter and context pre-evaluation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x				

Background

Three general phases of the humanitarian response can be identified*.

Acute Response

This refers to humanitarian relief interventions that are implemented immediately following natural disasters, conflicts, epidemics/pandemics or the further escalation of events during protracted crises. It usually covers the first hours and days up to the first few weeks/months, where effective short-term measures are applied to alleviate the emergency quickly until more permanent solutions can be found. Depending on the type of disaster, people affected by disasters are often much more vulnerable to diseases, which to a large extent are related to non-existing or inadequate WASH facilities and an inability to maintain good hygiene. The purpose of interventions in the acute response phase is to ensure the survival of the affected population, guided by the principles of humanity, neutrality, impartiality and independence. Essential water-supply-related services needed at this stage include the provision of clean water for drinking, personal hygiene and cooking in sufficient quantities primarily on a communal level and ensuring a safe environment and avoiding contamination of water sources.

Stabilisation

The stabilisation or transition phase usually starts after the first weeks/months of an emergency and can last to around half a year or longer. The main focus, apart from increasing service coverage, is the incremental upgrade and improvement of temporary emergency structures that would have been installed during the acute phase, or the replacement of temporary technologies with more robust longer-term solutions. This phase includes the establishment of community-supported structures with a stronger focus on the entire WASH system, the gradual involvement of water utility structures where applicable and the consideration of water safety and risk management measures. Water and energy sources should be reconsidered taking into account environmental factors and long-term sustainability, particularly where groundwater is used as the major water source or water supply relies on water tracking.

Recovery

The recovery phase, sometimes referred to as the rehabilitation phase, usually starts after or even during relief interventions (usually >6 months) and aims to recreate or improve on the pre-emergency situation of the affected population by gradually incorporating development principles. It can be seen as a continuation of already executed relief efforts and can prepare the ground for subsequent development interventions and gradual handing over to medium/long-term partners. Depending on local needs the general timeframe for recovery and rehabilitation interventions is usually between six months to three years and in difficult situations up to five years (or more in conflict-affected areas). Recovery and rehabilitation interventions are characterised by active involvement and participation of local partners and authorities in the planning and decision making to build on local capacities and to contribute to the sustainability of the interventions. Recovery interventions should include a clear transition or exit strategy including hand-over to local governments, communities or service providers to ensure that the service levels created can be maintained.

* Adapted from the Compendium of Water Supply Technologies in Emergencies, (Coerver et al., 2021)

In general, conducting a research and evaluation study in an acute context can be difficult, and might raise ethical concerns, specifically regarding a competition for available resources and priorities of the local team. Conducting a filter evaluation project in the contexts or stabilization and recovery or protracted crises context can be more feasible and ethically acceptable. Market-based approaches are more feasible during the recovery phase, and thus, assessment of willingness to pay might be useful. The durability and robustness as well as dependency on consumables need to be considered as well.

Description

Potential for implementation of the household filters during each phase of emergency will strongly depend on the local context. Household filters are often seen as a viable option in remote rural areas, where contaminated water sources are available, but a provision of community-based options are limited or impossible for different reasons. It can be also used in combination with community-based systems when deterioration of water quality between the source and household is observed due to poor hygienic conditions. This can also be a case in refugee or IDP camps when water sources are available but water quality is compromised and cannot be addressed easily by centralized chlorination. When source water quality is good, water can be chlorinated on the community, camp or centralized level, household water filters will likely not be used or recommended by implementing organisations.

Typical criteria for recommending or implementing household water treatment methods:

Household water filters are LIKELY to be recommended	Household water filters are UNLIKELY to be recommended
Remote rural areas, IDP and refugee camps, informal settlements	Urban peri-urban areas with available centralized or community water supplies
Multiple scattered unprotected water sources	One protected water source
Water from accessible sources is contaminated	Drinking water is chlorinated
There is a high risk of contamination of water between source and household	Water has residual chlorine and is not likely to be contaminated
Walking distance between the source and household exceeds 30 min	Water is available on-premises or at the distance less than 30 min round trip including queuing.
There is a high risk of water recontamination in the household due to prolong storage	Water is stored in the household for a limited time in safe storage containers
Water has high nutrient or organic matter content and is biologically unstable	Water is clear and has a low potential for microbial regrowth and formation of biofilms
Household water filers or other household water treatment technologies are available on the market and known to users	Household water treatment technologies and methods have never been used in the area previously

For the filter evaluation study, the contexts in which filters are likely to be recommended for use should be generally preferred.

Reference

Coerver, A., Ewers, L., Fewster, E., Galbraith, D., Gensch, R., Matta, J., Peter, M. (2021). Compendium of Water Supply Technologies in Emergencies. German WASH Network (GWN), University of Applied Sciences and Arts Northwestern Switzerland (FHNW), Global WASH Cluster (GWC) and Sustainable Sanitation Alliance (SuSanA). Berlin. Germany

L Logistics and preparation

Logistics and preparation section addresses different steps required to prepare and set up the study. The seven information sheets cover different aspects including logistical consideration, pre-evaluation of products in a lab, ethical approvals, setting up field lab and data management systems.

L1 focuses on the evaluation of the selected filters in the laboratory and defines the minimal standards for field evaluation of the filters. L2 discusses logistical constraints and considerations around a shipment of the filters into filed locations. L3 focuses on the selection of the users and locations for filter evaluation within a pre-defined area. L4 considers ethical research permits and approvals required to conduct such a study. L5, L6 and L7 address the set up of infrastructure for water analysis, major considerations around a data management system and finally training of the team.

L1	Pre-evaluation of the filters in a laboratory
L2	Filter logistics
L3	Selecting locations and users
L4	Study approvals
L5	Data management system
L6	Field laboratory management
L7	Team training

L.1 Pre-evaluation of the filters in the laboratory

Required	Optional	Group L	Detailed protocol/questionnaire	
x		Logistics and preparation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x		x		

Filter types selected for the field study should be safe for users, provide sufficient volume of water, be easy to install and operate and be accompanied by a user-friendly manual. Pre-evaluation of the filter should be done to assure that filters correspond to all those requirements. Pre-evaluation can be done in the laboratory or offices of the implementing organisation, research partner or a third party organisation capable of such evaluations. Methods used during the study can be used for technical evaluation.

Background

Manufacturers should obtain a third party evaluation or certification of their products before planning a field evaluation. This evaluation should provide basic technical information such as removal performance for bacteria, viruses and protozoa and turbidity, any limitation regarding tentative use of filters such as highest turbidity values the filter is capable of managing, as well as flowrate and expected life span. For newly developed products this data might not yet be available, or company/organisation manufacturing the filters or prototypes has only internal data. Production quality control brings another uncertainty into the performance of the products. Thus, the filter integrity as well as flowrate should be tested before study using the same methods planned for the study including filter integrity testing using spiked probiotic bacteria and flow rate measurement. These tests will also help to establish and verify the methods for the field and can be used as a basis for training local field staff. If any undisclosed post-disinfection system is incorporated in the filters, the toxicity, as well as immobility of the chemicals used, should be evaluated in an independent specialized research laboratory.

Description

We recommend testing 3-5 filters, possibly obtained from different production batches. The filters should be set and taken into operation using non-chlorinated water according to the user manual provided by the manufacturer. The filter should be operated during at least 1 day, filtering the daily amount of water before the testing is conducted to assure that any preservatives, air, etc. have left the filter. The user manual can be evaluated for applicability and modifications suggested to the manufacturer. Since the user manuals often need to be translated into local languages, small modifications might be relatively easy to implement. The integrity test, as well as flow rate measurement, should be conducted in triplicate with all filters following the Technical sheet T.2 and protocol P2 for integrity testing and Technical sheet T.3. for flow rate testing.

During the testing, operation and maintenance of the filter should be documented. Potential risks to users can be analysed according to the following checklist (table 11):

Table 11 – Checklist for assessment of potential risks

→ Can the filter be assembled correctly using the manual provided and would incorrect assembly lead to a health hazard?
→ Is filter likely to release or leak any toxic substance into the water? Are materials in contact with water known and certified for drinking water use? Materials, which are not certified for drinking water use, such as some types of plastics, e.g. PVC or ABS, should not be used.
→ Can any parts of the filter cause harm to users and specifically children in household if broken, or detached?
→ Can taps or tubes be mixed leading to consumption of untreated water?
→ Can filter cause harm in any way?
→ Are operation and maintenance procedures clear? Can the filter be easily destroyed by improper maintenance?
→ Does filter have any fail indicator in place?

In case of any doubt, a discussion should be thought with manufacturers and implementers, and in case of disagreement, an opinion of an independent third party considered.

Resources and materials

3-5 filters. Materials required for integrity testing and flow rate evaluation (see T.2 and T.3).

Data analysis and visualization

To estimate the performance of the filter, the log reduction values (also called Log removal values or LRV) are commonly used to calculate the magnitude of change of bacterial numbers due to a filtration process. Log reduction is calculated using the formula: Log reduction = Log

10(A)- Log10(B) where A is the colony count in raw water, and B is the colony count in the filtered water. We should consider that both raw water and filtered water will influence the LRV value, meaning that when raw water has low counts, the LRV will below, which can lead to misinterpretation of the filter removal performance. The LRV values proposed by WHO should be used as an indication of the acceptable performance.

Table 12 – Performance classification for housheold water treatment and safe storage based on removal of bacteria, viruses and protozoa proposed by WHO*

Performance classification	Bacteria ($\log_{10}$ reduction required)	Viruses ($\log_{10}$ reduction required)	Protozoa ($\log_{10}$ reduction required)	Interpretation (with correct and consistent use)
***	≥4	≥5	≥4	Comprehensive protection
**	≥2	≥3	≥2	
*	Meets at least 2-star (**) criteria for two classes of pathogens			Targeted protection
-	Fails to meet WHO performance criteria			Little or no protection

* https://www.who.int/water_sanitation_health/water-quality/household/scheme-household-water-treatment/en/

The integrity test should show at least LRV of 2 for all filters tested. If a lower value is repeatedly observed for two or more productions, filters should not be used in the field. If only one out of 3-5 filters shows repeatedly LRV < 2, the manufacturer should provide two additional products, which should be evaluated and both provide at least LRV 2 value.

If filters are implemented for entire households, the volume of water provided by filter per day should be at least 20 L. If the filter treats less than 20 L/day, multiple filters should be used in the same household or another filter type is chosen.

Considerations

The main goal of the pre-evaluation to assure that filters will not harm the field implementation. Thus, it is important to consider and discuss any doubts related to the use and implementation of the products. This step has a relatively high conflict potential between manufacturer and implementer, as it might lead to a delay or cancellation of the field study. The objectives of the evaluation, as well as the detailed protocol and consequences, should be discussed and agreed beforehand with the manufacturer.

References

International scheme to evaluate household water treatment technologies:

https://www.who.int/water_sanitation_health/water-quality/household/scheme-household-water-treatment/en/

L.2 Filter logistics

Required	Optional	Group L	Detailed protocol/questionnaire	
x		Logistics and preparation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x				

Filters need to be delivered to the locations before the start of the study. Large implementing organisations have logistics officers or even entire departments who can manage filter delivery respecting local regulations and requirements. For smaller organisations, not experienced with logistics in the countries, new products or prototypes or when small manufacturing organisation is responsible for delivery, filter logistics can become a challenge.

Background

Each country has its import regulations, which need to be respected at all times. In some cases, humanitarian good import tax waivers can be obtained, but for a small number of products, it can be simpler and cheaper to pay the import tax than to obtain the import tax waving permission. In some countries, import regulations require local certification of the performance of the good and conformity to local standards. In some cases, a certificate of conformity must be obtained from an international certification organisation such as SGS providing verification, testing and certification services worldwide. In any case, clarification of the import procedures is mandatory before shipment. A local sub-contractor specialized in import of special products might be consulted or sub-contracted to manage the import process. It might be necessary to send 1-3 filters in advance for certification and evaluation in the country. The whole process can easily take up to 6 months in some locations, and proper planning and preparation are required. The goods should never be shipped to the country without a confirmation of the local customs authorities, otherwise, they might be kept on the border for long periods leading to high fines and penalties for storage. Sometimes, double importing might be required, when the goods need to cross the different border when shipped over sea or land.

Description

Main steps include clarification of the import regulations and laws and obtaining required documents. Hiring specialized registered sub-contractor can be the only option in many cases. Assure that the sub-contractor has experience with water filters or similar products. Certifications by SGS or similar international organisations are straight-forward and often can be done remotely using virtual visit software, without a need of shipping products or external expert visits to facilities. Certification by local certification authorities or offices would require pre-shipment of prototypes which might cause additional costs.

Shipment can be done by air, land or sea, depending on the location. Cargo flight shipments require usually between 3-5 days. Most airlines offer direct cargo services, which often are cheaper compared to shipping companies when goods can be delivered directly to the airport by the manufacturer. Delivery by land or sea takes up to 1 month, but is usually cheaper and has a lower carbon footprint. Depending on if the country is landlocked or not, shipment by sea can be a viable option also for a small number of filters. All goods shipped need to be insured sufficiently to cover for loss or damage. The actual costs of the filters combined with the costs related to logistics (shipment, taxes, insurance) need to be carefully documented. When the study compares multiple products, the cost of logistics is an important factor, which needs to be considered. When multiple products are shipped together, the costs can be segregated based on the volume. Since most filters are relatively light, the volume and not the weight would define the cost of the shipment. Table 13 summarizes the potential cost categories related to shipment of filters.

Table 13 – Template table to summarize the costs related to logistics of the fitlers

	Procurement	Packaging	Shipment	Insurance	Import taxes	Certification	Other	Total
40 filters A								
40 filters B								

When a shipment of any laboratory material is required for the study, it can be done together with the filters and the documents collected and prepared in parallel. Some suppliers of laboratory goods might have local distributors in countries.

Considerations

All partners, members of the teams and possible sub-contractors should be aware and respect zero-tolerance policy for corruption. If the legal import of filters is not possible or feasible, another field-testing location should be selected. All payments and transactions between local import and certification authorities should be accompanied by valid official receipts.

L.3 Selecting locations and users

Required	Optional	Group	Detailed protocol/questionnaire	
x		Logistics and preparation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x				

This process contains two steps: The first step is to identify a location within your target area, where the study should take place. The second step is the selection of households within the defined location. The number of households that should be considered in your study depends on several criteria that are described in this chapter.

The location where the study is conducted depends on several points of consideration that need to be listed and then outweighed to see where the conditions are best and where the study can best deliver information for your organization and further decision-making processes. Additionally, the selection of individual households that participate in the study ideally follows a random design so that biases in the selection process can be avoided.

The decision to study locations

It is important to choose a study location where your study can yield results that are of best use for your purposes. Have a look at the following list but also think of other criteria that might be relevant in your area.

Is there a high demand for household water filters?	**YES**
→ If water quality is good or perceived as good, the demand for household water filters and user's ac-ceptance will be low.	
Is access to water easy?	**YES**
→ If no/only little water is available the effort of using household water filters might not outweigh the per-ceived benefits, therefore user's acceptance will be low. In this case consider improving access to wa-ter first.	
Are people in this area stable inhabitants?	**YES**
→ If people are prone to leave the area soon, the investments in the study set-up might not result in informative outcomes or you might even lose the study completely.	

If you cannot answer YES to all criteria outlined above or you are not sure about it, you should plan your baseline survey separately from the rest of the study and first confirm that you have the right study location and participants. You might want to consider to choose a different study location.

Sample size calculation

To know how many households should be included in your study it is first important to decide how many groups you will compare. This then leads in the decision on how many households pre-group should be selected and how.

a – The decision on the number of groups to compare

The size of your sample is defined by the number of comparisons that you want to do. Do you want to find out about the users' acceptance of one filter? Do you want to compare different filters? Alternatively, do you want to compare one group of filter users to a control group, which does not have a filter? These decisions will help you to define the number of groups and according to households in your study. You can use the table 14 to find out how many groups you would have by answering those questions. In the displayed example, the decision is to only test one filter and compare it to a group without filters. In this example you would have 2 comparison groups.

Table 14 – Number of groups for testing filter

Number of filters	Number of comparison groups	Example
I want to test 1 filter	1	**Yes, I want to test 1 filter: 1 group**
I want to test 2 filters	2	
I want to include a control group without a filter		
Yes	**+ 1**	**Yes: +1 group**
No	+ 0	

b – Sample size calculations

If your study follows the idea of assessing user's acceptance and preferences of filters, it is not necessary to do a sophisticated calculation of sample sizes. The calculation of sample size also depends on how the data analysis will be done. If you follow the methods described in this guideline, a group size of 50 households per group would be ideal. If this is impossible according to your study area, you can still reduce the group size to 40 households.

If you plan to conduct a scientific study which produces scientifically sound results, you should consider diving more into this topic. Under the resource section, you will find a useful online tool for sample size calculations.

Random selection of households.

A random selection of households assures that there are no biases concerning selected households. Biases might, for example, be that only households that are close to the centre of the community are selected or those households that have a good relationship to the community leader or households that have very good access to a water source. If the selection of households is biased, the results of your study will not be reliable.

Options for random selection of households.

a – Lottery box	Write the names or assigned numbers of all eligible households on a paper. Put all the papers in a lottery box and mix and blindly draw the required number of names from the lottery box.
b – Random route sampling	The selection of households is done on the ground: your staff starts in the middle of the target community and spreads into different directions. Every second/third/fourth household is selected, depending on the size of the community and the number of households you need in your sample. Make sure to cover the whole area of the community and do not leave out specific areas (e.g., those that are at the edge of the community). In case your staff reaches the boundaries of a community, a pen can be spun until it points to a direction within the community, and the data collector continues this way.

References

For scientific sample size calculation: Dhand, N. K., & Khatkar, M. S. (2014). Statulator: An online statistical calculator. Sample Size Calculator for Comparing Two Independent Means. Accessed 17 July 2020 at http://statulator.com/SampleSize/ss2M.html

L.4 Study approvals

Required	Optional	Group	Detailed protocol/questionnaire	
x		Logistics and preparation	Template of a consent form	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x				

For your study, it is mandatory to comply with ethical standards, especially if you are dealing with vulnerable groups of society. Depending on your context and study area, there might be several institutions or focal points where you need to present your study proposal and seek ethical approval.

This chapter wants to draw your attention to the importance of taking time for careful consideration of ethical aspects throughout all steps of study implementation. It is structured in three parts: i) the discussion of common ethical standards, ii) the short insight into the Research Ethics Tool provided by Elrha/The Humanitarian Innovation Fund and iii) shortly discuss the need of institutional ethical approvals.

Ethical standards

When working with vulnerable groups within the society, it is crucial to include certain considerations in the planning process of your study. Table 15 lists ethical principles if dealing with vulnerable people and especially when experimenting with emerging technologies. This list and content are quoted from the Humanitarian Innovation Fund (https://higuide.elrha.org/toolkits/get-started/principles-and-ethics/).

