Review of frameworks for technology assessment

Deliverable WP 3.1

A report produced by Skat

August 2011

The Water, Sanitation and Hygiene Technologies (WASHTech) is a project of the European Commission's 7th Framework Programme in Africa

Skat, 2011. *Review of Framework for Technology Assessment.* (WASHTech Deliverable 3.1) The Hague: WASHTech c/o IRC International Water and Sanitation Centre and Sankt Gallen: Skat. Available at: http://washtechafrica.wordpress.com

Water, Sanitation and Hygiene Technologies

WASHTech, 2012

Authors
André Olschewski, Kerstin Danert, Sean Furey, Florian Klingel

Cover photo *Rainwater tank evaluation*, photo by RWSN/Skat

The **Water, Sanitation and Hygiene Technologies (WASHTech)** is a three-year action research initiative that aims to facilitate cost-effective investments in technologies for sustainable water, sanitation and hygiene services (WASH). Through action research and the development of a set of methodological tools and participatory approaches, WASHTech embeds the practice of multi-stakeholder learning, sharing and collaboration – instilling individual and collective ownership and responsibility for sustainable WASH services.

WASHTech, c/o IRC International Water and Sanitation Centre * P.O. Box 82327 2508 EH The Hague, The Netherlands * WASHTech@irc.nl / www.irc.nl. Website**: http://washtechafrica.wordpress.com**

This publication is the result of research funded by the European Union Seventh Framework Programme FP7-Africa-2010 under Grant Agreement Number 266200

Table of Contents

Acknowledgements

Editor

André Olschewski

In close collaboration with

Dr Kerstin Danert, Sean Furey, Florian Klingel (Skat)

Many other individuals were consulted, including Vincent Casey and Richard Carter (WaterAid). Editing and proof reading support was provided by Joanna Rhodes (IRC).

This publication is the result of a research funded by the European Union's Seventh Framework Programme, FP7-Africa-2010 under Grant Agreement Number 266200.

1 Scope and objectives of the review

This review of frameworks for technology assessment is an **internal working document** of the EU-FP7 project WASHTech.

The objective of the review is to support the definition of the targeted users, purpose and scope of the Technology Assessment Framework (TAF)[1] to be developed in WASHTech. Furthermore, the review provides input to key issues in the TAF development by analysing the learnings from other related frameworks.

The review of frameworks concentrates on related frameworks with the objective of answering the following questions:

1. Does the TAF fill a gap or are there already existing frameworks with a very similar purpose?
2. How do other frameworks deal with key issues that are also relevant for the TAF?
3. What learnings from other frameworks should be considered when developing the TAF?

[1] The following initial definition of users, purpose and scope of the TAF was used at the time of the review:

- Targeted users: Local and National Governments, Action Research Institutions, Donor organisations
- Purpose: Assessing the potential of new/innovative technologies in a given context and providing guidance for fostering the uptake process of the technology
- Scope: all WASH-technologies

2 Approach

The review is conducted in two steps. First all frameworks are screened and analysed regarding their main characteristics:

- Who are the targeted users of the framework?
- For what purpose can it be used?
- What is its scope, what type of technologies are covered?
- What are its main features, what can it do, how does it work?
- What is the impression about its usefulness, its adoption by practitioners and its relevance for the development of the TAF?

In the second step, selected frameworks most relevant for the TAF development are further assessed in detail regarding key issues that are relevant for the TAF, as well as for drawing lessons learnt as input for the TAF development.

Key questions to be answered from the assessment of those selected frameworks include:

- WASH technologies are always part of a system and cannot easily be compared or evaluated without considering the whole system. Looking at entire WASH systems, however, is quite complex. How do the frameworks deal with this problem?
- Assessment and evaluation of technology usually follows pre-defined indicators, either giving a qualitative assessment or by quantitative scores and weighting. Assessment procedures can vary from simple questionnaires to complex programmed algorithms. How do the different frameworks organise this process?
- Indicators are intended to provide a concise way of measuring the performance and suitability of a technology against positive and negative criteria. The challenge is keep the number of indicators to a manageable level so that the TAF user can produce useful information on which to base his or her decision. How do the frameworks arrive at their indicators? Are they based on high level targets (e.g. Millennium Development Goals) or practical experience from using that type of technology? Are the indicators yes/no, numerical or descriptive? Are they absolute or relative to other similar technologies?
- Process of innovation and technology is critical to the TAF, so how have other frameworks approached it? How does the development and use of a particular technology consider the context that it is being applied in?

3 Screening of frameworks

3.1 Reviewed Frameworks

The following table summarises the reviewed frameworks and their main characteristics

Name, Author, Type, Source	Target users	Purpose	Scope	Features	Indicators	Innovation and Uptake	Comments
A **Review of Decision-Making Support Tools** in the WASH Sector Pacific Institute Report www.pacinst.org	Researchers (Pacific Institute researchers developing WASHCHOICES)	Review of available Tools, identify gaps, provide recommendations for the design of an "ideal" tool	Decision-making tools for WASH solutions	-	The study did not specifically evaluate how decision-making support tools used indicators	The study did not find the necessary information on scalability and replicability to allow practitioners to compare the appropriateness of different technologies and approaches There is no explicit mention of innovation or R&D	The review was used for the preparation of framework 2
ASPIRE: A Sustainability Poverty and Infrastructure Routine for	Project managers	Assessing impacts and inter-relations of projects	Infrastructure projects	Software based tool • leading user to allocate scores to 96 indicators • providing graphical outputs	96 indicators are grouped into four sectors:	Table 4 of the support document summarises lessons learned (by the	Interesting mechanism of assessment and presentation of

Name, Author, Type, Source	Target users	Purpose	Scope	Features	Indicators	Innovation and Uptake	Comments
Evaluation ARUP/Engineers Against Poverty Report, Software www.oasys-software.com	Engineers Planners	Assessing sustainability of projects with poverty reduction as objective		aggregating the scores	Society, Environment, Institutions and Economics	World Bank, DFID, OECD and the World Commission on Dams) from bad experiences with infrastructure projects	results
Compendium of Sanitation Systems and Technologies EAWAG-SANDEC Handbook, 150 p. www.eawag.ch	Engineers Planners	Providing overview of available technologies Promote system concept for sanitation	All sanitation technologies (urban/rural, centralised/decentralised/on-site, high tech/low tech)	Systematic and complete overview of sanitation technologies Promotes system concept for sanitation, presents technologies as components of a system Technology information sheets with specific advantages and disadvantages	Three types of indicators are used for each technology: colour-coded inputs and outputs; colour coded indicator of the functional system to which the technology belongs; open-ended descriptive indicators positive and negative characteristics	No discussion on uptake beyond the inter-dependencies of technologies within their functional systems No mention of innovation or new products Clear guidance on contextual issues for sanitation technology use	Clear and transparent Easy to use Limited, very specific target user, purpose and scope Apparently popular and widely used
Enhancing the sustainability of rural	Project	Assess	Management models for	Compilation and very brief description of	SWOT analysis and 6	Stakeholder mapping used to	Loose and not exhaustive overview