Table 15 – List of ethical principles when dealing with vulnerable population. Adapted from Humanitarian Innovation Fund`s Research ethics tool: https://higuide.elrha.org/toolkits/get-started/principles-and-ethics/

a – Compliance	your study should comply with international ethical standards and should be approved by an ethics review committee
b –Humanitarian Purpose	your study should serve the needs of the participants and should adhere to basic humanitarian principles, such as impartiality.
c – Do No Harm	none of your study components should lead to any harm for any involved stakeholders. This requires careful pre-assessment of potential risks within the specific context.
d – Responsiveness	if required according to the needs of involved participants, the study should be able to be adjusted to adhere to ethical standards.
e – Informed Consent	the participation in your study must be voluntary and the decision to take part must be taken on an informed basis. The participant always has the right to stop participation. For a template of an informed consent sheet, see supporting materials.
f – Justice	your study should treat all participants equally, independently from their age, gender, physical wellbeing or any other characteristic.

The Research Ethics Tool (Humanitarian Innovation Fund, R2HC, Elrha)

This chapter is based on the guidelines, standards and tools provided by the Elrha (https://higuide.elrha.org/toolkits/get-started/principles-and-ethics/, https://www.elrha.org/wp-content/uploads/2015/01/ELRHA-Interactive-Flipcards-F3.pdf). The following list only gives a short inside into the Research Ethics Tool and is adapted from it.

Planning the study: ask yourself, why you want to conduct the study and why you decided to conduct the study in this specific area/community? Reflect on the questions on how you decided to use certain methodologies and how these might be perceived by the participating community. Carefully evaluate anticipated benefits but also the potential risks related to your study for participants. Reflect on your measures how you ensure confidentiality and privacy and how you plan to ethically obtain and store the collected information. Those aspects related to information of study participants need to be clarified to the participants in an information sheet to which they can give their informed consent to participate. Finally, before starting the study, you might need to obtain ethical approvals from different institutions, such as your own organizational ethics committee, the research ethics committee or from local leaders or governmental bodies.

During implementation: think of the implementation phase and how all involved stakeholders can address any evolving and unforeseen ethical issues and how could you possibly manage required adaptations in your study plan?

At the end of the study: think of how you disseminate and share the findings of your study. Who will have access and how? Reflect on what went well and what could be improved regarding your study implementation and also regarding study outcomes. Ideally, your study results are accessible freely and online. You can use online platforms such as Ridie (https://ridie.3ie-impact.org/index.php).

Institutional ethical approval

It is recommended to seek ethical clearance from an institutional ethics review committee. The committee will help you to adhere to ethical standards and not oversee any critical point that might be connected with your study methodology. To achieve ethical clearance, you will have to check with the requirements of the individual body. Most probably your application for ethical clearance needs to entail the purpose of your study, your detailed methodology (including selection criteria for participants, the description of the filter to test, etc.). You will need to discuss how you plan to adhere to the above-listed ethical standards. A good guideline for this section will be to answer the questions provided in the Research Ethics Tool provided by Elrha/The Humanitarian Innovation Fund. You should also provide all study protocols and tools that you plan to administer. This means that the study needs to be well-developed before you apply for ethical clearance.

Considerations

Adherence to ethical standards is mandatory and should not be neglected. This also requires to plan enough time for developing tools, planning each step of the study and performing a careful risk-analysis before the start of the study. The process of receiving ethical clearance of one or several institutions might take time and be iterative and involve several rounds of feedback and adaptations of your study protocols.

References

Research Ethics Tool provided by Elrha/
The Humanitarian Innovation Fund:

https://www.elrha.org/wp-content/uploads/2015/01/ELRHA-Interactive-Flipcards-F3.pdf

https://www.elrha.org/researchdatabase/r2hc-ethics-framework-2-0/

Principles and Ethics described by the Humanitarian Innovation Fund: https://higuide.elrha.org/toolkits/get-started/principles-and-ethics/

L.5 Data management

Required	Optional	Group	Detailed protocol/questionnaire	
x		Logistics and preparation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x	x	x	x	x

For a filter evaluation project, a data management system needs to be established to keep track of the monitoring campaign, including questionnaires and technical measurements completed and planned, ensure the data are protected from disclosure and manipulation, as well as to prevent data loss and enable data transfer between partners.

Background

Most laboratories use data management systems, which enable keeping track of samples and experiments, prevent loss of data, fraud or disclose of protected data and - for certified labs – assure compliance with specific standards such as GMP or ISO 17025. Special data management software is available, which are widely used by laboratories and projects. However, for a relatively small filter evaluation project, the data management system can be established using software and processes already known to all partners including local staff, such as excel tables and document sharing spaces. For questionnaires (interviews, obervations), using mobile phone based systems such as ODK, Kobo or others has certain advantages, in terms of data quality and rapid data collection and transfer.

Description

Basic principles any data management system needs to follow include but not limited to:

- Ensure primary data is secured and protected in its original form and digitalized copy.
- Identify any personal or sensitive data, anonymize data and store any personal or sensitive data i.e. information identifying households (Names, phone numbers, GPS coordinates, consent forms) separately from the data, possibly offline and protected. Define when the personal or sensitive data (i.e. data identifying households, photo and video materials) should be deleted and who is responsible. Map different types of data and communication channel which can be used for its storage and transfer.
- Ensure primary and primary anonymized data is protected from manipulation. Primary data files should always be stored as files with disabled changes protected by a password. All paper-based data should be filed in folders and digitalized. Manual transfer to excel templates should be accompanied with a photo of the original paper sheet or equipment (e.g. agar plate with CFU count visible on it) stored in the same excel file or folder, with the date and name identifying the sample.
- Protect and limit access to primary data but allow easy access to primary anonymized data. If using online data-sharing platforms, ensure data transfer is encrypted, the access is limited to a defined list of people and further sharing of data is not possible without permission and password. Use protected data sharing space offered by organisations (Universities, NGOs) and avoid private solutions (dropbox, google drive) whenever possible.
- Ensure data consistency. Use always the same

templates for all monitoring campaigns, do not modify any questions in questionnaires and ensure the data sets can be integrated, use the same units throughout the whole data set. Identify and set name tags used for storing and exporting data.

- Prevent data manipulation and fraud and control data quality. During the study, basic rules to ensure data has been collected properly include distribution of responsibilities between different team members (e.g. persons collecting data in the field give their mobile phones for data transfer to other team members), collection of GPS coordinates, track of consumables and supplies spent and used during the monitoring campaign. Appointment of a person in charge of data quality control as well as quality control visits into the field by team supervisors can reduce the risk of data fraud. All members of the team should be aware of the measures taken in case misconduct or data fraud is detected, zero-tolerance policy and clear responsibilities and processes in place to address misconduct and data fraud. The clear processes to report data fraud must be established and protect the person who raised concerns. Photo documentation of the results (e.g. photos of the plates after counting colony forming units), as well as regular checks, are helpful. Open communication culture as well as a positive attitude to mistakes can reduce the risk of data fraud as well.

- Ensure data is available in time to all project partners. Set deadlines and ensure that all anonymized primary data is uploaded by these deadlines or otherwise, all partners are notified of a delay and its reasons and a new deadline is set.

- Ensure that any analysis of the anonymized primary data is done in a file stored under a new name tag which can be clearly distinguished from the primary anonymized data.

Resources and materials

Computers, multiple external data storage hard drives, access to a server with sufficient level of protection, sim card with sufficient data on it to upload the filled questionnaires into the server also using mobile network, access to excel, photo camera or mobile phone with a high-quality photo camera with GPS tracking function, mobile phones for questionnaires with sufficient storage space.

Considerations

Ensure that everyone in the team is trained on data management and aware of the general data management principles including management of personal and sensitive data, photo and video materials, data transfer and storage through unprotected channels (private emails, WhatsUp, dropbox, etc.). Ensure that this applies also for visiting project partners, HQ or communication staff and third party visitors. Ensure that "culture of research" is developed and supported within the team. Ensure that supervisionrs are aware of the responisbiity to establish and implement quality control for data management to assure none of it is lost and data protection requirements are respected.

References

KoBo toobox: https://www.kobotoolbox.org/

ODK (Open Data Kit): https://opendatakit.org/

L.6 Field Laboratory management

Required	Optional	Group	Detailed protocol/questionnaire	
x		Logistics and preparation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x		x	x	x

Installing and running a field laboratory for water quality analysis in a non-dedicated environment requires preparation and planning. Two major considerations are assuring the safety of all staff working in the laboratory zones embedded in the office space and the office, as well as ensure the proper and reproducible working process in the laboratory.

Background

To perform analytical work, specifically microbiological work with reproducible results with appropriate quality, it is important to introduce and maintain robust processes and create an adequate environment.

Laboratory space can be in principle set up in office space when tap water and power supply or gas cooking stove are available on spot or at a short distance.

Description

Team and responsibilities

The process starts with setting up a team and training responsible people to ensure they understand their roles and responsibility, which includes based general management and workflow organisation tasks also safety and quality control. Depending on the number of samples, and workload, it might be important to share responsibilities between team members, with a dedicated responsible person for one or few processes. The processes can include microbial water quality analysis, cleaning and sterilization of the equipment, waste management, maintenance, data recording and transfer. For each of these or other required processes, a standardized operation process (SOP) has to be developed, established and made available for the person responsible but also any other person working in the zone. Ideally, the person responsible for one process overseas also the need for infrastructure, consumables etc. to perform this process and required quality control procedures. This person is also the main contact person, and the name and contact information such as phone number should be accessible and visible to all team members. The person responsible for the entire laboratory space needs to be aware of all SOPs and ensure quality control. A schedule for regular training lessons needs to be established and implemented.

Infrastructure

The laboratory space can be set up basically in any office space, but if possible, a closed room with good ventilation should be preferred. Availability of power supply and running water is an advantage, although basic microbial testing can be done also without it.

The laboratory space has to be structured with dedicated zones for different processes and purposes, such as microbial water quality tests, equipment sterilization, cleaning, waste management, storage, and "office work" for data recording and transfer. The purpose of creating zones is to avoid cross-contamination and mixing of samples, as well as ensure the required safety level for all involved staff. The role of each zone needs to be marked and understandable for each person working in the laboratory space and the office it is embedded in. The visibility of the zones is important, e.q. coloured labels on the door or the floor will help to identify the zones and possible safety precautions required. Tables and other equipment (gas stove, pots, refrigerator, towels, pens, etc.) used in the laboratory zones should not be used for any other purposes.

Daily management and organisation

To organize the workload a working schedule is essential. The lab manager should do the organisation of the workload at least once per week. To ensure a proper information flow, it is useful to inform all the lab staff / involved persons by periodical team meetings. The experiment/analysis has to be performed according to the corresponding SOP. Each test/experiment has to be documented in a laboratory journal positioned in the laboratory zone. This journal is not personal but is used by everyone who is performing the SOP and should never leave the laboratory. A defined format for the data collection in a laboratory journal is strongly recommended. It should be clear who performed which task, the date and time the tasks were performed and any further relevant information. Once a day, the lab manager or another responsible person should proof the results and the documentation, and ideally sign the lab journal daily. The laboratory journal is a primary data (see L5) and needs to be archived also after the data have been transferred into electronic format.

Quality control / Quality assurance

Equipment and method tests are recommended to be done periodically. At least once per day, 1-3 blank samples with mineral bottled water, and when possible a standard sample (sample with known content, such as containing bacteria used in integrity test) should be analysed. Critical samples should always be measured in duplicates, and once a day, a measurement of a triplicate sample is required.

In case the results show variation exceeding 20% for microbial analysis, or blanks are contaminated with cells, all analysis should be stopped and the contamination reported to the responsible person. This or another equally qualified person aware of the SOP should be involved, and all steps critically analysed to detect and eliminate the source of contamination. The samples need to be stored in the refrigerator during this time and tested as soon as the problem is identified and eliminated. All samples need to be stored and only disposed of after the data in the laboratory journal have been signed by the responsible person.

Training

To ensure a constant and adequate quality of labwork including technical issues a continuous optimisation and training system has to be implemented. Ideally, a training matrix has to drown up and each training has to be documented.

Maintenance

Infrastructure might need periodical maintenance according to the specific supplier and quality requirements. To cover all necessary maintenance work and quality tests it is necessary to plan the activities in a calendar (hardcopy or electronically). The person who is doing the tests/Maintenance work, the time of execution, and according to which SOP it is implemented should be visible.

Waste Management

Any laboratory activity leads to generation of waste and no activity should begin unless there is a plan how to handle waste generated. The best way to manage laboratory waste is to prevent it generation as much as possible. The waste generated needs to be sorted in at least three categroies – general waste, waste presenting chemical hazard and waste presenting biological hazard. The water quality analysis required for evaluation of filters in field produces mostly two types of waste: general waste as well as waste presenting biological hazard. The information sheets T1 and T2 as well as corresponding protocols include Waste Management section which needs to be considered while setting up the methods.

Resources and materials

- Folder with SOP (hardcopy/electronically)
- Marking tape
- Workbench / Safety workbench/office bench
- Lab equipment (e.q. funnel, pipettes, disinfection material, incubator)
- Personal protective equipment if required by SOPs (e.q. safety goggles, gloves, lab coat)
- Access to Excel and Server used for data management (see L.5)

Considerations

When setting up the laboratory space with staff without prior laboratory experience, a re-organisation might be required after some time, after the processes are clear and implemented by all staff. Thus, the zone concept should be revisited and considered to optimize the workflow.

Data fraud and research misconduct is unfortunately a reality in many laboratories. This might happen for many reasons, such as high workloads, lack of understanding of the project goals and objectives, tendency to report good results only, fear to report mistakes, laziness, lack of ownership, conflicts with management or many others. At least two people must share the responsibilities and are capable of doing all work to ensure there is no information and knowhow loss as well as to reduce the risk of data fraud or misconduct. The clear processes to report data fraud must be established and protect the person who raised concerns. A project manager should always be aware of the main steps of the analysis and be able to control and verify the results. Photo documentation of the results (e.g. photos of the plates after counting colony forming units), as well as regular checks, are helpful. Open communication culture as well as a positive attitude to mistakes can reduce the risk of data fraud as well.

Waste management is often neglected and no activity in the lab should be started unless there is a clear plan for managing waste for each method implemented.

L.7 Team training

Required	Optional	Group	Detailed protocol/questionnaire	
x		Logistics and preparation		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x	x	x	x	x

Training and capacity building is a long-established critical component in any WASH project and a filter evaluation project is not different. Background, capacity, ability, workload, experiences, expectations as well as attitude and motivation of the field WASH team will define objectives and the extent of training, as well as need for regular, follow trainings required.

Background

The attitude and motivation of the team are essential for the success of any project. If the objectives of the project are not clear, or the team is overburdened and perceives the project as additional work, the discussion with the entire team has to be thought and problems and concerns identified and possibly addressed. The best practice is to involve the field team in the development and planning of the project from the very beginning, but in reality, this does not happen often. The main goal of the training is to ensure the team understands the objectives, understands the methods, is familiar with project documentation and manuals, responsibilities are defined, all questions related to logistics, infrastructure, materials and consumables, employment and training of volunteers or additional staff are clarified. The training can be used to develop workflows, revisit and adapt the timeline to reflect the local limitations and context as well as establish reporting mechanisms. The training can be done on different days, but ensure that all members of the team are present and aware of the responsibilities and tasks of other team members. Assure that you have all hardware (filters, lab space, consumables for analysis, mobile phones with installed software) available and at hand. Avoid PowerPoint presentations and do your training as “hands-on” as possible.

Description

Table 16 summarizes the major steps of the training.

Table 16 Training steps

Define and discuss the objectives of the training	Discuss the expectations of the team and your own. Set and discuss learning goals and expected outcomes
Define and discuss overall objectives of the project	Provide an overview of the background of the project, research questions, general project activities, timeline and deliverables.
Define and discuss the objectives of the field study	Explain and discuss how the objectives of the field study contribute to the overall project goals, what are drawbacks and limitations
Introduce the methodology and methodology documentation	Discuss in detail all steps of the methodology, ask questions and assure that all steps are understood. Introduce the manual and use it during the training.
Introduce the filters	Explain the working principle of filters. Provide hardware (filters) and let team members install, operate and maintain the filter as they would be community members (role game). Ensure that all team members are participating in the practical part. Assign tasks or roles if this is not the case.
Define, discuss, re-think and agree on the timeline	Discuss and define the project timeline and planned number of monitoring visits (see table 2). Discuss if there are any limitations and how the team perceives the timeline. Discuss if any holidays, events, etc. might cause delays. Reconsider the timeline with the team and create a timeline together in a participatory process. Assure that not only the team leader speaks.
Introduce the specific methods and clarify responsibilities and workflow	Explain the methods in general. The team might have preferences or be organized in the way to take responsibility for different methods. Clarify with the team and record the responsibilities on a whiteboard or sheet. For each task, there should be a leader, and at least one other responsible person. Together with the team, build and visualize the workflows.
Explain methods to responsible team members	Train the responsible team members, but assure that the rest of the team is involved and participating in the training. The specific topics include but not limited to: • Logistics, filter distribution and organization (general aspects, as well as sections L and D) • Technical data collection and analysis (section T) • User acceptance evaluation methods (Section U) • Data management and quality control (L.5.) • Reporting and communication channels Check that all consumables are available, the software is installed, questionnaires are uploaded, etc. Use videos or create videos of the complex methods (with the agreement of the team).
Revisit timeline	Discuss the timeline and assure that all changes required by the team due to a better understanding of methods and tasks are implemented.
Establish communication	Discuss and establish communication channels. Assure that all team members understand which communication channel can be used for which information and aware of ethical concerns and regulations regarding disclosure of sensitive information (e.g. photos of the households sent over WhatsApp is a no go). Map data types and communication channels.
Summarize	Revisit your learning goals, and summarize the main points
Arrange for follow up	Set up the time and define objectives for a follow-up training.

Resources and materials

Personal meeting or series of online trainings (ensure good quality internet connection), manual, all consumables, software, hardware required (use checklists in the resources and materials sections for all information sheets).

Consideration

The training is usually conducted before a project and if possible in a personal field visit. The amount of information and the usually very short time available for training lead usually to an overload of the team members. To avoid this, plan enough time, enough breaks and social interactions if possible. The practical part of the training needs to be conducted by the team members, and by using the manual, protocols or videos. Avoid demonstrations, not followed up immediately by hands-on practice.

D Distribution and user training

Section D addresses the interactions with the users concerning delivery of filters (D1), training on operation and maintenance of the filters (D2), as well as follow up discussion regarding the responsibilities and strategy to deal with damage or failure of products after the end of the study (D3).

D1	Filter distribution
D2	User training
D3	Follow-up briefing

D.1 Filter distribution

Required	Optional	Group	Detailed protocol/questionnaire	
x		Distribution & user training		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
		x		

Filters are distributed to each household one by one followed by a non-participatory observation of the assembly and operation, microbial water quality sampling, integrity test, monitoring questionnaire to capture first impressions and experiences as well as extensive training on operation and maintenance of the filter.

Background

Filter distribution is an important step of the study. Sufficient time needs to be planned for this step to avoid hurry resulting in poor training of the users and poor quality of the collected data. Reserve days need to be planned into the schedule in case some of the users are not at home. The appropriate vehicle should be used for transporting the filters to households. The filters should be fixed in the vehicle to reduce risk of damage to housing, packaging or filter elements.

Description

Plan how many households you can visit during one day and in which area depending on the distance, traffic, and state of roads. For the introduction of the filters, you would require about 1 hour per household. If multiple filters are begin evaluated in the study, check which filters are assigned to which households and make them ready, with filter IDs visible on the filter housing and packaging. Introduce yourself without waiting for the respondent to ask questions before you start. Remind the user about the study set up. Confirm that users are aware that the filters are part of a study and they gave consent to be visited by a monitoring team as well as answer questions.

Please deliver the filter to the household. Check that the household ID number corresponds to the filter ID number assigned. Do not unpack the filter - hand filter over to the household as provided by the manufacturer or assembled in the office. For the filters without integrated housing - provide buckets or jerry cans additionally but without any explanation. Do not fix taps, candles etc. beforehand. Provide also any materials provided by the manufacturer together with the filter. This step is usually followed by a non-participatory observation of the use (see U4).

Resources and materials

Filters, permanent marker, possibly water if users are likely to have a water shortage in the household, mobile phones with uploaded questionnaires, hand-sanitiser, equipment required for water sampling (see section T).

Considerations

When user expectations do not address by the design of the filter, all concerns should be discussed. Users have a right to drop out of the study any time, and should not be put under pressure to accept the filter if they do not want it. When only one filter is evaluated during the study, one filter could be carried out and shown to users before they sign consent forms. This can however interfere with the non-participatory observation of the assembly of the filter, as users would know how the filter should look like. Both factors need to be discussed with the team. Once the decision is taken, it should be implemented in all households.

D.2 User training

Required	Optional	Group	Detailed protocol/questionnaire	
x		Distribution & user training		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
		X	X	

Users should be trained on assembly, operation and maintenance of the filters to assure that they understand how the filter works and what is required to operate and maintain it correctly. Training should be done after non-participatory observation of use and operation (see U4) during the introduction visit. Follow up training proved to be very efficient during first filter monitoring to ensure that users operate the filter correctly, get all questions answered and concerns addressed.

Background

Training of users on operation and maintenance of filters usually follows the operation and maintenance (O&M) guidelines or the manual provided by manufacturers. If possible, the users who are finally responsible for operation and maintenance of the filter (often women) should be trained on its use actively, while other household members should be possibly present and support the main user in assembly, O&M.

Description

Any supporting information provided by the manufacturers should be translated into the local language before the study. It is usually an advantage when the filter assembly, O&M can be explained by pictograms without using words. Instructions printed on paper are likely to get lost, and printings directly on filter housing or water buckets and jerry cans should be preferred whenever possible.

The training usually includes three major steps:

- Control of the correct assembly and leakage of the filter element by tightening of the filter elements sealings
- Demonstration of the correct operation of the filter. After the user has observed the operation, she should try to do it on her own, till she can obtain a sufficient amount of water. Any questions at this stage should be answered by the trainer, and misunderstandings explained. Users who understand the principle of operation of the filter are likely to do fewer mistakes in its operation.
- Demonstration of the maintenance of the filter. Also, in this case, the user should try to implement and test the maintenance procedure on her own. The trainer should explain what materials can be sued for cleaning the filter, the major risks related to recontamination of the clean water tank. Whenever available, attention must be paid to pictograms and drawings on the filter or housing explaining the major steps.

Users need to receive clear instructions on what to do in case of the damage of the filter and provided with the phone number of a contact person. At the end of the training, users are handed in the sheets which they can use to record daily use of the filter for filter use estimation (see T.4.)

Resources and materials

Functional filter, water if not available or limited in the household, printed instructions.

Considerations

It is important to ensure that the trainer understands the functionality and operation of the filter. Training of trainers on operation and maintenance should be by manufacturers whenever possible followed by a detailed discussion and documentation of experiences.

D.3 Follow up briefing and wrap-up

Required	Optional	Group	Detailed protocol/questionnaire	
x		Distribution & user training		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x	x			x

An exit strategy is required after the filter evaluation study. This exit strategy needs to address the responsibilities concerning maintenance, reporting of damage, potential replacement of the products, provision or/and access to consumables or hardware as well as alternative water treatment strategies if filters fail. The communication of the exit study, leaving sufficient time to address concerns and answer questions is crucial at the end of the study.

Background

Users should be allowed to keep and use the filters after the evaluation study is completed if they want it and there are no concerns related to filter performance or ability of the users to operate and maintain the filters properly. If this is not possible, alternatives strategies for water treatment should be introduced and discussed. If users decide to keep the filter, they need to have a strategy on how to deal with damage and breakdown of the products. They also need to know where to buy spare parts or consumables and who to contact in case of any questions. If the filter can be replaced with the same or alternative product, users need to know where to find it and at what costs.

Description

Table 17 summarizes major steps and considerations.

Table 17 – Major considerations for follow-up briefing and wrap-up

Steps	When	Activities
Prepare the exit strategy	Preparation phase	Decide • If users can keep the filters • Who provides support after the study is over and how is it financed • What are alternative products if filters are not available on the local market • If locally available spare parts can be used • What additional information users might require after the study • What alternative technologies or concepts can be used beyond water filters
Communicate the exit strategy	General introduction of the study and baseline data collection	Communicate to the users what will happen with the filter after the study is over if • The filter performs well and is well accepted • The filter performance is poor or it is not accepted Discuss and assure the users understand the exit strategy before they sign the consent form for the study.
Define users who want to keep the filters	Final data collection	Ask if a user wants to keep the filters. If so, • Check the conditions of the filter. Check for leakage or damage. Replace any damaged parts, and maintain the filter using the maintenance guideline provided by the manufacturer. • Provide information about who provides support after the end of the study. Share contact phone number. • If filters can be bought locally, share contact information of service centre or next shop. If not, share information for alternative products or spare parts (e.g. taps) which can be used instead. • Discuss the steps required to deal with the most common damages. Provide any printed or online materials if available. • If consumables or replacing of elements is required, discuss and provide information on the frequency of change or indicators. • Inform and discuss possible alternatives to filter • Allow enough time to address concerns and answer questions. If you do not know the answer, clarify it afterwards and follow up with a phone call.

Steps	When	Activities
Define users who do not want to keep the filters	Final data collection	Ask if a user wants to keep the filters. If not, • Clarify the reasons • Inform and discuss possible alternatives to filter • Collect the filter
Collect and record any communications	1-2 years after the study	Keep record on any calls, reported damages, and strategies people use to deal with problems
Organise follow up visit	After at least 1 year after the end of the study	Make a follow up visit and collect information using standard monitoring questionnaire and technical performance evaluation.

Resources and materials

Filter operation and maintenance printed instructions. Spare parts if applicable. Information related to supply chain for filters. Template for recording which filters are kept and their condition.

Considerations

Since funding might not be available after the study it might be difficult to assure the quality support after the study. Especially for products which do not have an established supply chain in the country, the after study support might be very limited. If possible, some resources should be kept to assure support for at least 1 year after the end of the study. The support should focus on helping users to help themselves as filed visits might be difficult or impossible.

T Technical performance evaluation

T section addresses the technical performance evaluation of the filters including microbial water quality assessment using indicator organisms (T1), filter integrity evaluation using spiking of probiotic bacteria (T2), evaluation of filtration flow rate (T4), reported, observed and measured filter use (T5), filter robustness and durability (T6), as well as measurement of general water quality parameters such as turbidity, conductivity, pH, dissolved oxygen and colour (T3).

T1	Microbial water quality
T2	Filter integrity
T3	Filtration flow rate
T4	Filter use
T5	Robustness and durability
T6	General water quality parameters

T.1 Microbial water quality

Required	Optional	Group	Detailed protocol/questionnaire	
x		Technical performance	Annex P1	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x		x	x	x

Microbiological water testing involves testing for indicator organisms as a sign of potential faecal contamination rather than testing for specific pathogens. Testing samples before filtration, after filtration and at the outlet tap of the filter (which might be directly after filtration or after storage water container) provides information on the reduction of microbial contamination by the filter compared to raw water. This combines filtration performance of the filter as well as possible re-contamination occurring on the "clean side" of the filter element, in the storage container or at the tap.

Background

Traditionally, indicator organisms were defined as microorganisms which presence in water samples can be related to the probable presence of pathogenic organisms (disease-causing organisms). Today, it is recognized that there is no direct correlation between numbers of any indicator and enteric pathogen. Commonly, three groups of indicators are used for different needs summarized in the Table 18.

Table 18 – Overview oft he indicator microorganisms and their characzeristics (adapted from WHO, https://www.who.int/water_sanitation_health/dwq/iwachap13.pdf)

Group	Definition	Examples
Process indicators	A group of organisms that demonstrates the efficacy of a process	Total heterotrophic bacteria, total coliforms
Faecal indicators	A group of organisms that indicates the presence of faecal contamination and infers the presence of pathogens	Escherichia coli (E. coli), thermotolerant coliforms, Enterococci
Index and model organisms	A group/or species indicative of pathogen presence and behaviour, which can be used a models	E. coli as an index for Salmonella and F-RNA coliphages as models of human enteric viruses

E.coli is currently considered to be the most appropriate group of coliforms to indicate faecal pollution from humans and warm-blooded animals. However, thermotolerant coliforms and sometimes Enterococci are commonly used as well.

Description

The quantification of the indicator microorganisms such as *E.coli*, thermotolerant coliforms or Enterococci in samples can be done in a local certified lab for water quality analysis. Alternatively, an implementing organisation can conduct bacterial water quality analysis using the ready-made field test kits. Usually, the use of kits requires only limited training and no special additional infrastructure. There is a variety of test kits available on the market. These test kits utilize one of the three approaches:

- Presence-absence test does not provide quantitative information, but change colour in case microbial contamination has been detected. They are not well suitable for filter evaluation projects.
- Most probable Number tests are semi-quantitative. The user fills the sample in a set of already prepared plastic bags or tubes and adds a nutrient solution. After incubation, lasting between 12-48 hours depending on the kit and temperature, the colour change indicates the number of positive samples which can be converted after in the estimation of the concentration of bacteria using statistical method.
- Culture media-based test with or without membrane filtration. These tests are the most quantitatively accurate. When used with membrane filtration, a 100 ml sample is collected and filtered through a membrane disk filter with a pore size of 0.45µm. The membrane disk filter is after placed on a culture media and incubated for 24 hours at 36-37 degrees. The colonies grow on the media and change their appearance (usually colour). User can count colonies to determine how many colony-forming units were present in the 100 ml sample. When source water is considered contaminated, instead of 100 ml sample, 1 ml sample can be placed directly on the plate containing culture media. In this case, the final number needs to be corrected by factor 100 to account for the change of volume.

The most probable number and culture media based tests can be used for filter evaluation. Culture media based tests are usually preferred as as are often cheaper and provide more accurate results in field conditions. Presence-absence test does not provide sufficient information to draw any conclusions about the filter performance or recontamination and should not be used.

The tests can be done by the implementing organisation directly when there is space available to establish a basic field laboratory (see L6) and conusmables can be shipped or bought locally. Alternaitvely, sample processing and analysis can be outsourced to a local water laboratory or University. In this case, it is important to discuss and agree on the method, timeline and quality control measures.

Independently on the method used, the following steps will be required when samples are done by the implementer. If the sampes are processed by the local laboratory the implementer needs still to prepare samplie collection:

Preparation	Prepare a sufficient number of the sterile containers (glass, plastics bottles or sterile sampling bags) for sample collection and number them using permanent marker or a sticker at least in two places. If efforts to require to collect samples are high and involve long travel, un-secure environment or limited access, it is recommended to collect multiple samples and store then cooled to minimize loss of data and enable repetition of the measurements if needed. Prepare a cool box containing crashed ice or cooling elements of the appropriate size to accommodate all samples.
Sampling collection and transport	Always disinfect your hands with a hand sanitiser or an alcohol swab before taking samples. The first 100 ml of water should be discarded and the sample was taken without closing the tap in the between. When there is not enough water in the raw or the clean water tanks of the filters, ask the user to refill the filter. Samples need to be collected into sterile containers. The sample size is defined by the method used as well as the sampling protocol (e.g. necessity of triplicate measurements for each sample or only for selected samples). Collected samples need to be stored cooled, when possible at 4 °C and processed within 24 hours. Overheating, exposure to sunlight or UV light and freezing cause damage of the microorganisms in the sample and should be prevented.
Sample processing	The exact protocol provided by the manufacturer of the test kit needs to be followed. When culture media based tests are used in combination with membrane filtration, it might be necessary to plate also 1 ml sample directly without membrane filtration when the E.coli counts are expected to be high, i.e. in raw water samples. All equipment which comes in contact with the sample (filtration funnel or set, pipettes, tweezers) need to be kept sterile. In the field conditions, alcohol, open flame or boiling water are commonly used.
Incubation	Incubation should be conducted according to the information provided by the test kit manufacturer. Usually, incubation at 34-37 °C during at least 24 hours would be required. In some cases, manufactures of the test kits provide strategies to overcome data loss due to improper incubation due to power cuts or temperatures lower than required. This can include an extension of the incubation period for the duration of the power cut up to 36-48 hours. Carrying samples in the pockets or a body belt for incubation using body temperature can be done in exceptional cases, but is not recommended.
Counting and data recording	Most of the test kits rely on the manual counting of colonies, fields or points, the results need to be transferred manually into an electronic table (usually excel table). See data management sheet.
Disposal of waste	Used bacterial medium plates always should be disposed of as biohazardous material, because potentially pathogenic microorganisms can grow and replicate on the plates. If there are no safe hazardous waste disposal system in place, used plates need to be disinfected with chlorine or thermally (see Safe disposal section of the P1 protocol). After that the can be disposed of as solid waste.

Establishing reliable quality control procedures would help to increase the quality of data and is a must. The exact quality control procedure would depend on the number and type of samples, test kit used and the capacity. The minimal requirements for quality control include:

- at least two blank samples per sampling day. Blank samples mean sampling water which does not contain any microbial contamination in the field following the same steps as for the samples. Usually, bottled water or previously boiled and cooled water can be used as blank.
- Multiple samples (at least 3) taken from the same sampling point at least twice per day if multiple samples from each point are not possible for logistical or capacity reasons.

- At least 1 positive sample per sampling day. Positive sample means a water sample which contains E.coli bacteria. Under field conditions, this can be a sample taken from a toilet or untreated water source with a high probability of contamination.

The measurements need to be repeated if blank samples are contaminated with E.coli, or the positive control shows negative result.

Resources and material

Test kit for detection of indicator microorganisms	Microbial water quality test kit or its elements. For plating method, this includes: e.g. Delagua Test Kit or Compact Dry Plates EC, Vacuum membrane filtration device, Sterile membrane filters 0.45µm, Device for generating vacuum (vacuum pump, hand vacuum pump of the syringe)
Incubator	Field incubator capable to hold 36-37 ºC over 24 hours. If field incubators are not available, egg hatching incubators can be tested, or an incubator can be built locally using basic computer store suppliers following this instruction: https://www.jove.com/t/58443/construction-low-cost-mobile-incubator-for-field-laboratory
Sample bottles or bag	Sterile bottles or plastic bags such as Whirl Pak® should be used. Bottles or plastic bags can be re-used by cleaning properly and sterilizing with water vapour or hot water.
Sample cooling	Coolbox with ice packs or cooling elements or crashed ice
Equipment sterilization	Testing equipment can be sterilized by immersing it for 3-10 min in boiling water or by cleaning it with alcohol. If stainless steel equipment is used, it can be also sterilized over open flame or by flaming methanol in it.
Basic laboratory space and supplies	Table not used for any other purposes, power supply (grid, solar, auto-batteries), hand sanitizer, permanent marker, paper block or electronic device to record results.

Data analysis and visualization

Assure that all data is summarized in the excel table using the same units. Covert all numbers into one unit if required (e.g. CFU/100 ml) considering the sample volume. Usually, the data is presented in the graphical form which shows:

Actual numbers	The graph shows actual colony counts or most probably the number for raw water, filtered water and stored water. When the difference between raw water and filtered water exceed factor 10, the logarithmic scale might be useful. In this case, all 0 counts need to be replaced with 0.5.
Log-removal values	The log reduction values (also called Log removal values or LRV) are commonly used to calculate and visualize the magnitude of change of bacterial numbers due to a process (e.g. filtration, disinfection). Log reduction is calculated using the formula: Log reduction = Log_{10}(A)- Log_{10}(B) where A is the colony count in raw water, and B is the colony count in the filtered water. We should consider that both raw water and filtered water will influence the LRV value, meaning that when raw water has low counts, the LRV will be low, which can lead to misinterpretation of the filter removal performance.
Number of samples per type in each risk category	This method shows the number of samples with a result in a defined range. The ranges need to be defined and can indicate the risk of the presence of pathogenic microorganisms in a water sample. For example, following risk categories can be used for E.coli: 0 CFU/100ml (low risk), 1-10 CFU/100ml (medium risk), 11-100 CFU/100 ml (high risk); >101 CFU/100 ml (very high risk). This method is useful when raw water has many 0 or very low values or recontamination of water is observed and need to be visualized.

The data analysed in all three or any other way finally need to be interpreted to answer if

- Treated water corresponds to the local water quality guidelines for E.coli and is likely to be safe to drink;
- Recontamination of water in the storage tank is observed;
- The filter is functional and/or to which extent water the filter improves the quality of water compared to raw water with and without considering recontamination.

Considerations

Low concentration of indicator microorganisms in raw water makes evaluation of the filter performance difficult or impossible. Nevertheless, the testing would provide information if recontamination occurred in the system or not and if the water is likely to be safe in general. Presence of free chlorine in the raw water will influence the results leading to lower numbers or false-negative results. Thus, the free chlorine should be measured. This can be done by simple DPD based tests such as pool tester or test strips. In case the free chlorine is detected or likely to be detected, Sodium thiosulphate containing sampling bottles or sampling bags should be used to remove free chlorine from the water samples. Some test kits enable testing E.coli together with Total Coliforms using the same media. In such cases, the data need to be interpreted carefully considering the conditions. Coliforms are a heterogeneous group of organisms, many of which are not of faecal origin. Although useful as a model organism e.g. for detection of the efficacy of chlorination, the presence of coliforms in water filters is a poor indicator to evaluate microbial removal performance of filters. The reason for that is that many coliforms can multiply in a warm environment and may colonize the clean side of the filter or water storage containers, and persist in the filter over a long period of time. This behaviour is not common for most human pathogenic organisms, and therefore any correlations should be avoided.