Name, Author, Type, Source	Target users	Purpose	Scope	Features	Indicators	Innovation and Uptake	Comments
water supply services - Analytical framework for assessing management models Skat /**Aguasan workshop series 2008** Report www.skat.ch	managers (?)	sustainability	rural water supply	tools: • Stakeholder Function Matrix • Stakeholder Map • SWOT Diamond • Performance Criteria List	performance criteria to assess water management models	assist with uptake of water management models	on tools
Ethical Bio-Technology Assessment Tools for Agriculture and Food Production LEI Report www.ethicaltools.info	Public policy makers Public Private sector	Facilitation of ethical decision making Opinion formation Improve transparency of communication about ethics	Innovative agricultural and food technologies (particularly biotechnology)	Toolbox (selected and improved tools from a review of existing tools) Proposes appropriate tools for specific purposes and target users	Indicators are not explicitly discussed, but the criteria being assessed fell into nine categories of public concern with corporate food chain management and innovation	Uptake is discussed largely in the context of overcoming European public distrust towards genetic modification and handling the ethical issues around technology uptake	Interesting overall approach making use of existing tools
Facilitating innovation for development, a **RAAKS** (Rapid Appraisal of Agricultural	Field workers Trainers	Identify opportunities to improve knowledge and information	Agricultural development (but more focusing on social	Resource box containing a book with theoretical background on the methodology, a manual on the methodology and a set of tools (mostly participative tools)	Indicators and measures of success do not seem to be part of their	Beyond providing a range of tools on stakeholder analysis, there is not much that	Developed in the 90s, continuously improved, apparently widely used

Name, Author, Type, Source	Target users	Purpose	Scope	Features	Indicators	Innovation and Uptake	Comments
Knowledge Systems) resource box Engel/Salomon, KIT www.kit.nl	Managers Researchers Consultants	systems Create awareness regarding opportunities and constraints for improving performance for innovation Identify actors for removing constraints and using opportunities for improving performance for innovation	interrelations between actors than technology specific issues)	Methodology proposes 3 phases: A: defining the problem; B: Analysing constraints and opportunities; C: Strategy and action planning	'soft systems' approach	appears relevant technology uptake and promotion of innovation	
Mapping and landscaping review of the water supply, sanitation and hygiene sector, **Landscaping of Technologies** CU, Aguaconsult, IRC Report www.aguaconsult.co.	Bill and Melinda Gates Foundation	"Provide an overview of WASH technologies" "Framework for assessing technologies and reasons of past take up or failure" "… to inform the Bill and Melinda Gates Foundation's internal lesson-	WASH technologies	Categorisation of technologies in main groups based on function and then into categories of "proven", "emerging", and "blue-skies"; short descriptions of potentials and risks Emphasises contextual issues of technologies Not a tool in the sense of assessment procedure, but a set of technology assessment sheets and recommendations	Indicators are not really mentioned. One table describes water treatment technologies in terms of: What? Why, why not? How it works; Impact; Cost; and	For each technology category the 'Constraints on increased uptake' are presented	Targets the issue of innovation and up take of technologies No assessment framework but rather an extensive assessment report

Name, Author, Type, Source	Target users	Purpose	Scope	Features	Indicators	Innovation and Uptake	Comments
uk		learning as it determined whether or not to enter into a long-term programme of support to the sector"			Sustainability		
SANEX: A Simple Expert System for Evaluation Sanitation Systems in Developing Countries Dr. Thomas Lötscher (AWMC, SDC) Computer programme	Engineers Planners	Technology selection Technology comparison and evaluation	Sanitation technologies	Software based Two step selection process: elimination of "unfeasible" options; comparison of technologies based on indices for annual costs, implementability and sustainability System approach (not single technologies)	SANEX used 3 tiers of criteria to screen sanitation options, e.g. 1. Community Profile; 1.1 Demographics ; 1.1.2 Population Density	It is a tool for selecting from range of existing technologies rather than assessing a new one	Not available any more
Sustainable Sanitation And Water Management Toolbox Website http://www.sswm.info /	Decision makers, practitioners, education, media	The Sustainable Sanitation and Water Management Toolbox recognises that sectoral approaches are not going to solve the global water	Water and sanitation hardware and software options, planning and training resources	Training materials and clear explanations of the water cycle, nutrient cycle, IWRM A range of tools are provided to help participatory planning and decision making An evolving database on technologies	No indicators directly relevant to assessing new technologies	Tools and advice are provided, especially the section on 'Demand Creation' and for each technology type there are tools for creating an enabling environment.	A good, clear and developing resource but not focused on technology assessment and uptake

Name, Author, Type, Source	Target users	Purpose	Scope	Features	Indicators	Innovation and Uptake	Comments
		and sanitation crisis. It highlights that we need holistic approaches and must consider the entire water cycle from source to sea, and back, and puts human influence on the water and nutrient cycle at the centre				There is little or nothing on innovation or new technologies	
Technology Assessment Tool – An Application of Systems Engineering to **USDOE** Technology Proposals M.A. Rynearson, INEEL Computer programme www.inl.gov	Field organisations (?) Experts	Evaluate technology proposals Support structured decision making	Energy technologies	Computer aided Helps defining data needs for proposal evaluation Organises evaluator input and provides pre-defined and calculated outputs	The six categories of indicators are: 1. Environment, Safety and Health; 2. Risk; 3. Improvement (Benefit); 4. Schedule; 5 Cost; and 6. Savings to Investment Ratio	No mention of uptake	No information about actual use Unclear for what type of technology or situation

Name, Author, Type, Source	Target users	Purpose	Scope	Features	Indicators	Innovation and Uptake	Comments
TIP: Technology Information Package for Water and Environmental Sanitation UNICEF, SKAT Package of Factsheets, Hardcopy and CD artplatform.unicef.org	Project managers Engineers Planners	Technology selection Guidance on technology implementation Training material	Technologies for rural water supply Technologies for faecal sludge emptying	Detailed information on technologies, including excel sheets for technology selection, bills of quantities, etc	Some detail on performance indicators for handpumps	Not addressed	Limited scope
WASHCHOICES: Community Choices Tool for Water, Sanitation, and Hygiene Pacific Institute Web-based software tool washchoices.org	Communities Planners NGOs Local governments	Decision support on technology choice	Current prototype: on-site sanitation and household water treatment technologies Planned: “integrated solutions for the entire WASH sector”	Current version prototype for demonstration only Software tool, leading user through a series of questions on background of the situation (context-indicators) and providing a list of recommended and scored solutions Mechanism: Scores (appropriate, neutral, inappropriate etc.) for each context indicator are predefined for all technologies, depending on answers on situations, scores are summed up (precise algorithm not known) Planned: cover: the full range of WASH sub-sectors; adoption of new technologies as well as improvements in current practices; and identification and incorporation of local community and	Technologies are chosen for the user based on the match between the answers to questions presented to the user and the profiles for technologies in the database	There is no mention of innovation, research or uptake. There is no facility to enter new technology profiles so that they can be compared to the context	Limited scope of current demo version makes does not allow practical application yet Very ambitious, but unclear how this can be achieved, doubtful the procedure will work for a wide range of technologies No consideration of systems