References

World Health Organisation, Water quality: Guidelines, Standards and Health, Indicators of microbial water quality by N.J. Ashbolt, W.O.K. Grabow and M. Snozzi: https://www.who.int/water_sanitation_health/dwq/iwachap13.pdf

Constructing low cost mobile incubator: https://www.jove.com/t/58443/construction-low-cost-mobile-incubator-for-field-laboratory

T.2 Filter integrity

Required	Optional	Group	Detailed protocol/questionnaire	
x		Technical performance	Annex P2	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x		x	x	x

Filter integrity testing is important when the presence of the indicator microorganisms in raw water is low or varies considerably during the study and for different users. The integrity testing can be done by spiking non-pathogenic microorganisms in raw water at high concentrations and detecting these organisms in raw water and filtered water. The magnitude of reduction indicates the efficiency of water treatment disregarding the impact of recontamination and helps to detect any damage to the filter.

Background

The integrity of the filter in the field can be compromised by incorrect operation and maintenance, failure to install the filter correctly or manufacturing quality control problems. Common integrity problems include open or loosely tightened rubber or silicon sealing, mechanical damage of the filter elements not visible to users (micro-cracks, pinholes, broken fibres) or cracks in plastics between raw water and a clean water tanks in "two buckets" systems. Some manufacturers provide particles (usually clay particles), which can be used to spike water and measure turbidity or observe colour or cloudiness variations. This method is useful to detect severe leakages but might fail to detect small damages or poorly sealed connections. Particles might interact with organic matter in water or adsorb on plastics and filter material, which would make the results unclear. Usually, microbial water quality measurements using indicator organisms would provide clearer results. This measurement is sufficient when concentrations of indicator bacteria in raw water are high and relatively constant over time and hygienic conditions in households are generally good. However, when the presence of the indicator microorganisms (e.g. E.coli) in raw water is low, varies strongly between locations and in time, or there is a severe re-contamination issue in or after the filter, integrity problems with the filter cannot be identified by measuring indicator microorganisms in raw and filtered water. For this, a method based on spiking of non-pathogenic, pro-biotic microorganisms at high concentrations and measuring their removal by the filter is a reliable and relatively easy to implement option.

Description

Filter integrity test methodology includes spiking probiotic indicator bacteria (Enterococci or E.coli) in raw water in collecting samples of raw and filtered water, which are subsequently analysed using plating method suitable for testing the spiked indicator organisms. The method includes a preparation phase based on the identification and pre-testing of the concentrations required for spiking and dilution rates during the measurements to enable detecting at least 4-Log removal. The following general steps will be required:

General preparation for integrity testing	Identify the probiotic microorganisms available (Enterococci, E.coli) as well as the suitable detection method. We have applied Bioflorin® combined with Nissui® Compact Dry Plates ETC in multiple studies. However, other probiotic microorganisms and products can be used as well. Estimate the dilution rate required based on the volume of the filter tested, the number of cells contained in one pill, capsule or tab used, and the detection limit of the method you use and test it. Usually 1 capsule is dissolved in 1 L of water by opening the capsule and emptying its content in water, or crashing the tab or pill and mixing for 3-5 min. A defined volume of this stock solution is added into the filter. Based on the pre-testing, develop a detailed protocol for the field. P2 provides an example of such protocol.
Preparation for sampling	Prepare the solution used for spiking shortly before use using bottled, groundwater or previously boiled and cooled tap water (assure water is not chlorinated). Do not store it longer than 12 hours. Prepare a sufficient number of the sterile containers (glass, plastics bottles or sterile sampling bags) for sample collection and number them using permanent marker or a sticker at least in two places. If efforts to require to collect samples are high and involve long travel, un-secure environment or limited access, it is recommended to collect multiple samples and store then cooled to minimize loss of data and enable repetition of the measurements if needed. Prepare a cool box containing crashed ice or cooling elements of the appropriate size to accommodate all samples.
Sampling collection and transport	Always disinfect your hands with a hand sanitiser or an alcohol swab before taking samples. The first 100 ml of water should be discarded and the sample taken without closing the tap in the between. When there is not enough water in the raw or the clean water tanks of the filters, ask the user to refill the filter. Samples need to be collected into sterile containers. The sample size is defined by the method used as well as the sampling protocol (e.g. necessity of triplicate measurements for each sample or only for selected samples). Collected samples need to be stored cooled, when possible at 4 °C and processed within 24 hours. For integrity test, always take clean water samples before you take raw water samples and store clean water samples in different coolboxes or in different closed plastic bags in one cool box. This will reduce the risk of cross-contamination. Overheating, exposure to sunlight or UV light and freezing cause damage of the microorganisms in the sample and should be prevented.
Sample processing	Exact protocol provided by the manufacturer of the test kit needs to be followed. When culture media based tests are used in combination with membrane filtration, it might be necessary to plate also 0.1ml or 1 ml sample directly without membrane filtration when the Spiked bacteria counts are expected to be high, i.e. in raw water samples. All equipment which comes in contact with the sample (filtration funnel or set, pipettes, twizzers) need to be kept sterile. In field conditions, alcohol, open flame or boiling water are commonly used.
Incubation	Incubation should be conducted according to the information provided by the test kit manufacturer. Usually incubation at 34-37 °C during at least 24 hours would be required. In some cases, manufactures of the test kits provide strategies to overcome data loss due to improper incubation due to power cuts or temperatures lower than required. This can include extension of the incubation period for the duration of the power cut up to 36-48 hours. Carrying samples in the pockets or a body belt for incubation using body temperature can be done in exceptional cases, but is not recommended.
Counting and data recording	Manual counting of colonies on the plates would be required. If the number of counts on the plate exceed the detection limit (usually 150-300 CFU/plate), than this needs to be indicated in the data. If the conts are so high, it is impossible to count, the data should be recorded anyway as too many to count or by a number agreed in advance (e.g. 999 or 301 CFU/plate). Counts exceeding the detection limit can still be useful for data analysis, but repetition of the measurement with a proper dilution of the sample should be done whenever possible. The results need to be transferred manually into an electronic table (usually excel table). See data management sheet.
Disposal of waste	Used bacterial medium plates always should be disposed as biohazardous material, because potentially pathogenic microorganisms can grow and replicate on the plates. If there are no safe hazardous waste disposal system in place, used plates need to be disinfected with chlorine or thermally (see Safe disposal section of the P1 protocol). After that the can be disposed as solid waste.

Establishing reliable quality control procedures would help to increase the quality of data and is a must. The exact quality control procedure would depend on the number and type of samples, test kit used and the capacity. The minimal requirements for quality control include:

- at least two blank samples per sampling day. Blank samples mean sampling water, that does not contain any microbial contamination in the field following the same steps as for the samples. Usually, bottled water or previously boiled and cooled water can be used as blank.
- Multiple samples (at least 3) taken from the same sampling point at least twice per day if multiple samples from each point are not possible for logistical or capacity reasons.
- Positive samples for all raw water samples containing spiked microorganisms and which are in the range of detection of the method used. This means the number of cells counted on the plate does not exceed the specific detection limit for plating (usually 150 -300 CFU/plate). If this is the case, dilution of raw water before testing is required.

The measurements need to be repeated if blank samples are contaminated with spiked microorganisms, or the positive control shows negative result.

Resources and materials

Pro-biotic microorganism for spiking	Pro-biotic Enterococci or E.coli can be used. The stability of the microorganisms needs to be tested. Bioflorin® showed to be well suitable with around 800`000-2`000`000 cells probiotic Enterococci per capsule.
Test kit for detection of indicator microorganisms	Microbial water quality test kit or its elements specific for the microorganisms used for spiking. For Enterococci this can be Nissui® Compact Dry Plates ETC from Hyserve®, Vacuum membrane filtration device, Sterile membrane filters 0.45µm, Device for generating vacuum (vacuum pump, hand vacuum pump of the syringe).
Incubator	Field incubator capable to hold 36-37 °C over 24 hours. If field incubators are not available, egg hatching incubators can be tested, or an incubator can be built locally using basic computer store suppliers following this instruction: https://www.jove.com/t/58443/construction-low-cost-mobile-incubator-for-field-laboratory
Sample bottles or bag	Sterile bottles or plastic bags such as Whirl Pak® should be used. Bottles or plastic bags can be re-used by cleaning properly and sterilizing with water vapour or hot water. If chlorine is likely to be present in water, sodium thiosulfate tabs might be required to remove chlorine.
Sample cooling	Coolbox with ice packs or cooling elements or crushed ice
Equipment sterilization	Testing equipment can be sterilized by immersing it for 3-10 min in boiling water or by cleaning it with alcohol. If stainless steel equipment is used, it can be also sterilized over an open flame or by flaming methanol in it.
Basic laboratory space and supplies	Table not used for any other purposes, power supply (grid, solar, auto-batteries), hand sanitiser, permanent marker, paper block or electronic device to record results.

Data analysis and visualization

Assure that all data is summarized in the excel table using the same units. Covert all numbers into one unit if required (e.g. CFU/100 ml) considering the sample volume. Usually, the data is presented in the graphical form which shows:

Log-removal values	The log reduction values (also called Log removal values or LRV) are commonly used to calculate and visualize the magnitude of change of bacterial numbers due to a process (e.g. filtration, disinfection). Log reduction is calculated using the formula: Log reduction = Log_{10}(A)- Log_{10}(B) where A is the colony count in raw water, and B is the colony count in the filtered water. We should consider that both raw water and filtered water will influence the LRV value, meaning that when raw water has low counts, the LRV will be low, which can lead to misinterpretation of the filter removal performance.

The data analysed needs to be interpreted to answer if the filter is functional and to what extend compared to laboratory values.

To estimate the performance of the filter, the LRV values suggested by WHO (see Table 19) could be used as an indication of the acceptable performance. Filters showing less than 2-Log reduction for indicator bacteria should be tested again and repaired or replaced.

Table 19 – Performance classification for housheold water treatment and safe storage based on removal of bacteria, viruses and protozoa proposed by WHO*

Performance classification	Bacteria (log_{10} reduction required)	Viruses (log_{10} reduction required)	Protozoa (log_{10} reduction required)	Interpretation (with correct and consistent use)
***	≥4	≥5	≥4	Comprehensive protection
**	≥2	≥3	≥2	
*	Meets at least 2-star (**) criteria for two classes of pathogens			Targeted protection
-	Fails to meet WHO performance criteria			Little or no protection

* https://www.who.int/water_sanitation_health/water-quality/household/scheme-household-water-treatment/en/

Considerations

Concentrations of the probiotic bacteria added to raw water should be chosen so, it is possible to detect them within the detection limit of the method. Depending on the method used, this could be e.g. 150-300 CFU/plate. It might be necessary to dilute raw water before plating it, which can be done with bottled water. 1 ml samples applied directly to the plate without filtration can be considered as well. Usually, a pre-test would be required to define the raw water concentration, which would allow detection of at least 4-Log removal. Presence of free chlorine in the raw water will influence the results leading to lower numbers or false-negative results. Thus, the free chlorine should be measured if it is likely to be present in raw water. This can be done by simple DPD based tests such as pool tester or test strips. In case the free chlorine is detected or likely to be detected, Sodium thiosulphate containing sampling bottles or sampling bags should be used to remove free chlorine from the water samples.

T.3 Flow rate

Required	Optional	Group	Detailed protocol/questionnaire	
x		Technical performance	Annex P3	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x		x	x	x

Filtration flow rate is an important parameter to evaluate filter performance. User acceptance of filters will likely relate to the volume of water filter can treat per day as well as the volume of water available at specific peak times. Flowrate is a typical design parameter for the filter. Commonly used units are Liters per hour or litres per minute.

Background

The flow rate of the filter depends on the properties of the filtration element including the surface area, the permeability of the material (e.g. ceramics, membrane), and pressure, which can be hydrostatic (water level difference) or generated by a hand pump. Temperature and conductivity of the water will have a slight effect on flowrate as well. Filters can be classified in gravity-driven filters operated by the pressure difference in the raw water tank and outlet of the filter and pressure-driven filter, operated by a manual pump.

During operation, the presence of organic matter and particles will reduce flowrate in time due to clogging of the filtration element in gravity-driven filters. Cleaning or backwashing can recover flowrate entirely when clogging is reversible. Chemical cleaning will be necessary to recover irreversible clogging, or it cannot be recovered at all. In filters operated by the pump, flowrate remains constant, or reduce only slightly, while the pressure or effort required for pumping will increase due to clogging. In such a case, the measurement of flowrate is more difficult compared to gravity-driven systems as both flowrate and pressure will change and installation of the pressure gauge in the filter might be impossible.

Description

For gravity-driven filters designed as a two bucket, one bucket or a syphon system, flowrate can be measured by filtering a defined volume of water (e.g. 0.5 L) and measure the time required for filtration with a stopwatch. (Measuring volume of water filtered in a set time interval, usually around 2-5 min, can be used as well). For gravity-driven filters, flowrate will directly depend on the water level in the raw water tank. Thus, for measuring flowrate it is important to standardize the water level for all measurements and keep it always the same. Usually, flowrate should be measured when the filter is full. It might important to carry water to measure flow rate, as in dry areas, households might not have enough water or not be willing to fill the filters till the required level.This should be done only after all water samples for microbial water quality analysis are taken.

For the syphon filters, or if syphon is built unintentionally in the filter, the water level between the raw water tank and the outlet of the filter should be controlled. Syphon tubes should not run dry or partly dry during the measurement, as this will change the pressure in the system and affect the result.

In filters operated by manual pumping, flowrate measurement is less straightforward, and might not make any sense as flowrate is likely to remain constant despite clogging (leading to an increase of pumping effort). When the measurement of pressure generated by the pump is impossible for design reasons, the compromise can be the measurement of water collected during a set number of pump strokes or maximal volume of water generated during intensive pumping during 1 min. In this case, the same person should do the measurement whenever possible to reduce uncertainty due to pumping pressure applied manually.

If backflushing or cleaning needs to be done regularly, it would be important to record whether the filter has been backflushed on this day. At least three measurements for each filter at the time are required to account for variations and reduce mistakes.

Resources and materials

Stopwatch graduated cylinder or scale, and book for recording.

Data analysis and visualization

Data measured should be recorded in the field and transferred into excel file. It is important to compare the filtration flow rate in time from the new filters distributed in the field and during set periods of operation. Thus, the flow rate should be visualized for each filter against the time it is in operation. Data can be aggregated for a certain filter type for each measurement day and visualized using box plots when multiple filters are compared to each other.

Considerations

Water quality, operation and maintenance frequency and quality, and type of filter will have a considerable impact on the flowrate. Damage of the filter or leakages can cause an increase of flowrate. If flowrate is higher than the values obtained for the new filter, the filter should be inspected for leakage. If the filters are clogged, users should be trained again on operation and maintenance.

T.4 Filter use

Required	Optional	Group	Detailed protocol/questionnaire	
x		Technical performance	Annex P4	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x		x	x	x

Filter use is an essential parameter to understand user acceptance. It relates directly with flowrate, as well as treatment performance of the filter, as obviously not used filters are likely not to clog and perform well. Filter use is an indirect parameter and rather difficult to measure. In filter evaluation studies, reported and observed filter use can be monitored. Reported filter use relies on data recorded and reported by users. Observed filter use is estimated based on the set of indicators of filter use, such as availability of water in the filter, filter location, etc. When financial resources are available and regulations allow, data loggers and pressure or flow sensors can be used to monitor actual use.

Background

If possible data on reported, observed and actual (measured) used should be collected whenever possible. Currently, many new developments aim to measure use in household filters using sensors. Although most of the devices and sensors are tested only in pilots, technologies have high potential. Tables 20 and 21 provides an overview of the background, differences and description for the reported, observed and measured use.

Table 20 – Reported, observed and measured use – background of the measurements

Use	Method	Background
Reported use	Use recorded and reported by users	Users record the number of fillings of the filter per day on sheets of paper.
Observed use	Use estimated based on the set of indicators and questions	Implementer observes and records the location of the filter, its general status including the presence of water in the filter (raw and clean water tanks) and cleanliness, using a checklist. Observation is followed by questions regarding the frequency of use of the filter, water containers used to fill in the filter, time of the day, etc.
Actual (measured) use	Use measured by pressure or flow rate sensors logging or transferring data.	The most precise measurement of use would be by measuring the flow rate of the filter. However, there are currently no commercially available low-cost flowmeters suitable for very low hydrostatic pressures observed in gravity-driven filters. The standard low costs of water meters have too high resistance to be used in such applications. However, few prototypes are being developed. Other methods which can be used to measure actual use: Pressure sensors to measure hydrostatic pressure variations due to filling in filters and using water (e.g. Solinst Levelloggers) Sensors to record the opening/closing of the taps. If these methods are used, calibration is required to assure that data can be separated from the “noise” (e.g. children playing with taps, changes in atmospheric pressure, etc.).

Description

Table 21 – Reported, observed and measured use – methods description

Use	Method	Description
Reported use	Use recorded and reported by users	Users get sheets of paper with dates and are asked and trained to record each filling of the filter with a mark on the paper as well as the volume of the water-filled in (by recording the number of fillings done by a certain container positioned next to filter). In some cases, containers for filling filters (e.g. 2-5 L jags) are distributed as well. The implementer makes the photo of the sheet during monitoring visit and transfers data manually into excel. Data can be collected for each date, or without recording of the date for a certain defined period.
Observed use	Use estimated based on the set of indicators and questions	The monitoring questionnaire (see U5) includes the questions and observation checklist used to estimate the observed use of the filters.

Use	Method	Description
Actual (measured) use	Use measured by pressure or flow rate sensors logging or transferring data.	The sensors are placed in the filters and users are informed about the sensors. When water level sensors (such as Solinst® or Omega® level loggers) are used, they need to be programmed beforehand to collect data at specific time intervals (e.g. every 5-10 min). Frequent time intervals will use the available storage space in the logger very soon, and will also detect water level fluctuations during filling, very rare measurements might result in overseeing of the filling events. Some pressure loggers need to be corrected for fluctuations in atmospheric pressure, meaning that a one logger recording atmospheric pressure needs to be placed and secured in the area. When the temperature of raw water differs considerably from ambient temperature (over 5 °C), low cost data logging temperature sensors can be used to detect use as well (e.g. i-buttons®). If senosrs are not water- proof, they might be placed in rubber balloons or gloves and tightened on top after releasing air. The data needs to be read-out regularly. It is important to synchronise starting time and measurement intervals of different sensors to simplify data analysis.

Resources and materials

Questionnaire pre-installed on the mobile phone, book or printed paper sheets with pens to be distributed to households, sensors, loggers and data transfer equipment.

Data analysis and visualization

Reported use data is collected during the field visit. Usually, a photo of the sheet used for recording by households should be done with the GPS of the camera on, and the time of the photo is recorded in the field book together with the study ID of the household. The sheet should have the Study household ID. This would simplify the identification and allocation of photos to the right households.

Filter use might change in time and therefore visualization of data on filter use in time using box plots is advisable. Use data can be also used to calculate the study dropout rate.

Considerations

Users tend to overestimate the use of the filters for different reasons. Non-users might refuse to report that they are not using the filter and pretend they do. For this, observed use should be always analysed in parallel to reported use for consistency. When use is measured with sensors, reported and observed use data can be collected in parallel and consistency of the data evaluated. In some locations, using sensors for data collection might require special approval from authorities or ethics committee. Users might refuse using electronic sensors in some conflict zones in fear of being under surveillance.

T.5 Robustness and durability

Required	Optional	Group	Detailed protocol/questionnaire	
x		Technical performance		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x		x	x	x

Durability is a filter feature that indicates the ability of the filter to withstand the impact of environmental factors as well as incorrect user and maintenance during the whole supply chain, including shipment, distribution, assembly and use. Robustness indicates the consistency of performance of the filter across different settings and conditions.

Background

Durability and robustness of the filter depend on:

Filter related features	The general production quality of the filter, design of the filter, number and quality of moving parts, the materials used for filter production and their quality, the packaging quality
Environment and context	Environmental conditions: temperature, humidity, dust exposure during transport, storage, distribution and use; source water quality Household conditions: exposure to sunlight, conditions of water storage containers, quality of the surface filter is placed on, the necessity to move filter within the household, space available, etc. Users: care is given to filter in general, understanding and implementation of O&M procedures, handling taps and moving parts, spilling water during filling

Durability and robustness relate directly to each other, as less durable products are likely to show higher variability in different settings and environmental conditions. The most reliable indicator for durability is the number of filters damaged during the study at each stage of the supply chain. For robustness, the variability of the performance regarding flowrate and quality of filtered water depending on water quality and context (environmental, hygienic conditions in households, frequency of maintenance) should be analysed.

Description

Assessing durability using filter damage as an indicator. The number of filters damaged during logistics and after each phase of the evaluation project should be recorded. For each damaged filter, the part damaged, the severity of the damage, potential reason (when known) and if the filter can be or cannot be repaired should be recorded. Below few examples are summarized. Table 22 can be adapted depending on the filter design and context.

Table 22 – Filter damage checklist

Phase	What is damaged	Can the damage be repaired?
Preparation (incl. transport, storage) Introduction visit (distribution, assembly and first use) Monitoring Final data collection	Filter housing Filter core element (membrane, ceramic candle) Tap Pump Handle	Yes – by user Yes – by the implementer Yes – involves procurement of new parts No
Reasons for damage	**Action done**	
Handling by the transport company Bad roads Lack of maintenance Filter fell off the support structure/table Playing or misuse of parts (pump, taps) Exposure to sunlight, dust Leakage/failure of the core element	Filter is repaired Filter is replaced The filter is removed without replacement	

Assessing robustness using flowrate, filter integrity and user information as an indicator.

The flow rate of the filter, as well as filter integrity, depend on the use of the filter, as well as the ability of the filter to withstand the impact of environmental conditions as well as operation and maintenance. In field conditions, the variability of the filter integrity and flowrate between filters will be higher than in the laboratory. The flow rate and results of the filter integrity evaluation can be visualised for each monitoring campaign using box plots (or box and whisker diagram). The plots are well suitable to visualize the degree of dispersion in the data and show outliers (see data analysis and visualisation).

Large box, which is called interquartile range (IQR), “long whiskers” and a large number of outliers indicate large dispersion of the data. Large dispersion indicates that robustness of the filers is likely to be low. To compare two different monitoring campaigns, areas or filters, the visual illustration can be very powerful to understand the dispersion.

Resources and materials

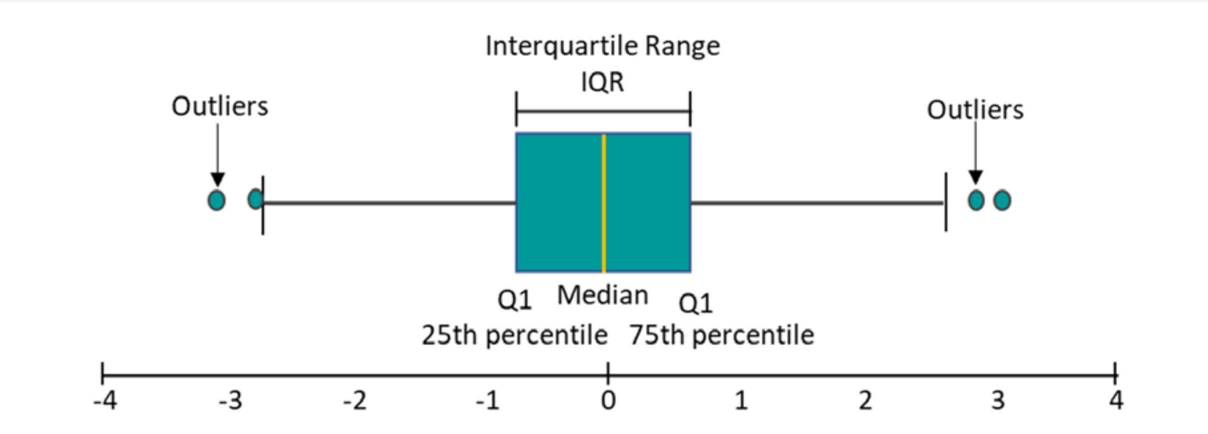
Data collected through filter use (see T.5.), flowrate measurements (see T.4.) and integrity test (see T.2.), and access to excel or data analysis software with integrated function to create box plots easily such as SigmaPlot, Mathlab, R.

Data analysis and visualization

Filter damage – the standard "stacked column" charts can be useful to visualize the proportion of the filters which had damage compared to the entire number of filters and type of damage.

Robustness – box plot with whiskers (Figure 3) can be used to illustrate the dispersion and outliers. The box plot is built using the 5 main values retrieved from data: median, Q1, Q3, Minumum and Maximum as shown on the image below.

Figure 3 – Box and whiskers plot *



*Adapted from https://towardsdatascience.com/understanding-boxplots-5e2df7bcbd51

- The median – is the middle value in a data set that has been arranged in numerical order so that exactly half the data is above the median and half is below it. So, the median divides the data into two equal sets.
- The low quartile (Q1) - is the value of the middle of the first set, where 25% of the values are smaller than Q1 and 75% are larger
- The upper quartile (Q3) - is the value of the middle of the second set, where 75% of the values are smaller than Q3 and 25% are larger.
- The difference between Q3 and Q1 will give the Interquartile Range (IQR), which thus, describes where the bulk of data lies, illustrating the middle 50% of the data values.
- "Minimum" value shows the furthest data value which is within one and a half IQR of the lower end of the box.
- "Maximum" value shows the furthest data value which is within one and a half IQR of the upper end of the box.
- Outliers are those data values which are larger than the "maximum" or smaller than the "minimum" value.

Considerations

Filters which are not used, will likely to show high flowrate and integrity. Thus, the data to estimate robustness should be only visualised for filters which are used at least once a week, and the rest of the data not taken into the calculation of damage and robustness.

Some types of damage, such as broken tap or tube, are not related to the general performance of the filter. If this type of damage is observed frequently, the option of replacing with locally available products should be considered.

T.6 General water quality parameters

Required	Optional	Group	Detailed protocol/questionnaire	
	x	Technical performance		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x		x	x	x

General physico-chemical water quality parameters include turbidity, conductivity, temperature, dissolved oxygen, pH and colour. Turbidity can be used to estimate the performance of the filter as well as evaluate the impact of water quality on flow rate and maintenance requirements for filters. All other parameters do not provide any direct indication of the performance of the filter. However, they can be a valuable indicator to understand the use and acceptance of water sources and water filtration and/or detect problems related to biological regrowth in water storage tanks (before or after filtration).

Background

Parameter Units	Background and description of the parameter
Turbidity NTU (Nephelometric Turbidity Units), FTU (Formazin Turbidity Units)	Turbidity of water arises from the presence of fine organic and inorganic solids. The existence of turbidity in water will affect its acceptability to consumers and will affect the performance of disinfection technologies. Often turbidity is related to clogging of filters, and waters with high turbidity are expected to have high clogging potential. For ceramic and biosand filters, this is often the case. For membrane filters, however, this is not exactly correct. For membrane filters, which are regularly backflushed, turbidity generated through inorganic particles (e.g. clay particles) does not have any irreversible effect on filtration rate. Only in combination with organic matter, high turbidity of water will lead to (irreversible) clogging of the filters. For surface waters, sometimes increase of turbidity would correlate with an increase of organic matter content (for example after flooding), and thus can be an indication of the potential for clogging. Reduction of turbidity by filtration is a simple proxy for the performance of the filters, but should never be used alone without microbial water quality measurement.
Temperature °C	The temperature of raw water reflects the climatic conditions as well as the origin and means of water storage (over or underground, covered vs not covered). The temperature might affect the acceptance of water, with chilled water preferred by households compared to water of ambient temperature. The temperature has a strong effect on physico-chemical processes, such as solubility of compounds such as oxygen or metals, has an effect on pH and conductivity as well as biological processes. When biological processes are concerned, around 10 °C increase in temperature of raw water will lead to a doubling of the rate of biological processes. In such case, biological re-growth on the clean side of the filters, not observed under laboratory conditions, can become a problem in warm climates, where the water temperature can increase above 30 °C in water storage tanks. Under such conditions, naturally occurring indicator microorganisms such as Coliforms might grow in raw water as well as clean water tanks, leading to high numbers not related to the actual performance of the filtration. Measurements of temperature are useful in filter evaluation studies as an indication for the risk of biological re-growth processes, as well as an indication of filter used when the temperature of raw water differs from ambient temperature by 2 °C or higher. When the difference of temperature of raw water and ambient temperature exceeds 5 °C, low-cost temperature loggers (e.g. “i-buttons”) can be used to monitor filter use.

Parameter Units	Background and description of the parameter
Conductivity µS/cm	Also referred to as electrical conductivity and, the conductivity of water is an expression of its ability to conduct an electric current. This property is related to the ionic content of the sample, which is, in turn, a function of the dissolved solids concentration. In itself, conductivity is a property of little interest for filter evaluation, but it is an invaluable indicator of the range of the order of the dissolved solids content of the water. While a certain proportion of the dissolved solids (for example, those which are of organic origin) will not be ionised (and hence will not be reflected in the conductivity figures) for many surface waters the following approximation will apply: Conductivity (µS/cm) x 2/3 = Total Dissolved Solids (mg/l). The Total Dissolved Solids can vary considerably for different water sources in the same area (rainwater, surface water, groundwater, tap water) and can be a good indication for major water source used or changes in water sources within the study, which might affect filter clogging, and microbial water quality results. Users might reject saline water sources (with the conductivity exceeding 1000 µS/cm). It is important to note that there is an interrelationship between conductivity and temperature, the former increasing with the temperature at a rate of some 2 per cent per degree C rise.
pH	By definition, pH is the negative logarithm of the hydrogen ion concentration of a solution and it is thus a measure of whether the liquid is acid or alkaline. The pH scale ranges from 0 (very acid) to 14 (very alkaline). The range of natural pH in freshwaters extends from around 4.5, for acid, peaty upland waters, to over 10.0 in waters where there is the intense photosynthetic activity by algae. However, the most frequently encountered range is 6.5-8.0. In waters with low dissolved solids, which consequently have a low buffering capacity (i.e. low internal resistance to pH change), changes in pH induced by external causes may be quite dramatic. Extremes of pH can affect the palatability of water, cause a severe corrosive effect and affect the efficiency of disinfection with chlorine, metal solubility or ammonia toxicity. There is no health hazard from pH, except that extreme values will show excessive acidity/alkalinity, with organoleptic consequences and cause corrosion of metal parts. Filtration usually does not have any effect on the pH of water. pH monitoring however can be useful when different water sources are used with varying pH in the filter evaluation study.
Dissolved Oxygen mg/l O2	Dissolved oxygen can be sometimes monitored when waters with high organic content are used as source water. The significance of oxygen in filters is purely organoleptic, with the risk of taste and odor developing at low Disolved Oxygen content of water. The risk of oxygen depletion leading to taste and odor problems is present mostly in source waters with high organic matter content and when raw water tanks are never or rarely cleaned from sediments. The solubility of Oxygen in water decreases with an increase of temperature, which might intensify the problem in warm climates.

Parameter Units	Background and description of the parameter
Color mg/l Pt/Co [mg/l Hazen]	Natural colour usually reflects the presence of complex organic molecules derived from organic (humic) matter such as peat, leaves, branches, etc. Its effect can be enhanced by the presence of suspended matter. Sometimes natural colour may arise from the presence of colloidal iron/manganese. Objections to high colour are generally on aesthetic grounds rather than on the basis of a health hazard. Consumers might be reluctant to drink water, however safe, which has a yellowish-brown colour. Depending on the nature of the colour, different filters will reduce it to a certain extent. Organic matter is one of the major foulants for membrane and ceramic filters, leading to clogging, thus monitoring and recording of color for surface water sources might be useful during filter evaluation projects where surface water is the major water source.

Description

Turbidity, temperature, dissolved oxygen and colour will inevitably change during transport and storage of water, thus all general water parameters should be measured directly in filters using portable equipment. Multimeters with electrodes specific for conductivity, dissolved oxygen and pH are available from providers of field testing equipment. All electrode-based systems need to be regularly calibrated according to the information provided by manufacturers; otherwise, the measurements will be unreliable. Low-cost systems including conductivity and pH "pens" and electrodes which can be attached to mobile phones are available on the market. The precision and robustness of these low-cost devices vary considerably and should be evaluated in advance. pH can be also estimated by pH strips, or a comparator, although the precision of such measurements is comparably low. Turbidity is measured by a portable turbidity meter (nephelometer) or a glass turbidity tube depending on the resources available and precision required. In the low range (< 5 NTU), turbidity tubes are unreliable and portable electronic turbidity meters should be used. The costs of the electronic turbidity meters decrease a lot in the past years, with reliable portable battery-powered devices available for 300 USD. Colour is measured by comparing the colour observed to the defined scale in a comparator in forms of cells, cards or disks. Temperature can be measured by a thermometer carried separately. Most multimeters and turbidity meters have internal temperature measurement. Low-cost temperature loggers (cheapest available at 20 USD) such as i-buttons can be used to monitor and record temperature over time.

Resources and materials

Single devices, or a multimeter for pH, Dissolved Oxygen and Conductivity including calibration solutions and power supply system (batteries or researchable), Turbidity meter (calibration solutions and power supply is required for electronic devices) or turbidity tube, Comparator for colour measurement. Beakers for taking samples might be practical in some cases.

Data analysis and visualization

Water quality parameters are measured in raw water and filtered water and the data are shown in absolute values. Visualization of data in percentage of removal should be avoided, when there is a high variation in raw water or filtered water values, or filtered water values are very low (e.g. > 1 NTU for turbidity).

Considerations

Turbidity in the clean water tank is an indicator filter failure or leakage. Turbidity reduction is also often used to prove the efficiency of performance of the filters. This is also a powerful marketing trick to convince users and implementers of the performance of the filter. However, turbidity particles are a couple of orders of magnitude larger than bacteria and turbidity reduction does not necessarily confirm an acceptable reduction for bacteria and viruses. Thus, presence of turbidity is a clear indication or filter malfunction or severe contamination, while its absence does not confirm the filter is fully functional.

U User perception and attitude assessment

User perception, attitude and acceptance of the household filters in general or a specific product largely determines if the products will be used consistently and correctly. This section proposes a set of methods used during the filed study at its different phases to measure and understand the user perception, attitude and acceptance.

This chapter introduces the objectives and structure of the baseline survey (U1), explains how mobile phones can be used for data collection using KOBO or ODK open-source data collection systems (U2), describes the RANAS methodology to behaviour change, which can be applied to better understand user behaviours of regarding water treatment (U3). The distribution and assembly of the filters are supported by the non-participatory observation of filter assembly and operation (U4) followed by a general monitoring questionnaire (U5). Qualitative methods such as focus group discussions (U6) and co-design workshops (U7) are suggested as optional methods for better understanding of the users` motivations and preferences, as well ideas and suggestions for optimization. Finally, willingness to pay (U8) can be evaluated, in the situations when selling filters and development of a market-based supply chain is of interest.

U1.1	Baseline survey
U1.2	Baseline questionnaire
U2	Use of mobile phones for data collection
U3.1	The RANAS methodology of behaviour change
U3.2	The RANAS questionnaire on acceptance and use of household water filters
U4	Non-participatory observation
U5	Monitoring questionnaire
U6	Focus Group Discussion (FGD)
U7	Co-design workshop
U8	Willingness to pay
U9	Final data collection

U.1.1 Baseline survey

Required	Optional	Group	Detailed protocol/questionnaire	
x		User acceptance	Annex BL questionnaire	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
x	x			

The baseline survey is one of the key elements of any filter evaluation study. The baseline survey takes place before participants receive their filters. The information collected here is later compared to information collected in the final data collection.

To conduct the baseline survey, there are several steps which need to be considered before it can start and it is important to plan enough time for the preparation. This sheet takes you through the different steps and refers to other documents within this guideline, where more information can be found.

Steps of the study

The steps of the study as described in this guideline include a preparation phase, the baseline survey, the implementation phase and a final data collection. It is important to think of the whole set-up already from the beginning and plan accordingly. The questions that will be asked in the baseline questionnaire will repeat in the final data collection. Like these changes in the perception and attitudes of participants can be recorded and analysed. But to make this possible you need to interview the same people again for the final data collection and the data you collect needs to be connected: you need to know who is who (see section participants ID below).

Ethical considerations

The set-up of the study must follow ethical considerations. It is important to obtain the informed consent of the participants before the study, ideally people sign/thumb-print this consent sheet, and according to the requirements stated in your ethical approval of the study A template for an informed consent sheet is provided by WHO and can be found in supplementary information or online (see references).

Selection of study participants

The selection of participants is discussed in more detail in L3. As soon as you have selected the list of study participants you can continue by assigning them unique IDs.

Participants ID

The information collected during the final data collection shall be compared to the information of the baseline survey. For this, you must know which interview data belongs to which participant. To ensure ethical standards you must keep the names of your study participants separate from their answers to the baseline questionnaire. This means you can prepare a list with the names (and if required phone numbers) of the study participants and their unique study ID. This list will only be stored in one place and not in the same place as the responses to the survey (see L5). When the enumerator starts the interview, he/she will enter the unique ID number first. You can assign a number of participants with their IDs to each enumerator. The list might for example look like this:

Participant's ID	Name	Village name	Phone Number
BL1	YY	XX	+33 45 000 0000
BL2	ZZ	MM	+33 45 000 0001

Logistical set-up

Think of the timing of interviews: when are the participants at home and have time to answer your questions? How much time does one interview take and how many interviews can be done in one day? How days do you need then to complete all interviews and accordingly plan for the size of your time of enumerators? Plan accordingly for transportation and/or accommodation. If you plan to collect data by using electronic devices you have to plan for data saving and battery charging, too.