Name, Author, Type, Source	Target users	Purpose	Scope	Features	Indicators	Innovation and Uptake	Comments
				expert knowledge, needs, and preferences. Multiple formats (e.g. online, DVD-ROM, and printed; in local languages), with multiple access points, and graphics and pictures to assist those with low levels of literacy "The Community Choices Project aims to release and channel the wealth of trapped knowledge in the WASH sector to those who most need it."			
Water source options – a comparison, WaterAid http://www.wateraid.org/documents/water_source_options__a_comparison.pdf **(Appendix 0)**	NGOs Local governments Public	Awareness raising and basic training	Water supply and treatment technologie.	A one page table that presents major water supply and treatment technology options in terms of water source; capital cost; running cost; yield; bacteriological water quality; situation in which technology is most applicable	Each column is scored as 'High', 'Medium' or 'Low' some with explanation	Not addressed	A simple summary sheet that does not provide enough detail to support decisions. Includes some 'high-tech' options such as reverse-osmosis but not others such as conventional municipal filtration. Includes water storage in sand and sub-surface dams but not other storage options. Is not designed to help the evaluation of new technologies

3.2 Summary of screening

A Review of Decision-Making Support Tools in the WASH Sector by the Pacific Institute, published in 2008, provides a useful starting point. The study examined 120 existing support resources (in 2008) and concluded that there was not a comprehensive decision-support tool for the WASH sector. The main gaps they highlighted were:

- economics/cost;
- financing models;
- social and equity implications of technological and financial choices;
- regional specificity;
- appropriate user interface;
- information access/multiple languages;
- comprehensive wash directory;
- evaluation and monitoring;
- hygiene approaches.

Their recommendations for a decision-making support tool were that:

- the user interface should guide the user from problem to solution in a way that they do not have to sift through hundreds of technical fact sheets;
- the tool needs to be supported and updated regularly. “Commonly support resources are funded during the initial development, but lack funding for ongoing, regular revisions.”
- success stories and case studies should be included;
- the tool should be available in multiple languages;
- it should be available online and in hard copy;
- regional workshops should be run to demonstrate applicability of the tool to potential users;
- regional technical support teams support the training and use of the tool.

Four frameworks target project managers, planners and engineers and aim at providing support for technology choice in project implementation: **Compendium of Sanitation Technologies, TIP, WASHCHOICES, SANEX**. All four frameworks have a similar scope to the TAF as they cover water supply and sanitation technologies. The one with the narrowest focus (the compendium) seems also to be the one most used in practice. WASHCHOICES and SANEX aim at providing automated algorithms that propose decision on technology choice; however, the first one is still at the stage of a demo version and the latter one is no longer available.

Landscaping of Technologies is not an assessment framework but a review specifically conducted to support the Gates Foundation's decision on investing in the WASH sector. The review is interesting for the TAF development as it specifically targets the issue of innovation and up take of technologies.

The **RAAKS** resource box targets a wide range of users and provides theory and practical tools for the RAAKS method, which focuses on stakeholder roles in innovations for agricultural development. It is a complete approach and set of tools, but despite the term 'innovation' it is of little relevance for the TAF because it is almost exclusively focuses on 'soft systems' of stakeholder analysis and social interactions rather than 'hard systems' of technology.

ASPIRE targets project managers and provides an IT-based tool for assessing sustainability of infrastructure projects. Regarding user, purpose and scope it is different from the TAF. However, the mechanism of assessment and presentation of results and its IT-implementation is interesting.

The **AGUASAN 2008** report is not a proper framework or method but provides a rather loose overview on tools for assessing sustainability of management models for rural water supply. While this is of limited use for technology assessment, it does provide some useful analytical approaches that are applicable to technology uptake and stakeholder roles in that process.

The **Ethical Bio-Technology Assessment Tools** are interesting as they combine existing tools in a framework, including proposed adaptations. However, due to very different users, purpose and scope they are of little relevance for the TAF.

The **USDOE** assessment tool is in users, purpose and scope very different and not relevant for the TAF.

3.3 Conclusion

The purpose of the TAF (according to the initial definition: assessing the potential of new/innovative technologies in a given context and providing guidance for fostering the uptake process of the technology) clearly fills a gap as none of the reviewed frameworks has a similar purpose.

However, several of the reviewed frameworks include elements that are of relevance for the TAF and therefore need to be taken into account for the development of the TAF.

4 Assessment of key issues

4.1 Technology as part of a system

Question: WASH technologies are always part of a system and cannot easily be compared or evaluated without considering the entire system. Looking at entire WASH systems, however, is quite complex. How do the frameworks deal with this problem?

The only frameworks considering technologies as part of a system are the **Compendium of sanitation** technologies and **SANEX**. The other frameworks look at technologies without considering their functions within the system (TIP, WASHCHOICES, Landscaping of Technologies) or do not focus on WASH-technologies at all.

4.1.1 Compendium of sanitation technologies

Besides creating awareness of users on the wide range of available sanitation technologies, the Compendium specifically aims at promoting the system concept of sanitation. For this aim the Compendium proposes the following systematic for presenting sanitation systems, sanitation technologies and the functions that technologies fulfill within a system:

Eight basic types of sanitation systems are proposed:

- System 1: Single Pit System
- System 2: Waterless System with Alternating Pits
- System 3: Pour Flush System with Twin Pits
- System 4: Waterless System with Urine Diversion
- System 5: Blackwater Treatment System with Infiltration
- System 6: Blackwater Treatment System with Sewerage
- System 7: (Semi-) Centralised Treatment System
- System 8: Sewerage System with Urine Diversion

Each of these systems are composed of different technologies that fulfill the following specific functions:

- User Interface (urine diverting dry toilet, pour flush toilet, etc.)
- Collection and storage/treatment (dehydration vault, septic tank)
- Conveyance (motorised emptying and transport, simplified sewerage, etc.)
- (Semi-) Centralised treatment (waste stabilisation ponds, drying beds, etc.)
- Use and/or disposal (irrigation, soak pit, etc.)

All technologies are presented in detail according to these functions.

The Compendium's concept for presenting sanitation systems and technologies is very detailed and exhaustive but also quite complex. However, this complexity does not harm the usability of the Compendium because it limits itself to presenting all options and pointing to the complexity of sanitation systems, rather than attempting to integrate this system concept into algorithms for comparing and evaluating technologies or systems and producing decision proposal.