Preparation of the questionnaires

Have a close look at the provided questionnaire and adapt the questions to your specific context if needed. You might need to translate the questions into the local dialect. Also already think of the final data collection. Questions should remain the same so that they can be compared.

Data collection using electronic devices

Sheet L5 which introduces the set-up and application of electronic data collection and data management.

Training of enumerators

Schedule time for your staff to be trained on the questionnaire items and translations; conduct a pre-test with some households and discuss possible challenges. Your team needs to know about the assignment of participants ID and it's important for the final data collection. Include a session where you introduce the projects background and the goal of the survey. You can also plan for role plays and discussion of interviewing techniques and ethical considerations.

During the training, each item of the questionnaire needs to be discussed so that everyone knows what the question wants to assess and why. Participants also need to agree on one translation of the questions and ensure that questions are always asked in the same way. The questions have different answer scales. Enumerators should be aware of the different question types as discussed in U.1.2.

Interviewing ethics and techniques

There are some common dos and don'ts for data collection. You might want to practice interviewing techniques in role-plays during the training. Enumerators can then support each other in learning how to treat for example someone who is in a hurry or very hesitant. Here is a list, but you can think further and include more points according to your cultural/religious context.

- You must remain absolutely NEUTRAL about the content of the interview and in your reactions to the respondents answers.
- Do not assume any answer he/she might give. If you do not get the answer, just probe.
- You must not under ANY circumstance talk about the respondent's private information to any third person.
- Each response must be directly recorded in the questionnaires, not afterwards.
- If you receive irrelevant or complicated answers, do not break in too suddenly, but listen to what the respondent is saying and then lead him/her back to the original question.
- Treat all your respondents with kindness and respect: use appropriate language, keep distance which is comfortable for your respondent, keep eye-contact.
- Do not judge anything your respondent tells you.

- Respect the participant’s personal privacy by not causing them any unnecessary personal embarrassment or discomfort

Pre-testing questionnaires

A part of the training of your staff might be the pre-testing of the survey instruments. For the pre-testing choose a location and households that are as similar as possible to the “real” study population, but is located somewhere else. Let each enumerator conduct 1-2 interviews and report any flaws or insecurities. Like this, you have time to adapt the instruments were needed and help your staff to deliver high-quality data and achieve the best results for your study. Try to observe as many interviews as possible, note situations sections which seem difficult for the interviewer or the respondent and discuss them later with the team.

Supervision of data collection in the field

The data quality is very important for the outcome of your study. If data is not trustworthy, the results you might get are corrupted. Therefore plan for quality management. Discuss the importance of high data quality already during the training and make sure to provide constant support during data collection. You might want to plan for (uncommunicated) visits during the data collection, check the incoming data regularly on any mistakes or misunderstandings. Include regular debriefings so that you have a constant exchange with your team and can detect any problems early.

Resources

- Informed consent sheet, mobile phones with pre-installed questionnaires, a set-up server for saving the data

Considerations

The preparation of the baseline survey is necessary to achieve high data quality and ensure sound and reliable results. But there might always happen unforeseen challenges or issues raised by any stakeholder involved in the process. You should plan for some extra time to be able to adapt your strategy and schedule if needed.

Table 23 – Checklist for baseline survey

Checklist baseline survey	✓
Questionnaire items adapted to my context	
List of participants or selection method defined	
Participant IDs defined and distributed	
Questionnaire programmed and uploaded	
Electronic devices prepared	
Data saving schedule and strategy designed	
Training of enumerators planned and conducted	
Questionnaire pretested and adapted where needed	
Survey logistics (transport, accommodation) planned	
Data quality management set up	

References

Template for informed consent form by WHO

https://www.who.int/groups/research-ethics-review-committee/guidelines-on-submitting-research-proposals-for-ethics-review/templates-for-informed-consent-forms.

U.1.2 Baseline questionnaire

Required	Optional	Group	Detailed protocol/questionnaire	
x		User acceptance	Annex BL questionnaire	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
	x			

The baseline questionnaire is the tool used during the baseline survey and contains a set of questions to be asked to the participants of the study. Some important considerations need to be taken before using the baseline questionnaire, such as a careful translation and adaptation to the local context.

The questionnaire components are discussed in the following. If measuring behaviour change towards the use of household water filters and related motivators and barriers is part of your study outline consider including the RANAS questionnaire (U3.1 and U3.2) to your baseline survey.

Questionnaire content

- Section A: General information

This section collects information concerning the respondent and his/her household. The reasons why this information is relevant are twofold. One reason is that the acceptance and use of the filters might for example differ between gender, age groups households size or other household characteristics. The other reason is that for the follow-up survey, it is necessary to relocate households that are part of the study and if you plan to interview the same respondent again, you will need information about your respondent. If you feel, the information collected here is not enough or too much; adapt the questions to your context.

- Section B: Information on WASH practices

If participants have received other information than provided by your organization, this might either support or conflict with the willingness to use the household water filters and their acceptance. Knowledge about the exact content of provided information helps to close gaps or complement information when needed.

- Section C: Access to water

Questions about the access and availability of water for participating households allow understanding the context related to using household water filters. Questions about satisfaction with water quality and availability allow assessing changes in those parameters after the use of household water filters.

- Section D: Collection and storage of drinking water

This section asks about the handling of drinking water within the household. This helps to assess the safety of the water chain from the source to the consumer. Therefore it asks for the container which is used for collecting water and how this container is cleaned.

- Section E: Current water treatment practice

To know what the target audience already knows and which practices for water treatment are already in use, this section assesses key features about current water treatment practices and the existing knowledge about it.

- Section F: Water filters

This section asks for the acceptance and preferences of potential users for household water filters, as well as their willingness to pay for a household filter. This will help to plan the selection of household water filters for the trial. By assessing preferences in the baseline survey, the results of the follow-up survey can be compared and changes identified.

- Section G: Observation of handwashing and sanitation facilities

In a short observation checklist, the access to handwashing and sanitation facilities is assessed and functionality indicated. This information helps to cross-check data which is collected on the functionality of household water filters.

Optional:

- Section H: Emergency context

This section finally assesses information on the emergency context. If this does not apply to your working context, you can decide to delete this part from the questionnaire. The information helps to plan the survey and decide on the project set-up and timelines if, for example, people are prone to leave the area again.

Different answer and response styles

Table 24 summarizes different types of questions.

Table 24 Types of question and answers in baseline questionnaire

Example of a question	Question type	Answer type
C4: Do you need to pay for your drinking water? 0= No, 1= Yes	Yes or No question	Only one choice possible
How satisfied are you with the following aspects regarding your current water supply? – C6: Quality. 0=not at all satisfied to 5= very satisfied	Rating question: enumerator reads the answer options out and respondent chooses one option	Only one choice on a scale of 1-5 possible
D2: What kind of water storage do you use to store water outside the house? 1= Jerry cans (10-50 L), 2= Containers 50 – 500L, 3= On-ground or elevated tank 500 - 1000L, 4= On-ground or elevated tank/cistern > 1000L, 5= Underground cistern, 99= Other	Open question: answer options are not read to the respondent. Enumerator ticks the options that are mentioned by the respondent.	Multiple choices possible, if the option is not pre-coded use “other” and specify further

Note: for the rating questions, the different answer options should be chosen so that they follow a clear increasing sequence. In the questionnaire provided in this guideline you will find 5-point scales with e.g., 1= not at all easy 2= somewhat easy, 3= rather easy, 4= easy and 5= very easy.

Resources and materials

Baseline questionnaire uploaded on the mobile phone as well as established system to manage the data collected (e.g. server).

Data analysis

After the final data collection, the end-line, the information from the baseline survey is compared to the information collected in the end-line. The data analysis depends on the question type. For questions with multiple answer options (example in Table 25), calculate percentages of individuals of your sample which mentioned certain answer options and compare those from the two time points.

Table 25 – Example of data analysis for questions with multuiple answer options

C1: Which main water source do you currently use to collect water for drinking and cooking?	Baseline	End-line	Change
Piped water in the village	20%*	19%	-1%
Rainwater harvesting from roof	5%	35%	+20%
Rainwater harvesting from surface run-off	15%	16%	-1%

*to calculate percentages, count the number of times this option was mentioned and relate this figure to the whole sample size (=100/ XX (sample size)/ YY (times mentioned))

Interpretation: for the example above, people experienced a decrease in access to piped water supply in the village by 1% but increased their rainwater harvesting from roofs by 20%. The harvesting of run-off rainwater from surfaces has decreased very little, by 1%. To interprete whether a change has been considerable or too small, depending on your context, you might want to consider changes above 20% as considerable.

For questions that ask for a rating on a scale (example inTable 26), calculate the mean value and compare this value from baseline to end-line.

Table 26 – Example of data analysis for questions that ask for a rating on a scale

C6: How satisfied are you with the following aspects regarding your current water supply? Water quality	Baseline	End-line	Change (End-line – Baseline value)
Mean value	2.3*	4.5	2.2

*to calculate mean values, sum up all values from all respondents and divide this value by the number of participants (=sum(all values)/XX (sample size)).

Interpretation: The satisfaction of participants concerning water quality has strongly increased compared to the baseline survey, by 2.2 points on a scale from 1 (not at all satisfied) to 5 (very much satisfied).

In order to make the results easier to understand, you can visualize the data by using graphs.

Considerations

To collect high-quality data it is important that everyone who is dealing with the questionnaire has understood every item. This means that he/she is aware of what the question wants to assess and why. This also accounts for the participants, therefore, a careful translation is needed and questions must meet the specifics of the study context.

U.2 Use of mobile phones for data collection

Required	Optional	Group	Detailed protocol/questionnaire	
x		User acceptance		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
	x	x	x	x

Collecting data with mobile devices is convenient as data is immediately saved and does not need to be transferred from paper sheets into digital versions. This saves time and reduces the number of mistakes. There are many different tools for digital data collection: KoBo and ODK collect, for example, are very common in the WASH sector and are free of charge. This guideline focuses on KOBO, but the questionnaires that are developed for KOBO can also be used in ODK. For both tools, you need to open a server so that you can develop your tools and upload/ save your collected data.

Introduction of KoBo

information is taken from the official homepage of OCHA services and can be accessed online via https://www.humanitarianresponse.info/en/applications/kobotoolbox. You can also find detailed instructions on how to set up the questionnaires and on data collection on this page.

- KoBo Toolbox is a free open-source tool for mobile data collection, available to all. It allows you to collect data in the field using mobile devices such as mobile phones or tablets, as well as with paper or computers.
- It is being continuously improved and optimised particularly for the use of humanitarian actors in emergencies and difficult field environments, in support of needs assessments, monitoring and other data collection activities.
- The adaptation of KoBo Toolbox for humanitarian use was a joint initiative between OCHA, Harvard Humanitarian Initiative (HHI) and the International Rescue Committee (IRC).

Questionnaires

The questionnaires that are provided in this guideline are all ready for upload and use in KOBO/ODK. However, if you want to adapt questions and change the questionnaires, you can do that.

Data saving and upload

- In the settings of the KOBO collect application, you need to define the server name, where interviews should be saved. You can do so by going to “settings”, then under URL enter your server name. Then enter your username and password.
- Back to the home screen go to “get blank form”. Choose the right form for your interviews, select and download. If you now go to “fill blank form” the form will open and you can start the interview.

- If you mistakenly chose one option you can undo so by holding the option for a while
- Make sure to always save each interview properly by clicking “save form and exit” and the box should be selected which says “mark form as finalized”. You can find the finalized interviews in the folder “finalized forms” on the home screen. After you have collected all interviews for one day, open this folder, select all interviews and “send finalized forms”. They will be automatically uploaded to the server and saved. For this upload, you will need an internet connection.

Table 27 – Checklist for mobile phone based data collection

Checklist electronic data collection	✓
Date and time: make sure that all devices that you use are set to the correct time and date	
Tool: make sure that all devices use the correct form for data collection	
Battery: always use a fully charged device so that no data can be lost or you have to stop an interview while ongoing, you can also always carry a power bank as a back-up	
You can adapt the brightness of the device if you work in sunlight and this also saves battery	

Considerations

It is recommended that at least one person in the project management team is familiar with Kobo or ODK to help set up the questionnaires, the server, train the enumerators and trouble shoot. If this is not the case, an online course or training on how to use one of the tools might be necessary prior the study. It is also recommended to try all steps with invented or old data before actual data is collected to check that all prcesses work correctly and understood by the team.

References

KoBo Toolbox is available at https://www.kobotoolbox.org

U.3.1 The RANAS aproach to systematic behaviour change

Required	Optional	Group	Detailed protocol/questionnaire	
	x	User acceptance		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
	x			

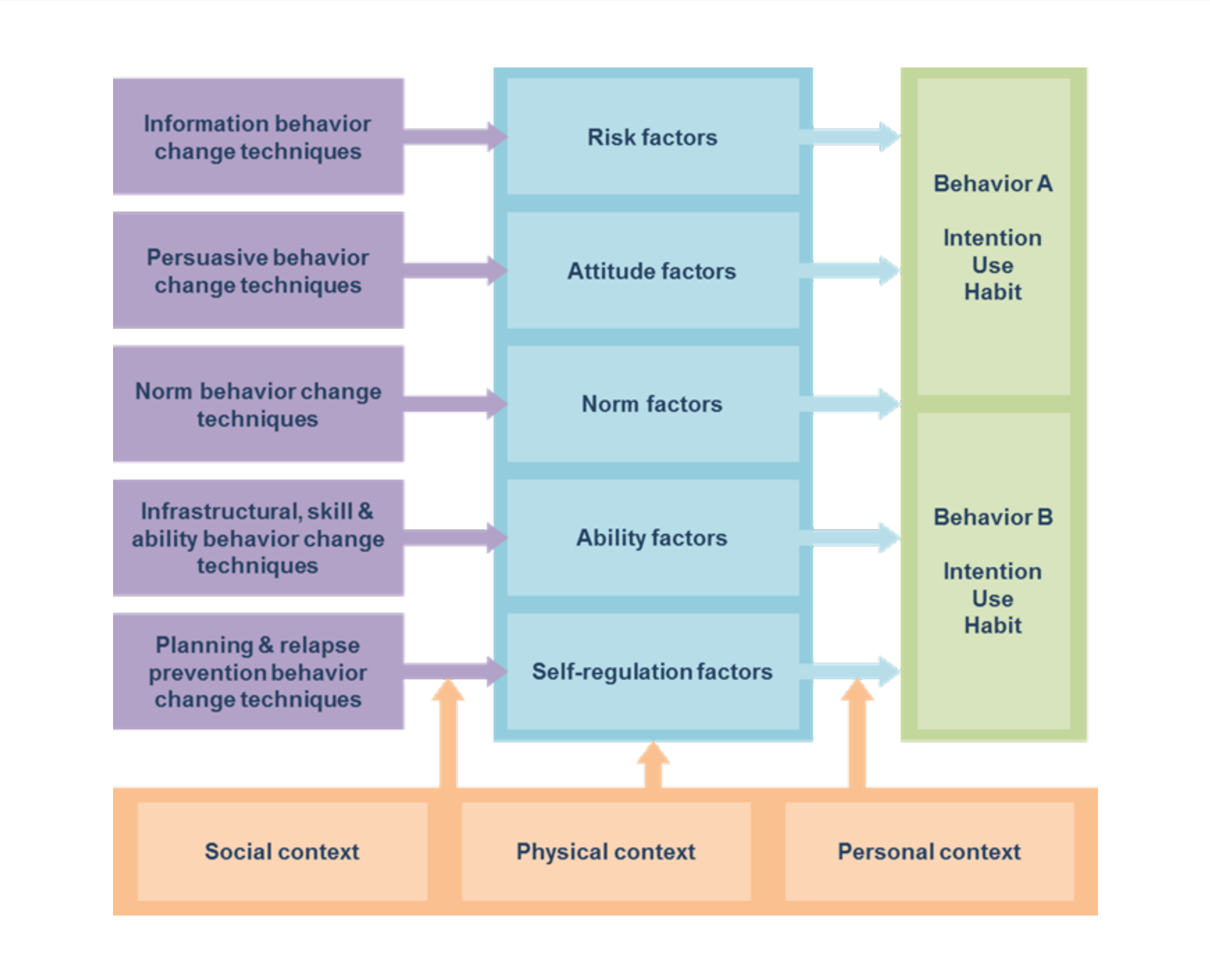
Including the behaviour change aspect of your study enables the planning of population-tailored and data-driven development of behaviour change interventions. Those interventions enhance the uptake and use of household water filters. RANAS stands for Risks, Attitudes, Norms, Abilities and Self-regulation and describes a theoretical model of psychosocial drivers that steer a target behaviour. This model is the basis for the practical RANAS approach which follows 4 steps, described in this chapter.

This chapter gives an over view on the theoretical RANAS model and the practical approach. Interested readres can find more details in the RANAS guideline, which is accessible online (see ressources below).

The RANAS model of behaviour change

The core of the model consists of five factor blocks (blue boxes, Figure 4). Those represent the mind-set of the users: they are the thoughts, attitudes and believes that people have related to a new target behaviour (e.g., using household water filters). Those so-called psychosocial factors steer the behaviour and must be in favour of the target behaviour (target behaviour A: users consistently use household filters or undesired behavior B: users do not use the household filter, in the green boxes). If we know which factors steer the target behaviour, we can directly target those beliefs, attitudes, the psychosocial factors, by specific behaviour change techniques (BCTs, purple boxes). The whole model is embedded in the context of the users. The context includes personal (e.g., age, disabilities, gender, and income), social (e.g., social cohesion) and physical (e.g., availability of water) factors that enable or hinder the uptake of new behaviour.

Figure 4 – The RANAS model of behaviour change



The psychosocial factors of the RANAS model

This section describes the psychosocial factors in more detail. The understanding of the factors helps to administer the questionnaire on the RANAS factors and later to identify behaviour change techniques to use. The following table 28 is retrieved from the original RANAS guideline and can also be found online (Contzen & Mosler, 2015).