4.1.2 SANEX

SANEX is an IT-tool for decision support, based on an algorithm that collects user input on situation criteria, eliminates unfeasible sanitation solutions and evaluates feasible solutions in a multi-criteria procedure. SANEX uses a list of predetermined sanitation systems as basic unit of the tool, This means that SANEX does not consider single technologies but entire systems (consisting of several technologies).

Some examples of the systems used in SANEX:

Aquaprivy + settled sewerage
Double vault composting (DVC) latrine
Latrine + vault
Pour-flush latrine
Pour-flush toilet + biogas digester
Pour-flush toilet + seepage pit

Similar systems are grouped together, e.g. all systems based on sewerage are grouped together, regardless of the different options for treatment technology. This allows reducing the number of possible systems, which is necessary in order to simplify the evaluation algorithm.

While the chosen approach seems to be a very simple and robust one, which indeed allows including the system concept in an automated evaluation procedure, it is also quite rigid and is likely to not cover all existing system options. It also does not allow including new innovative technologies or systems. For example, SANEX excludes septic tanks when buildings are not accessible by de-sludging trucks, ignoring the option of smaller equipment suitable for de-sludging in narrow alleys that have recently emerged in many countries.

As SANEX is not available on the internet any more, conclusions about its practical applicability are difficult.

4.1.3 WASHCHOICES

WASHCHOICES does not look at sanitation or water supply systems but technologies only, while still attempting a SANEX-like decision support algorithm. In its current demo version, only a couple of technologies are covered. It seems likely that the inclusion of a wider range of technologies will be difficult, if not impossible, without grouping technologies according to their function in the system, which in turn will complicate enormously the evaluation process.

4.1.4 Conclusion

The Compendium of sanitation technologies and SANEX have chosen contrary approaches for including the systems view: SANEX does use programmed evaluation algorithms and therefore has to use a very simplified system concept, which seems too simple to represent the complex reality appropriately. The compendium covers sanitation systems in all their complexity; however the concept seems too complex to be used in evaluation algorithms, which the compendium consequently does not attempt.

The example of WASHCHOICES, on the other hand, shows that algorithms for technology evaluation that ignore the system concept probably fail due to high complexity and the impossibility of comparing technologies which fulfill different functions in a system (comparing apples and oranges).

In conclusion, the question of how to include the system concept into evaluation tools repr esents a major challenge and none of the reviewed frameworks provide a satisfying solution. The Compendium uses the most pragmatic approach by accepting the complexity of reality, attempting to best represent this complexity in its system concept but abstaining from developing automated algorithms for supporting decision making.

4.2 Scoring procedures

Question: Assessment and evaluation of technology usually follows pre-defined indicators, either giving a qualitative assessment or by quantitative scores and weighting. Assessment procedures can vary from simple questionnaires to complex programmed algorithms. How do the different frameworks organise this process?

4.2.1 SANEX

SANEX applies a two-step procedure: first a screening for eliminating unfeasible options, and then a rating and weighting of the remaining options.

For the screening, a number of criteria are formulated to identify unfeasible options. Failing one criterion is sufficient to eliminate an alternative, even if it is acceptable with regard to all other criteria.

Examples of criteria and related conditions (for the complete list of feasibility criteria see appendix):

Project design life	Sewerage-based alternatives require a design life greater than five years. This criterion is also used to verify that alternatives can cope with increasing population density
Project urgency	If urgent implementation is required, only latrine and vault systems are feasible
Accessibility of buildings	Sanitation options which require frequent desludging (e.g. vaults) or the removal of large quantities of sludge (e.g. communal septic tanks) are infeasible if they cannot be accessed with a large van or a truck. On-site options which require desludging less frequently than once a year are only feasible if access to most dwellings is possible with at least a car or a small van

Following the screening, the user is asked to provide input for rating criteria that characterise implementability and sustainability of the solutions. User input to the criteria determining the factors is boolean, discrete or continuous. Users are also asked to weight the different criteria. The rated criteria are then aggregated using various mathematical algorithms (the author refers to this as Multilevel Amalgamation).

Outputs of SANEX are indices in the range from 0 to 1 for following aggregated criteria:

T. Loetscher, J. Keller / Socio-Economic Planning Sciences 36 (2002) 267 290

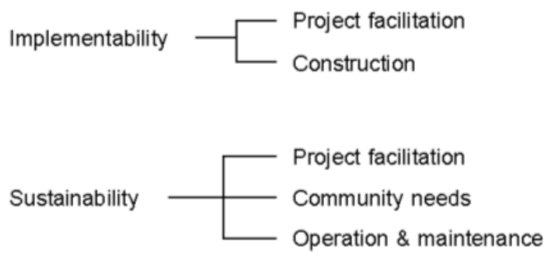


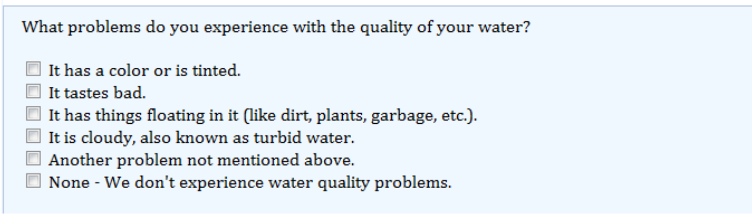
Fig. 3. Factors determining the indices 'implementability' and 'sustainability'.

SANEX deals with the criteria of costs in an independent module. Cost functions for the different sanitation solutions are supposed to allow approximate cost estimates. The functions use different variables, including technical criteria and local construction and capital costs.

While screening and rating criteria appear to be well chosen, they are very rigid and probably will not allow to properly take into account all location specific particularities. Aggregation procedures are complex and to the user will appear very much as a black box system.

4.2.2 WASHCHOICES

WASHCHOICES leads the user through a questionnaire, see example below (for choice on household level water treatment):


What problems do you experience with the quality of your water?

- ☐ It has a color or is tinted.
- ☐ It tastes bad.
- ☐ It has things floating in it (like dirt, plants, garbage, etc.).
- ☐ It is cloudy, also known as turbid water.
- ☐ Another problem not mentioned above.
- ☐ None - We don't experience water quality problems.

In the current demo version, there are 32 questions for sanitation (4 options for on-site sanitation technologies) and 15 questions for household water treatment (6 technology options). The output provides recommended solutions with a score in percentage. The calculation procedure for the scoring is not explained, however a detailed list of criteria and the appropriateness per technology are provided.

The scoring process is user-friendly and straightforward; however the user has little information in order to understand the recommendation and to appreciate the logic of evaluation.

4.2.3 ASPIRE

ASPIRE does not compare or evaluate technologies but does support the user evaluating the sustainability of projects. It is a software tool that leads the user through a series of questions and assists the user in allocating a non-weighted score to each of the sub-themes. The user also has to enter a short justification for each score.

The scores of subthemes are then aggregated (averaged) for each theme to provide a graphical output based on the ‘traffic light’ system to indicate strengths (green) and weaknesses (red) (see appendix). There are 20 themes and 96 subthemes (indicators), which means that 2 to 6 subtheme scores are aggregated into one theme score that is represented in the output chart. The aggregation algorithm is not explained, it is probably done by averaging.

Additionally, the user is requested to provide a verbal justification for each score, that is reproduced in a detailed excel output.

User guidance and output are very clear and intuitive. The output is easily understood as the tool does little calculation and aggregation but merely organises and represents graphically the user’s input. The main benefit of the tool is to direct the attention of the user to all dimensions of sustainability of a project and therefore to assist the user in not missing out issues important to sustainability.

4.2.4 Conclusion

Regarding the scoring procedures, there is a conflict between the desire to properly reflect complex reality and providing automated decision support algorithms.

SANEX and WASHCHOICES attempt to propose the best solutions with a score of suitability to support decision making by the user. However, their algorithms tend to miss transparency and there is a risk that valid options are excluded by the algorithms without the user being aware of that.

ASPIRE uses an interesting approach that is not based on processing user input by complex algorithms and producing output proposals, but merely by guiding the user through relevant considerations and providing a visualisation of the user’s own judgments.

In a similar way to the question about systems concepts, it appears that the most convincing approach is the one that limits its scope and purpose.

4.3 Indicators

Question: *• Indicators are intended to provide a concise way of measuring the performance and suitability of a technology against positive and negative criteria. The challenge is keep the number of indicators to a manageable level so that the TAF user can produce useful information on which to base his or her decision. How do the frameworks arrive at their indicators? Are they based on high level targets (e.g. Millennium Development Goals) or practical experience from using that type of technology? Are the indicators yes/no, numerical or descriptive? Are they absolute or relative to other similar technologies?*

4.3.1 Aguasan Workshop 2008

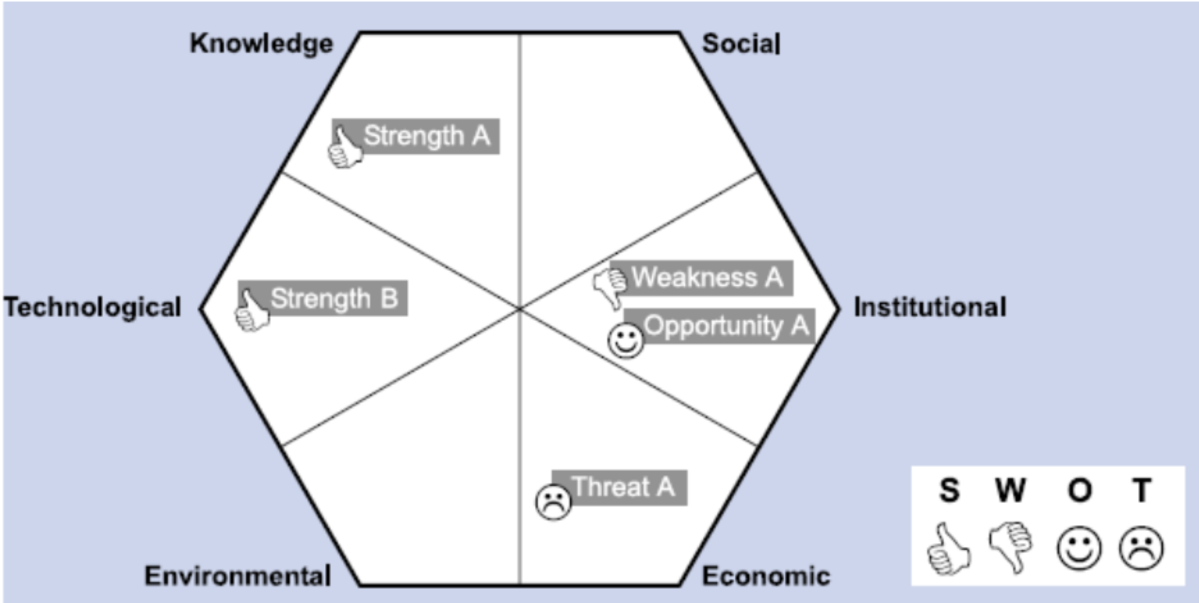
The report from the 2008 Aguasan Workshop uses a number of tools, indicators and performance criteria, though in the context of water management structures. A similar approach could be applied for assessing technologies. Models were evaluated on:

- Social aspects

- Economy
- Environment
- Institutional
- Knowledge
- Technology

Using a SWOT (Strengths, Weaknesses, Opportunities, Threats)

Figure 4-1: SWOT hexagon



Management models were also assessed on six further performance criteria:

- Financial and management autonomy
- Demand responsiveness
- Incentives for expansion
- Professional support
- Regulation
- Transparency and accountability

Figure 4-2: An example of water management model evaluation

Criteria	Rating	Comments
Financial and management autonomy	☺	Water committees are completely independent in their management
Demand responsiveness	😐	Water committees capture reasonably well the demand of the rural users
Incentives for expansion	☺	Committees have an impressive record of expanding networks using their own funds
Professional support	😐	Professional support is limited but the Ministry still trains the pump attendants
Regulation	☹	There is no regulation to speak of – the Ministry only advises on water pricing
Transparency and accountability	😐	Depends on the level of control by the users – usually not considerable

4.3.2 Compendium of sanitation technologies

The compendium lists pros and cons for each technology type. Overall, 144 descriptive indicators areas used to describe the positive or negative attributes of the sanitation technologies featured in the compendium. There are not tabularised standard indicators but there is some repetition between types, which can be categorised as follows:

Positive Attribute (no. of indicators)	Negative Attribute (no. of indicators)
▪ Good Aesthetics, User Experience and Public Acceptability (7)	▪ Poor Aesthetics, User Experience And Low Public Acceptability (12)
▪ High Performance (Quality, Time) (10)	▪ Low Performance (Quality, Time) (9)
▪ Reduces Public Health Risks (4)	▪ Introduces Public Health Risks (3)
▪ Low Risk Sustainability: Low Maintenance and High Reliability, Robustness and Life-Span, Easy to Upgrade (4)	▪ High Risk Sustainability: High Maintenance And Low Reliability, Robustness And Lifespan, Hard To Upgrade (7)
▪ Need For Specialist Skills and Materials Minimised (3)	▪ Specialised Skills and Materials Needed (9)
▪ Low Financial, Human and Natural Resource Requirements (7)	▪ High Financial, Human and Natural Resource Requirements (19)
▪ Good Relative Performance (8)	▪ Poor Relative Performance (3)
▪ Physical Context Suitability (1)	▪ Physical Context Constraints (2)
▪ Useful By-Products, Co-Benefits (Social, Environmental, Economic) (15)	▪ Risks/Limitations of By-Products (Social, Environmental, Economic) (9)

The indicators are typically generalised statements with relative modifiers (High, Medium, Low or Good, Poor). Some could be seen as contradictory, as they state a positive being 'Potential for local job creation' but others have 'labour intensive' as a negative. Clearly behind these statements there are economic assumptions and value judgements on what is good or bad.