Table 28 – Defintions of behavioural factors

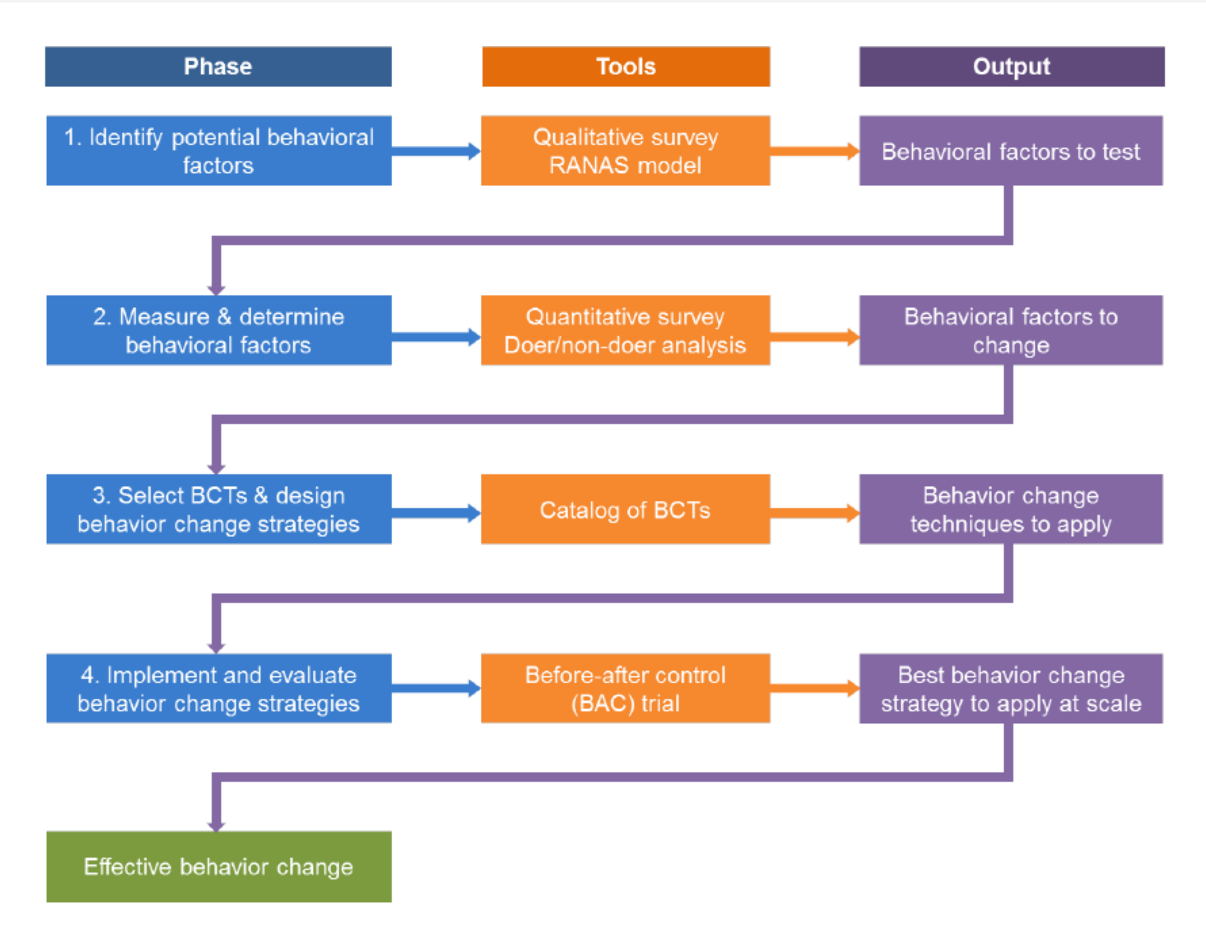
Behavioural factor	Definition
Risk factors: represent a person's understanding and awareness of the health risk.	
Health knowledge	A person's knowledge about a disease's causes and (personal) consequences and its preventive measures.
Vulnerability	A person's estimate about the general probability to contract a disease and the subjective awareness of the personal risk of contraction.
Severity	A person's assessment of the seriousness of the infection and the significance of the disease's consequences.
Attitude factors: represent a person's positive or negative stance towards a behaviour.	
Beliefs about costs and benefits	A person's beliefs about monetary and non-monetary costs (time, effort etc.) and benefits (lower medical costs, improved health) of behaviour, including social benefits (higher status, appreciation by others).
Feelings	A person's emotions (joy, pride, disgust etc.) which arise when thinking of behaviour or its consequences or when practising the behaviour.
Norm factors: represent the perceived social pressure towards a behaviour.	
Others' behaviour	A person's observation and awareness of others' behaviour, his or her perceptions as to which behaviours are typically practised by others.
Others' (dis)approval	A person's perceptions as to which behaviours are typically approved or disapproved by relatives, friends, or neighbours. This includes the awareness of institutional norms, i.e. the dos and don'ts expressed by recognized authorities such as village, tribe, or religious leaders, and other institutions.
Personal importance	A person's beliefs about what she or he should do or should not do.
Ability factors: represent a person's confidence in her or his ability to practice a behaviour.	
How-to-do knowledge	A person's knowledge of how to execute the behaviour
Confidence in performance	A person's perceived ability to organize and execute the courses of action required to practice a behaviour.
Confidence in continuation	A person's perceived ability to continue to practice a behaviour which includes the person's confidence in being able to deal with barriers that arise.
Self-regulation factors: represent a person's attempts to plan and self-monitor a behaviour and to manage conflicting goals and distracting cues.	
Action planning	The extent of a person's attempts to plan a behaviour's execution, including the when, where, and how of the behaviour.
Action control	The extent of a person's attempts to self-monitor a behaviour by continuously evaluating and correcting the ongoing behaviour toward a behavioural goal.
Barrier planning	The extent of a person's attempts to plan to overcome barriers which would impede the behaviour.
Remembering	A person's perceived ease of remembering to practise the new behaviour in key situations.
Commitment	The obligation a person feels to practice a behaviour.
Confidence in recovering	A person's perceived ability to recover from setbacks, to continue the behaviour after disruptions.

The four phases of the RANAS approach (Figure 5)

Phase 1: identify potential behavioural factors

For the first step, we conduct qualitative interviews with individuals in our target community. These interviews will inform us about how the mind-set of the users is- thoughts and believes they have regarding the use of household water filters. We will receive information on related positive or negative feelings, costs and benefits and hindering reasons regarding the uptake of the household filters. This information will be used to develop the quantitative questionnaire for the second phase.

Figure 5 – Four phases of the RANAS approach



Example: *During the qualitative interview, one of our respondents tells us that she is unsure of how she can collect sufficient water for the use of the household water filter. She sais that it is difficult for her to include water collection into her daily routines.*

Phase 2: Measure & determine behavioural factors

The quantitative questionnaire will be administered to all study participants. Based on the behaviour which particiapnts report, they will be classified as doers…. Then doer and non doers will be compared… and lead to solid information on the differences between so-called "doers" (e.g., people who are willing to use the household filer) and "non-doers" (e.g., people who are not willing to use the filters). This step, therefore, results in a set of psychosocial factors that explain the differences between doers and non-doers and that need to be targeted by the behaviour change intervention.

Example: *In our quantitative questionnaire, we ask -besides others- questions about problems that might hinder people of using the filter and we ask how these problems could be solved (factor barrier planning from the Self-regulation factor block). From this, we learn that many non-doers have the same problem as our respondent from phase 1 and that they could solve it by collecting water several times a day and including the water collection in their daily routines.*

Phase 3: Select BCTs & design behaviour change strategies

For each factor that we identified in phase 2, we select one behaviour change technique (BCT) from the catalogue, which is provided in the RANAS guideline. After we have selected all BCTs that we need, we decide how we could deliver the BCTs to the participants. The RANAS approach differentiates between the content, which is defined by the BCTs and the communication channel, which describes the way, how a message is delivered (e.g., through radio bulletins or household visits). Then, we combine BCT and communication channels into one coherent behaviour change campaign.

Example: *We identified that we need to target "barrier planning" and selected BCT 30: Prompt coping with barriers. We decide that we want to deliver the BCT through household visits, sit with the responsible person for water collection, and discuss individually problems and possible solutions. We have drafted a paper, where the problems and solutions can be drawn and which is handed over to the respondent as a reminder of how she/he planned to overcome problems*.

Phase 4: Implement & evaluate behaviour change campaign

The planned campaign needs to be delivered to the study participants, and ideally to the whole community. After the implementation, we evaluate the effects of the interventions on the mind-set of the users and their behaviour. Like this, we learn in detail what was changed in the attitudes and believes of the users and how these changes were related to changes in their behaviour. It is important to interview the same respondents again that has been interviewed in phase 1. Only by doing so, we know how their individual mind-set has changed. For the evauation, we use the same questionnaire of Phase 1 and add some questions that assess the acceptance of the intervention.

Example: *our respondents tell us that now they don't face problems any more with filling the water filter and that they consistently use clean and safe water for drinking and cooking at home. Additionally, we learn that they liked the intervention. The analysis of all interviews shows us that roughly 60% has changed their behaviour and have done so mainly because they have developed strong barrier planning skills. Some others remained non-doers and we now can adapt our interventions to also target their needs.*

References

More information and practical guidelines on the RANAS model and approach can be assessed online:

- The RANAS guideline containing all steps and examples: https://76ddba31-385f-4f1b-a8fc-00db654c6cbf.filesusr.com/ugd/accbe3_5c9557ff3d424500a4644e3e22e88bd4.pdf
- A fact sheet on the RANAS model: https://76ddba31-385f-4f1b-a8fc-00db654c6cbf.filesusr.com/ugd/accbe3_5b935457433944c7a46741aa58122b87.pdf
- A fact sheet on the RANAS approach. https://76ddba31-385f-4f1b-a8fc-00db654c6cbf.filesusr.com/ugd/accbe3_44e4612f73e9450d8a21ffb9936ea5db.pdf
- Explanation of the Doer/Non-Doer analysis:
- More details on the RANAS behavioural factors: https://76ddba31-385f-4f1b-a8fc-00db654c6cbf.filesusr.com/ugd/accbe3_6f4dd907513c4e7ab31726e3986dc602.pdf https://76ddba31-385f-4f1b-a8fc-00db654c6cbf.filesusr.com/ugd/accbe3_db150cee6a8349fb8681adcce888bd95.pdf
- The catalogue of RANAS BCTs: https://76ddba31-385f-4f1b-a8fc-00db654c6cbf.filesusr.com/ugd/accbe3_3e953ce700924bc18969aca4f11d0d60.pdf

Contzen, N., & Mosler, H.-J. (2015). The RANAS behavioural factors. Methodological Fact Sheet 3. Dübendorf, Switzerland: Eawag, Swiss Federal Institute of Aquatic Science and Technology.

U.3.2 The RANAS questionnaire on acceptance and use of household water filters

Required	Optional	Group	Detailed protocol/questionnaire	
	x	User acceptance	Annex RANAS questionnaire, Annex FD	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
	x			

If you decide to apply the RANAS approach you will first need to collect information about the users' preferences, reasons for or against filter usage and motivators and barriers. Therefore, the administration of a questionnaire is recommended to gather the necessary information which can then be translated into population-tailored and data-driven behaviour change interventions.

Assessing RANAS factors

The questions assessing RANAS factors cannot be answered by yes or no. Usually, they ask for a rating on a scale: "How much do you like the taste of the filtered water?" (for the factor feelings). So people have to give an answer that ranks between 1= I don't like the taste at all to 5= I extremely like the taste. This is because changes in psychosocial factors can be very subtle and only differ from "I like the taste a little" to "I quite like the taste". But this difference is already important and can explain why someone is using a filter and someone else doesn't. This is why the differentiation between the different answer options is important and should also be discussed during interviewer training.

Qualitative pre-survey

To know which feelings are relevant for filter use in your context or which barriers people usually face and how doers manage to overcome them, a qualitative pre-study is recommended. This helps to finalize the RANAS questionnaire and fill them according to gaps in the questions (see RANAS questionnaire in supplementing information). Annex FD is a qualitative interview guideline which can be used and administered with 5-10 individuals in a first step. The gathered information should then be used for the quantitative questionnaire.

Quantitative questionnaire on the use of household water filters and related psychosocial factors.

The questionnaire consists of two parts. The first part contains the assessment of the behaviour itself to later distinguish between people who consistently use household water filters (doers) to those who don't (non-doers). The second part entails the questions assessing psychosocial factors according to the RANAS model.

- Behaviour assessment of household water treatment

Table 29 – Example questions to measure behavioural outcomes

Example questions to measure behavioural outcomes		
Behavioural outcome	**Example question**	**Response scale**
Behaviour (frequency)	How much of your household's drinking water is treated?	0 = Almost none; 1 = Less than half; 2 = About half; 3 = More than half; 4 = Almost all
Intention	How strongly do you intend to treat all your drinking water?	0 = Not strongly; 1 = A little strongly; 2 = Strongly; 3 = Quite strongly; 4 = Very strongly
Habit (automaticity)	How much do you feel that you treat your drinking water automatically?	0 = Not automatically; 1 = A little automatically; 2 = Automatically; 3 = Quite automatically; 4 = Very automatically

- Assessment of psychosocial factors related to using household water filters

The following table offers examples to assess the RANAS factors related to using household water filters. Where questions are marked with an asterisk and parts are written in *italics*, input from the qualitative survey is needed or questions should be cross-checked with information gathered during qualitative interviews.

Table 30 – Example questions to measure behavioural factors

Example questions to measure behavioural factors		
Behavioural factor	**Question example**	**Response scale**
Health knowledge	I will present to you some potential causes of diarrhoea. Could you please tell me for each whether it is a cause or not? 1. Water contaminated by bacteria 2. Mosquito bite 3. Spicy food 4. Raw water	A = Yes; B = No. Each correct answer is awarded one point.
Vulnerability	How high do you feel is the risk that you contract diarrhoea?	0 = No risk; 1 = A little risk; 2 = A risk; 3 = Quite a risk; 4 = A high risk
Severity	Imagine you contracted diarrhoea, how severe would be the impact on your daily life?	0 = Not severe; 1 = A little severe; 2 = Severe; 3 = Quite severe; 4 = Very severe
Beliefs about costs and benefits (effort)*	How effortful do you think is it to only use water from your household water filter?	0 = Not effortful; 1 = A little effortful; 2 = Effortful; 3 = Quite effortful; 4 = Very effortful
Beliefs about costs and benefits (time)*	How time-consuming do you think is it to only drink water from your household water filter?	0 = Not time-consuming; 1 = A little time-consuming; 2 = Time-consuming; 3 = Quite time-consuming; 4 = Very time-consuming
Beliefs about costs and benefits (health)	How certain are you that drinking water from your household water filter prevents you from getting diarrhoea?	0 = Not certain; 1 = A little certain; 2 = Certain; 3 = Quite certain; 4 = Very certain
Feelings (behaviour)*	How much do you like to use your household water filter?	0 = Don‘t like it; 1 = Like it a little; 2 = Like it; 3 = Quite like it; 4 = Like it a lot
Feelings (taste)*	How much do you like the taste of the water provided by your household water filter?	0 = Don‘t like it; 1 = Like it a little; 2 = Like it; 3 = Quite like it; 4 = Like it a lot
Others' behaviour	How many people in your community filter all their drinking water?	0 = (Almost) nobody; 1 = Some of them; 2 = Half of them; 3 = Most of them; 4 = (Almost) all of them
Others' (dis)approval	People who are important to you, how much do they approve that you use a household water filter for all drinking water?	0 = Disapprove a lot; 1 = Disapprove; 2 = Neither approve nor disapprove; 3 = Approve; 4 = Approve a lot
Personal importance	How strongly do you feel an obligation to yourself to use a household water filter for all drinking water?	0 = Not obliged; 1 = A little obliged; 2 = Obliged; 3 = Quite obliged; 4 = Very obliged
How-to-do knowledge	What are the steps for the correct use of your household water filter?	No answer options are provided. Each mentioned critical step of using the household water filter is awarded one point.
Confidence in performance	How confident are you that you can always drink water from your household water filter?	0 = Not confident; 1 = A little confident; 2 = Confident; 3 = Quite confident; 4 = Very confident

Confidence in continuation*	How confident are you that you can continuously use your household water filter even though you have to spend a substantial amount of time for doing so?	0 = Not confident; 1 = A little confident; 2 = Confident; 3 = Quite confident; 4 = Very confident
Confidence in recovering*	Imagine you have stopped using your household water filter for several days, for example, because it needed to be cleaned. How confident are you that you would start using your household water filter again?	0 = Not confident; 1 = A little confident; 2 = Confident; 3 = Quite confident; 4 = Very confident
Action planning	Do you have a plan when during the course of your day to fill your household water filter? If yes: Could you please specify the point in time?	No answer options are provided. Answers will be classified into "specific plans" (e.g. after breakfast; at 9 am) and "unspecific/no plans" (e.g. in the morning).
Action control	How much do you pay attention to only drink water from your household water filter?	0 = Pay no attention; 1 = Pay a little attention; 2 = Pay attention; 3 = Quite pay attention; 4 = Pay much attention
Barrier planning	Do you have a plan for how you can treat all your drinking water even if your household water filter is not functional?	No answer options are provided. Answers will be classified into "correct plan" (e.g. I'll boil the water) and "incorrect/no plan" (e.g. I'll drink raw water).
Remembering/ forgetting	How often does it happen that you forget to use the water from your household water filter?	0 = (Almost) never (0%); 1 = Seldom (25%); 2 = Sometimes (50%); 3 = Often (75%); 4 = (Almost) always (100%)
Commitment	How important is it for you only use water from your household water filter?	0 = Not important; 1 = A little important; 2 = Important; 3 = Quite important; 4 = Very important

Considerations

The administration of the RANAS questionnaire needs careful training and an understanding of the approach and the meaning of the different psychosocial factors. Make sure to include an according to training for enumerators into your project schedule. Additionally to the checklist of the baseline survey, make sure to also complete the following steps.

References

More information can be found on www.ranas.ch

Contzen, N., & Mosler, H.-J. (2015). The RANAS model of behaviour change. Methodological Fact Sheet 2. Dübendorf, Switzerland: Eawag, Swiss Federal Institute of Aquatic Science and Technology.

Contzen, N., & Mosler, H.-J. (2015). The RANAS behavioural factors. Methodological Fact Sheet 3. Dübendorf, Switzerland: Eawag, Swiss Federal Institute of Aquatic Science and Technology

U.4 Non-participatory observation

Required	Optional	Group	Detailed protocol/questionnaire	
x		User acceptance	Annex Observation checklist	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
		x		

During the introduction visit, the participants receive the filter and printed instruction for assembly, operation and maintenance of the filter. Ideally, the instructions are easy to understand, e.g. in form of pictograms, so that users do not need additional support from outside. To understand whether this is the case, a non-participatory observation of the filter assembly is conducted without any further support or training. Training on filter installation, operation and maintenance is conducted afterwards.

Background

The goal of the observation is to evaluate whether the filter is self-explaining and can be assembled and operated without external support and training. The results will also help to define if incorrect installation might lead to any malfunction of the filter. Thus, the non-participatory observation aims to understand the ease, simplicity, challenges, problems experienced by users as well as assess possible health risks during

- assembling the filter (fixing filter elements and taps into the filter, connecting the filter parts, placing the filter in the bucket, priming (removing air of the system if needed), etc.)
- the first use of the filter (filling in water, waiting for water)
- handling of treated water (collecting water, use of external containers, bottles, cups)

while only using the written instructions provided by the manufacturers and no support from the trainers.