While the approach taken in the compendium is good for the technologies presented, it would be harder to use all these detailed indicators and descriptions for a more generalised TAF.

4.3.3 WASHCHOICES

WASHCHOICES guides the user through a series of questions to build up a profile of context indicators against which the stored profiles of water and sanitation technologies can be compared so that the % match between context and technology can be presented.

For each indicator, the technology is given a descriptive score (and presumably a numerical weighting associated with it, but this is not explicit).

4-1: WASHCHOICES scores for Sanitation Technologies

Very Appropriate	This approach or technology is likely to work very well
Appropriate	This approach/technology is likely to work
Somewhat Appropriate	This approach/technology is somewhat likely to work
Neutral	This technology may be inappropriate, not applicable, or neutral
Should never be used	This technology or approach is not likely to succeed under these conditions

4-2: WASHCHOICES scores for Household Water Treatment Technologies

Very Appropriate	This approach or technology is likely to work very well
Appropriate	This approach/technology is likely to work
Somewhat Appropriate	This approach/technology is somewhat likely to work
Neutral	This technology may be inappropriate, not applicable, or neutral
Somewhat Inappropriate	This approach/technology is somewhat unlikely to work
Inappropriate	This approach/technology is unlikely to work
Very Inappropriate	This approach/technology is very unlikely to work
Should never be used	This technology or approach is not likely to succeed under these conditions

For Sanitation Technologies there are 58 contextual sub-indicators that are described using the scores above. For household treatment technologies there are 90 sub-indicators. However, the number of indicators is smaller than this because these numbers represent the answers of each sub-indicator.

For example: *Indicator*: Soil Type; *Sub-indicators*: Sand /Clay/Loamy

4-3: WASHCHOICES Sanitation Indicator Hierarchy

Indicator	No. of sub-indicators	Technology score for each sub-indicator
Household or Community?	2	
Number of Users per community/household	2/3	
Land availability (community/household)	4/2	
Water availability	3	
Consistency of water access	2	
Settlement pattern	3	

Site topography	3	
Depth of groundwater	2	Very Appropriate
Flood risk	3	Appropriate
Soil type	3	Somewhat Appropriate
Rockiness of soil	3	Neutral
Availability and affordability of pipes, concrete and services	3	Should never be used
Availability of soil, ash or leaves	3	
User priorities and preferences	5	
Community organisations exist	2	
Community organisation has previously promoted behaviour change	2	
Access to labour and skills	2	
Financial resources and access to funding	4	
Integration between users and agriculture	4	

4-4: WASHCHOICES Household Water Treatment Indicator Hierarchy

Indicator	No. of sub-indicators	Technology score for each sub-indicator
Existing health problems with users	11	
Known water quality hazards	3	
Taste, colour, odour	20	
Current user charging for water supply	3	Very Appropriate
Willingness/Ability to pay	3	Appropriate
Current water treatment	20	Somewhat Appropriate
Cost	1	Neutral
Operation and Maintenance	3	Somewhat Inappropriate
Water treatment time	1	Inappropriate
Storage container availability	4	Very Inappropriate
Materials availability	7	Should never be used
Skills and education	8	

Indicator	No. of sub-indicators	Technology score for each sub-indicator
Access to finance	1	
Access to external organisations	3	

It is not clear why Household Water Treatment has more grades/scores, which are mostly going to be subjective anyway, e.g. what is the different between Somewhat Appropriate and Appropriate?

4.3.4 ASPIRE

The ASPIRE team reviewed indicators from other tools and concluded that most were qualitative and thus dependent on the competencies and perspective of the user. They initially developed a list of 160 indicators, which was reduced to 96, which were grouped into four sectors: Society, Environment, Institutions and Economics. There is an attempt to relate the indicators to MDGs; however, they admit that it is not possible to measure the performance of infrastructure projects against MDGs.

4.4 Process of innovation and technology uptake

Question: *Has anything been done to guide technology promoters from the initial R&D phase through to widespread uptake and adoption?*

4.4.1 AGUASAN 2008

The report of the **AGUASAN Workshop 2008** discusses many elements of technology uptake and lessons learned. A number of models were identified for rural water supply management (which could include technology uptake):

Table 4-2: Water management models (AGUASAN 2008)

Brief description of the model	Key actor	Scale of model	Extent of delegation	Private sector
The four main models				
Community management models	Community	Local	0	0
Municipal management models	Municipality	Local	+	+
The delegated management models	Operator	Variable	+++	+++
The privately-owned management models	Investor	Local	0	+++
Other existing models				
Nationwide or “national utility” models	Utility	National	0	Variable
Maintenance-oriented “packaged” models	Supplier	National	+	++
The “regional” management models	Federation	Regional	Variable	+

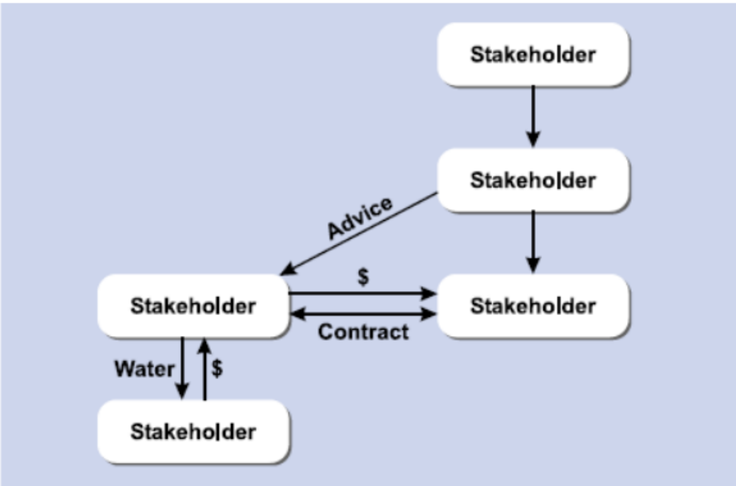
A further process relating to management (and technology uptake) is summarised in the following table for mapping actor interactions at different stages, or area of responsibility:

Table 4-3: Stakeholder roles and responsibilities (Aguasan 2008)

Functions \ Stakeholders	Individuals	Communities	NGOs, associations	Private sector	Local government	National government	International organizations
Ownership							
Financing construction							
Managing funds							
Setting tariff							
Regulating							
Controlling / Reporting							
Operation							
Maintenance							
Replacement							
External support							

Associated with this is Stakeholder Mapping, which shows the interactions between stakeholders in terms of transfers of advice/information, money, water, contracts and agreements, service and support:

Figure 4-3: Stakeholder Mapping (Aguasan 2008)



4.4.2 AGUASAN 2010

The AGUASAN meeting of 2008 focused on Scaling Up, which is applicable to new technologies as well as 'islands of success' with regard to best practice of WASH project and programme management. The objectives of the workshop, which served as a framework for discussion were:

- Learning from practice regarding concepts on scaling-up efforts and broadening the evidence base around successful and failing scaling up processes;
- Identifying barriers and triggers that affect the scalability at regional/national levels of service delivery models;

- Defining how to adapt and shape service delivery models for large scaling up efforts;
- Developing practical strategies and tools for fostering large scaling up initiatives;
- Locating gaps/open issues which would require further action and analysis.