Description

Observation follows the steps below:

1	Inform the user that he/she can now install the filter and you would just observe him/her during this procedure and that you will take notes. Users are allowed to ask for help from family members or other community members, but not from the observers. Please assure that the user is aware that she /he can keep the filter even if assembled incorrectly and there are no other implications of the incorrect actions concerning the filter.
2	Hand over the filter
3	Ask the user to assemble and install the filter where it is supposed to be used. Try not to provide suggestions even when you see a strange behaviour or approached directly. Interact only if you are convinced that the filter can be damaged.
4	Additionally, use a stopwatch to record the time the user needs to assemble the filter.
5	Fill out the observation checklist on your electronic device.
6	Stop observation if • the filter is assembled correctly • the filter is assembled incorrectly but user says that he/she has done it • the user does not know how to proceed and stopped trying, shows signs of frustration and actively requires help. In such a case you can first suggest asking for help someone else.
7	Confirm with the user that he/she is done with assembling the filter or ultimately requires help and stop recording only if the answer is yes.
8	In case the filter is assembled incorrectly, explain the problem and fix it. If the filter is assembled correctly - proof the tightness of candles etc. if needed
9	Check with the user that there is raw water, and ask to use the filter. In case there is no water, ask the user to go to the source together with you and collect some. If the source is not reachable in an acceptable timeframe or there are other reasons which prevent you or the user from going to the source, use water you brought with you.
10	Start observation of the use of the filter. Fill out the observation checklist on your phone.
11	Interact with the user when • the user tends to drink water which is not treated (the wrong hose used, etc.) • the user finds that it takes too long - encourage to wait
12	Stop observation when • the user has drunk the first glass of water • there is no water coming out of the filter or filter is obviously non-functional
13	Ask the user how he/she will clean the filter. Encourage to use the information materials provided with the filter if any.
14	Ask to demonstrate this to you and observe the behaviour
15	Stop recording when the user • has finished the cleaning process (either in accordance with instructions or wrongly or partially wrongly) • does not know how to do it and does not receive help from anyone

Resources

- KoBo form: Observation checklist

Considerations

In some cases, it might be interesting to do a video recorded observation to analyse or explain the possible challenges better to the manufacturers and implementers not present during the observation. However, the team has to apply for ethical approval to do this well in advance, and all users would have to be properly informed and sign a consent form.

Table 31 – Checklist for the observation

Checklist for the observation	✓
Have the filter and according to instructions ready	
Make sure to have the observation checklist on your device	
Bring a stopwatch or your mobile phone to take the time	
Bring water in case water is unavailable to test the filter	
Make sure that you know how to assemble the filter correctly, and you have tested it before	

U.5 Monitoring questionnaire

Required	Optional	Group	Detailed protocol/questionnaire	
x		User acceptance	Annex Monitoring questionnaire	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
			x	

After the baseline survey and the distribution of household filters, participants are expected to start using the filters and integrate the use in their daily routines. Monitoring visits help to assess information on functionality, use and acceptance of the filter. This information again helps to better guide your decision at the end of the study regarding the suitability of the tested filter to your specific context.

The monitoring information can be collected the first time during the introduction visit (see D1). After this, the minimum of one monitoring visit is recommended before the last one which again can be combined with the final data collection. The monitoring visit has four sections: i) Observation of filter usage, ii) Interview on usage and acceptance, iii) Self-recorded use of the filter (see T4) and iv) General water quality parameters (see T6). The last section assessing the general water quality parameters is optional.

Observation of filter usage

The observation questions are part of the monitoring questionnaire. First, the filter functionality and cleanliness, as well as other water containers that might exist are observed and information is then entered into the questionnaire. During the training of your staff make sure that everyone has the same understanding of the questions, even for the observation. For example, the perception of cleanliness might vary among your team members. To gain a common understanding you can use pictures or conduct mock observations and discuss the outcomes together.

Interview on usage and acceptance

The questionnaire contains questions about ease of use and cleaning the filter as well as questions about the liking of the taste of water and anything participants like or dislike about the filter.

Self-records

As described in sheet T.5., participants get sheets of paper with dates and are asked and trained to record each filling of the filter with a mark on the paper as well as the volume of the water filled in. These sheets are copied to the questionnaire during the monitoring visit. If more feasible, a picture can be taken and data entered after the visit.

General water quality parameters

In sheet T.3. the parameters and their measurement are described and the assessment is done during the monitoring visit to measure the functionality of the filter and quality of the filtered water. The assessment of these is optional (the questions will not appear in the questionnaire, if not selected). The parameters that can be assessed are: flow rate (ml/s), turbidity (NTU/FTU), temperature (°C), conductivity (**µS/cm**), pH, Dissolved Oxygen (mg/l O2) and Color (mg/l Pt/Co [mg/l Hazen]).

The questionnaire contains an item which assesses the number of the monitoring visit. This is in case more than one monitoring visits are done.

Resources

- Trained data collectors need to have functional electronic devices and the KoBo/ODK monitoring questionnaire downloaded on it.
- Testing equipment depending on the selection of water quality parameters to test.

Considerations

Besides the baseline survey, the introduction visit and the final data collection, the monitoring is another important source of information. To be able to connect all sources of information on one household, make sure to always repeat the same study participant ID which you assigned to the household in the baseline survey. You might want to consider to write the participant ID on the filter if possible.

U.6 Focus Group Discussion (FGD)

Required	Optional	Group	Detailed protocol	
	x	User acceptance		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
				x

The Focus Group Discussion (FGD) is a participatory and interactive tool for collecting information on the study participants. They are invited to share their experiences about the study and the use of the filters, as well as their preferences and attitudes. The FGDs should be conducted for different groups (e.g., men and women), in order to enable everybody to express their opinions frankly.

The FDG allows getting in-depth information about the experiences, preferences and attitudes of the study participants. So two characteristics are crucial and are typical for FDG: a) there is a moderator who facilitates the discussion and keeps the overview and b) every participant should get his/her space to share his/her opinion. Therefore the FDG is a structured and well-organized, but participatory and interactive tool. The facilitator needs to be aware that participants may not share the same opinion and that different participants (e.g., women) may feel uncomfortable to share their views in front of others. A careful planning process is mandatory before conducting an FDG. The following section offers different tools and checklists for this process, but a lot of resources are available online if other information should be preferred. A collection of online resources is provided below.

Selection of participants

You might want to select participants that have been part of the study and invite them to the planned FGD. If you feel this is necessary you can plan for different groups:

- Adult women
- Adult men
- Religious leaders/village leaders/elders
- Adolescents

Depending on the size of your sample, you can either invite all study participants or do a random selection of all study participants. Make sure that no one feels excluded or that preference is given to certain individuals and their opinions. Usually, the size of an FGD ranges from 6-12. But also smaller groups are informative and fine. The advantage of smaller groups is that participants have more time to share their opinions.

Drafting a list of questions

Part of the preparation process is to draft a list of questions that serve as guidance for the moderator of the FGD. The questions that are discussed with the participants should be open and no questions that can be answered with yes/no. A possible collection might be:

- ✓ What were your experiences with using the filter(s)?
- ✓ What did you like or dislike about the filter(s) that you received?
- ✓ How do you evaluate the different features of the filter(s)?
- ✓ How do you evaluate the flow rate, design, capacity and water quality of the filter(s)?
- ✓ What would you like to change about the filter(s)?
- ✓ Which filter would you prefer? Why?
- ✓ How did your family members react to the filter? What do you neigbours say?

Operational preparation

- ✓ Preparation of list of questions
- ✓ Ask for the permission with village leaders to conduct FGDs
- ✓ Train moderators and minute takers
- ✓ Arrange for a venue which is easily accessible for everyone
- ✓ If you want to record the session: informed consent sheets, video/audio recorders (with extra batteries)
- ✓ Organize invitation of participants
- ✓ Plan timings according to the schedules of your target group
- ✓ Plan for an appropriate kind of incentive for their voluntary participation

Facilitating FGDs

The moderator plays a crucial role during the facilitation of an FGD. He/She needs to

- ✓ Ensure that the discussion follows the developed guideline and does answer the questions defined before the FGD
- ✓ Make sure that the discussion is inclusive and balanced
- ✓ Avoid dominating the discussion and expressing his/her opinion or judgements
- ✓ Be ppen, alert, encouraging and enabling.

Theoretically, the moderator should be able to establish a group dynamic in which participants discuss the guiding topics among themselves.

Usually, an FGD contains these steps (Dawson, Manderson, and Tallo 1993):

- ✓ Use an “ice-breaker”, e.g. a round of introduction, a prayer or even a game.
- ✓ Explain the topic of the whole study and the specific purpose of this FGD
- ✓ Start the discussion and use the list of questions as guidance, but ideally just as inputs that encourage the discussion. No need to follow the order of the questions.
- ✓ Thank participants and say good-bye.

Data analysis

You can either use the notes taken by your staff or the video/audio recordings to later recapitulate the process and discussion. Make sure that you don't let yourself guide by your interest but by the content of the discussion.

- ✓ List all information that answer the questions of your list.
- ✓ Group the information according to topics.
- ✓ Check whether the information is different for different sub-groups (men, women, leaders, etc.).
- ✓ Also critically analyse your individual impression of the discussion and your thoughts that evolved during the process or when doing the analysis.

After you have achieved a synthesis of the discussion, try to find a structure for the results. This might look like this:

- ✓ Mentioned advantages/disadvantages of the filter overall
- ✓ Mentioned feedback on different features (flow rate, design, water quality, capacity, flow rate, etc.)
- ✓ Preferences for filters (divided by groups)
- ✓ Feedback on the further development of the filter (divided by groups)

Considerations

The main goal of an FGD is to create a space where participants can honestly share their experiences and attitudes concerning the use of the filters. This might sound easier than it is, so careful preparation and training of staff are important, as well as planning enough time both for preparation and facilitation. Finally, the check-lists, questions and resources provided here shall only serve for inspiration and can be adapted and further extended.

References

This document is strongly based on the guidance of the Swiss Tropical and Public Health Institute (link) https://www.swisstph.ch/fileadmin/user_upload/SwissTPH/Topics/Society_and_Health/Focus_Group_Discussion_Manual_van_Eeuwijk_Angehrn_Swiss_TPH_2017_2.pdf.

Focus group discussions with children and adolescents by Terre des hommes: https://www.tdh.ch/de/node/29406

U.7 Co-design workshop

Required	Optional	Group	Detailed protocol/questionnaire	
	x	User acceptance		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
				x

The co-design workshop aims at collecting experiences of users after the study. Their feedback on the different features of the filter will help improve it and in the end ensure a better acceptance and uptake of the filter. This is especially important if manufacturers want to adapt the design of their filter to local contexts and if parts of the filters are produced on local markets. Co-designing as a concept wants to give voice to people and shape a democratic and collective process to achieve user-centred designs.

Planning the co-design workshop

Participants

Think of who are the users of the filters and who else might be relevant stakeholders relevant to share their opinion on the filter's design. Make sure to include representatives of all stakeholder groups (manufacturers, users, designers) and give them a voice equally (similar to the focus group discussions).

Time and place

Plan according to the schedules of your target group and choose a convenient location (e.g., in the middle of the community) where everyone has access and feels comfortable to share their views. You can think of an appropriate time-frame for your workshop, usually not more than 2 hours.

Facilitator(s)

The role of the facilitator(s) is crucial. They have the responsibility to create an environment where all participants feel free to share their opinion and experiences. Following is a list of recommendations:

- Encourage equal participation
- Take visible notes (if applicable)
- Be neutral
- Let people develop their solutions but try to converge diverse ideas to common sense in the end

Define the goal and the agenda of the workshop

Think of what are the goals of the workshop and plan activities accordingly. You could for example structure the workshop in two parts: sharing of experiences (e.g., by demonstration) and sharing ideas for improvements, needs and visions.

Implementation of the co-design workshop

Many different participatory activities can help to collect ideas and create solutions to experienced challenges while testing the filters. Have a look at the existing resources to find activities that best fit your context. Usually, a co-design workshop consists of three phases (also see https://de.slideshare.net/userspots/codesign-workshop):

Opening: an explanation of the goal of the workshop, the introduction of all participants, opening the field by presenting the findings of your study and the questions that are related to it

Example: *participants include filter manufacturers, designers and users that have been part of the study. In the first step, everyone is introduced and people can say what they expect from this workshop. Then the study results regarding one (or more) filters are presented: users overall have been satisfied with the filter but rate the design and ease of cleaning of the container very low. The goal of this workshop, therefore, is to i) verify if those are the relevant aspects that need to be discussed, ii) discuss possible solutions and alternatives and iii) rate the discussed alternatives to in the end have one option which then can be handed over to manufacturers and are realistic to be produced.*

Shaping: creating ideas or solutions to challenges, users have faced during the study

Example: *ideas of improving the design are collected by letting participants draw their ideal filter on a large piece of paper and present their work in smaller groups. Important aspects are noted down. Regarding the cleaning of the container, users and manufacturers discuss in small groups what the needs are and how they could be confronted. Each group presents only one solution to the entire group.*

Evaluation: users rate the discussed solutions and related advantages and disadvantages

Example: *several different ideas of how to adapt the design and the container for better cleaning have been presented. All options are presented to the group and everyone receives 3 post-its they use to rate their preferred options. The options with the most votes are discussed again by the entire group regarding advantages and disadvantages.*

Data analysis

All notes and drawings, pictures taken of produced outputs serve as a data basis for the evaluation of the results of the co-design workshop., It is required to carefully evaluate all materials. Also, check the data analysis presented for focus group discussions (U.6) which are very similar to the analysis of co-design workshops. The product of the co-design workshop should be a list with ideas to improve the filters and according to advantages and disadvantages. The list should be approved by all participants to ensure feasibility (manufacturers) and acceptability (users). The list should be used in the decision-making process along other data to discuss how the potential improvements can improve performance or acceptance.

Considerations

It might be difficult to get all stakeholders to participate in the co-design workshop. However, without for example including manufacturers or local producers the ideas produced by users of how to improve filters might not be incorporated by producers and or in the worst case even impossible to be implemented. On the other side, without the experiences of users, the ideas that are created in a co-design workshop, will most probably not meet their needs and wishes and not lead to user's acceptance.

References

https://medium.com/@gyngyifekete/designing-a-co-design-workshop-7686eaf4bf0f

https://de.slideshare.net/userspots/codesign-workshop

http://www.cocreate.training/wp-content/uploads/2019/03/co-design_handbook_FINAL.pdf

U.8 Assessment of willingness to pay

Required	Optional	Group	Detailed protocol/questionnaire	
	x	User acceptance		
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
		x		x

The concept of willingness to pay (WTP) is mainly an economic tool to measure the perceived value of a product. WTP, however, is not a fix and constant value but depends on different parameters, such as income, context and availability of connected resources (e.g., water).

For the context of evaluating the acceptance of household water filters the perceived economic value and the possibility and willingness to pay for distributed filters is of interest. Of course this only accounts for contexts, where users can invest in filters. In acute emergency responses, where filters might be distributed for free, willingness to pay might not be of interest. If, however, the filters are planned to be for example locally produced and available on local markets, the value serves as an indicator of how likely the filters will be accepted and bought by end-users.

Assessing willingness to pay

Both in the baseline questionnaire and the extended list of the final data collection include questions that assess the willingness/ ability to pay for the water filters. In the baseline questionnaire, the question F2: How much would you be willing to pay for a household water filter? Generally asks for the willingness to pay for *any* filter not related to the one which will be tested in the study. The value given can be related to the price users have to pay for their current water supply system (question C9) and to their current monthly income (question A10). In the extended list of the final data collection the question about willingness to pay is repeated but this tame related to the water filter the household has received (FE6: How much would you be willing to pay for your filter?). If two (or more) filters have been provided and tested, users will be asked which one they would rather buy (FG15: If you would need to decide to purchase one of the two filters. Which one would you rather buy?) and how much they would be willing to pay for it (FG16: How much would you be willing to pay for your preferred filter?). If in your study, the willingness to pay is not of interest, the questions can be removed from the questionnaire before data collection.

Data analysis

As mentioned above, the willingness to pay is not necessarily a fixed value but may alter and depend on different parameters. For example, users, after having used the filter, might evaluate the value much higher as previously because they have liked the use and features of the filter. The amount they are willing to pay for it might increase. If the value even decreases, this is a sign of low acceptance of the filter. To analyse the information, the two values are given in the baseline and final data collection are compared. If there is interest in evaluating changes in willingness to pay, the values should be deducted from each other to either see decrease or increase.

References

https://cenrep.ncsu.edu/2020/06/04/willingness-to-pay-for-in-home-water-filtration-in-rural-northern-ghana/

https://hal.archives-ouvertes.fr/hal-00522828/document

U.9 Follow-Up survey

Required	Optional	Group	Detailed protocol/questionnaire	
x		User acceptance	Annex Follow-Up questionnaire	
Applicable to:				
Preparation	Baseline	Introduction visit	Monitoring	Final data collection
				x

The last step of the data collection phase is the follow-up survey. The administration of the monitoring questionnaire as well as the extended list is required. This will allow to compare baseline and endline data and show changes that can be attributed to the filter. There are several optional components to the final data collection, such as the RANAS questionnaire (U3.2) Focus Group Discussions (sheet U6), Co-design workshops (U7) or the assessment of the Willingness to Pay (U8).

Some of the questions from the final data collection questionnaire (extended list) are the same as in the baseline questionnaire to be able to compare and evaluate changes achieved by the distribution of the filters. This is the reason why questions should not be changed or only changed in both questionnaires (baseline and extended list).

Adaptation of the questionnaire to the study set-up

If your study set-up contains the comparison of two (or more) different filters you need to adapt the questionnaire accordingly. The template comprises a section which requests households to rate and compare two different filters they have received. If your study does not entail the comparison of two filters you can either leave the questionnaire as it is and instruct your data collectors to always choose “no” for the following question: Did households receive different filters that shall be compared?. If you want to avoid possible confusions, you can also delete this part of the questionnaire before data collection.

Components of the final data collection

Depending on the goal of the study, it might be useful to further include other components apart from the monitoring questionnaire and the extended list. If more in-depth and qualitative information is needed, the inclusion of focus group discussions is helpful. This accounts especially if the study results are unexpected and need more clarification. A Co-design workshop is especially recommended when manufacturers have an intention to further optimize their products for the local context, or filters are partly produced locally (e.g. local housing is used).

Resources

Trained staff and carefully planned tools for the data collection are needed, as well as the allocation of resources for logistics. The questionnaires need to pre-loaded on mobile phones and pre-tested before the data collection.

Considerations

Regarding the logistical set-up, the training of the data collectors as well as any ethical considerations, please refer to other sheets in this guideline. It is very important for all phases of the data collection to always enter the same household ID which was assigned at the beginning of the project and if possible also interview the same respondent throughout the whole process. This also and especially accounts for the final data collection. Always make sure to keep the names of the respondents separate to their given information to keep privacy and anonymity.

References

M. Peter and M. Harter (2021) Selecting household water filters in emergencies: a manual for field evaluation, University of Applied Sciences and Arts Northwestern Switzerland, Muttenz, Switzerland.

Graphic Design and Layout

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