Some key messages that relate to technology uptake were:

- Activities of the project have so far not been actively supported by the national government, rather they have been tolerated. A fast scaling up of activities does not seem to be very realistic in the immediate future, rather a long term ongoing support and strengthening of local capacities
- Scaling up can be described in its three key dimensions as follows:
    - Vertical: embedding of approach into local, regional and national institutions; streamlining with national policies and strategies; involvement of different institutional levels including key actors in other sectors;
    - Horizontal: broadening and increase of coverage; replication on operational level; linking with other actors in the sectors;
    - Timeline: extension of lifetime of infrastructure and services; issue of lifetime of policies, strategies, support and funding commitments
- Six Key Elements to initiate and foster successful large scaling up between Governments, Development Agencies and Financing Institutions in the WatSan Sector:
    - 1.Coordination and Partnership
    - 2.Long Term Sector Strategy
    - 3.Good Governance and Enabling Environment
    - 4.Sustainable Service Delivery Models
    - 5.Implementation Capacity
    - 6.Marketing and Communication Strategy
    - 7.Strong inter-linkages between all six key elements

    No top priority element, rather follow a comprehensive approach. One mandatory requirement: For large scaling up the Government has to be in the driver's seat!

5 Recommendations

What can be concluded from this literature review is that there is a gap for a WASH technology assessment tool and a WASH technology uptake tool. Various approaches have been examined but it is concluded that a computer tool based on an algorithm is not appropriate because it is too rigid.

Choosing a manageable number of appropriate indicators is going to be key for assessing new technologies.

The uptake process, and particularly the tipping point stage between piloting and widespread adoption, is generally done badly and there appears to be little guidance or support in the literature. However, what is clear is that guiding the user through this process will require a lot of emphasis on stakeholder mapping and defining clear goals and responsibilities for all involved.

6 Appendix

6.1 SANEX

SANEX screening criteria

T. Loetscher, J. Keller / Socio-Economic Planning Sciences 36 (2002) 267 290

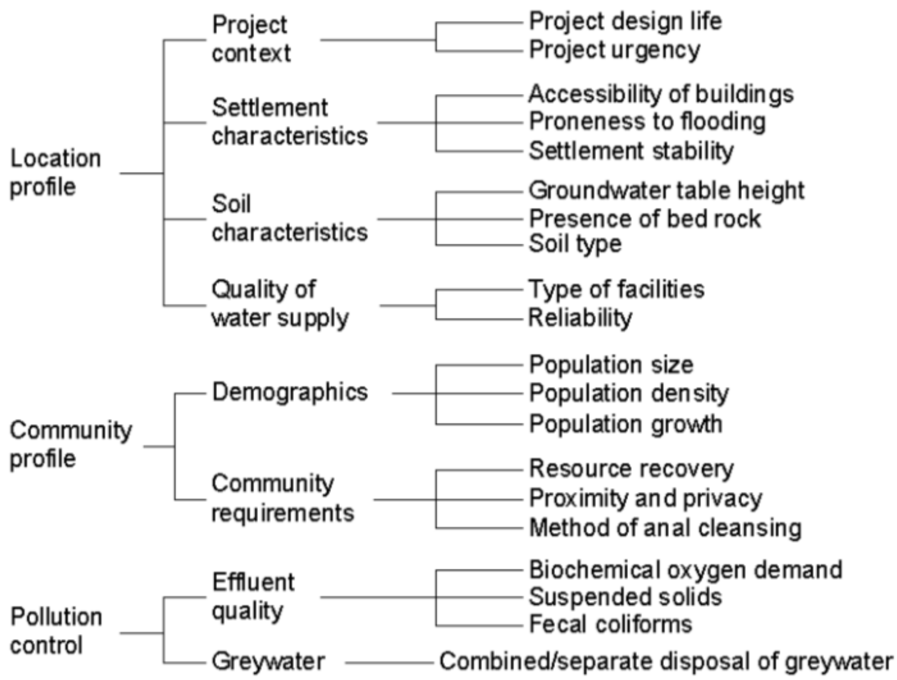


Fig. 2. Criteria to assess the feasibility of alternatives (screening).

Table 2
Screening criteria

Project design life	Sewerage-based alternatives require a design life greater than five years. This criterion is also used to verify that alternatives can cope with increasing population density
Project urgency	If urgent implementation is required, only latrine and vault systems are feasible
Accessibility of buildings	Sanitation options which require frequent desludging (e.g. vaults) or the removal of large quantities of sludge (e.g. communal septic tanks) are infeasible if they cannot be accessed with a large van or a truck. On-site options which require desludging less frequently than once a year are only feasible if access to most dwellings is possible with at least a car or a small van
Proneness to flooding	If the project area is subject to regular flooding, alternatives based on soil absorption, or which are relying on stormwater drains for sewage collection, are unsuitable
Settlement stability	If there is a danger that the community could get evicted, sewerage-based options are inadequate
Groundwater table height	If groundwater is abstracted locally (i.e. from wells or boreholes), alternatives that rely on soil absorption (e.g. latrines) are only feasible, if the groundwater table is more than 5 m below the ground surface. If the water supply is piped, they are suitable with groundwater up to 2 m. If the distance is less than this, all alternatives relying on soil absorption are infeasible
Presence of bed rock	If bedrock is common <2 m below the ground surface, alternatives based on on-site soil absorption are infeasible .
Soil type	In coarse or medium sand, alternatives based on soil absorption are not suitable (high risk of groundwater contamination due to insufficient filtration). With the exception of dry latrines, they are also infeasible in clay (very slow or no percolation). Fish ponds are inappropriate in sandy soils
Water supply facilities	Cistern-flush toilets are only suitable if there is piped water available in the houses (abundant supply required for flushing). Water carriers suffice for pour-flush toilets. If piped water to households is installed, the volume of greywater is likely to be too large for disposal into latrines, aquaprivies or vaults. Therefore, if the combined disposal of grey- and blackwater is desired, these alternatives are infeasible
Reliability of water supply	If the water supply is unreliable, water-based sanitation systems are not appropriate
Population size	The (current) population size and population growth are used to calculate the population size at the end of the design life. Activated sludge off-site treatment requires a minimal population size of 2000 persons
Population density	The (current) population density and population growth are used to calculate the population density at the end of the design life, which limits the suitability of alternatives based on on-site soil absorption If water supply is piped to each household and combined disposal of black- and greywater is not desired, the maximum feasible population density is 500 persons/ha

Table 2 *Continued*

	If water supply relies on local groundwater abstraction, distances between abstraction points and toilets need to be sufficient to prevent contamination. If the combined disposal of black- and greywater is not desired, the maximum density is 300 persons/ha If water supply relies on local groundwater abstraction and combined disposal of black- and greywater is desired, the maximum density is further reduced to 200 persons/ha to allow for larger absorption facilities If water supply is piped and combined disposal of black- and greywater desired, the resulting large effluent volumes require very large absorption facilities. In this case, a limiting density of 100 persons/ha applies
Population growth	Used to calculate population size and population density at the end of the design life. It is assumed that two thirds of the population growth lead to increased population density and the rest to area expansion
Resource recovery	Dedicated resource recovery systems (e.g. composting toilets, fish ponds, etc.) are only feasible if there is a demand for their product
Proximity and privacy	If public toilet blocks are not acceptable to beneficiaries, they are eliminated. If neither public nor shared facilities are acceptable, it is assumed that each household will have their own latrine or toilet. If only in-house toilets are acceptable, all latrines and aquaprivies are infeasible
Method of anal cleansing	Since alternatives using flush toilets with a siphon easily block, they are unsuitable where hard or bulky cleaning materials such as maize cobs are used
Biochemical oxygen demand (BOD)	The feasibility of off-site treatment systems is determined by effluent quality requirements/standards. Assuming a BOD of raw sewage of approximately 500 mg/l, primary settling (e.g. communal septic tanks, Imhoff tanks, primary treatment) can reduce the BOD of raw sewage to approximately 300 mg/l; waste stabilization ponds and activated sludge systems to approximately 20 mg/l
Suspended solids (SSs)	Assuming that raw sewage contains about 500 mg/L SS, primary settling can reduce the SSs to approximately 200 mg/l; waste stabilization ponds and activated sludge systems to approximately 20 mg/l
Faecal coliforms (FCs)	It is assumed that raw sewage contains about 200 million FC per 100 ml. Primary settling does not significantly reduce FC contamination (i.e. by $<50\%$). Waste stabilization ponds can reduce the FC content to approximately 1000 per 100 ml. It is assumed that activated sludge treatment includes chlorination. FC contamination can therefore be reduced to any desired limit.
Combined/separate disposal of greywater	If the water supply is piped to each house, this results in large volumes of greywater. In this case, aquaprivies, latrines, biogas digesters, septic tanks for excreta reuse, public toilets and vaults are infeasible if the combined disposal of toilet- and greywater is required. If the soil type is clay (very low absorption capacity), latrines cannot accept even small volumes of greywater

SANEX rating criteria

T. Loetscher, J. Keller / Socio-Economic Planning Sciences 36 (2002) 267 290

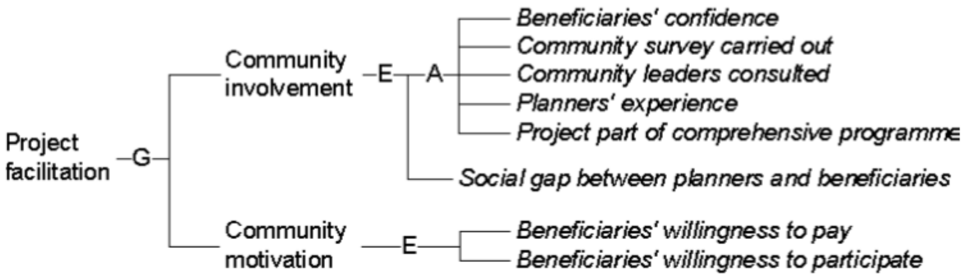


Fig. 4. Aggregation of criteria determining project facilitation.

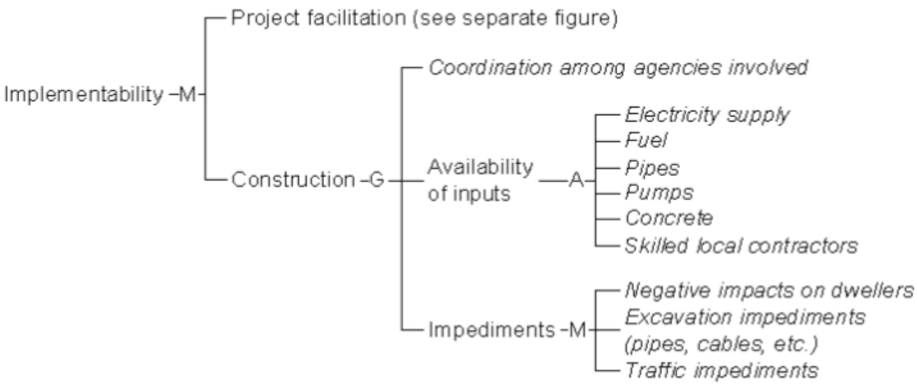


Fig. 5. Aggregation of criteria determining implementability.

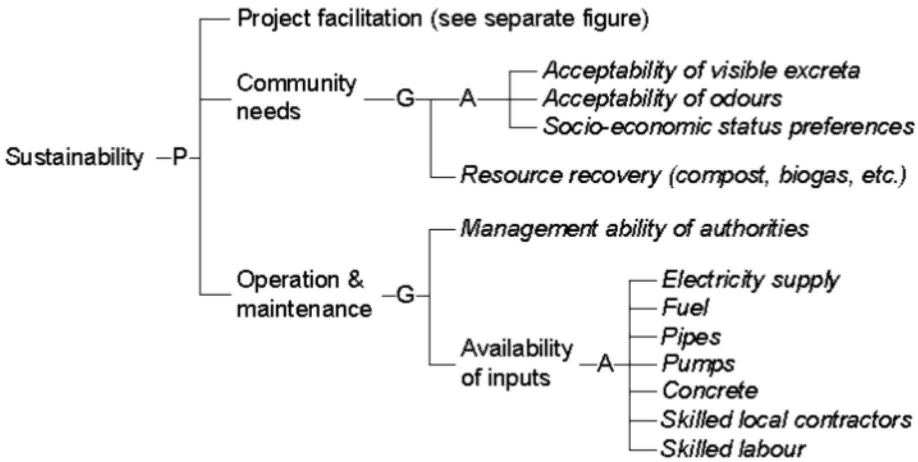


Fig. 6. Aggregation of criteria determining sustainability.

Table 3
Criteria determining project facilitation. The table outlines those questions SANEX™ asks the user. Each question represents one criterion

---

Community involvement

1. Are beneficiaries confident in expressing their views?
2. Was a survey carried out to assess community preferences?
3. Were community leaders consulted?
4. Are planners experienced in participatory planning?
5. Is the project part of a larger programme (i.e. containing a training component, etc.)?

Input to questions 1–5 is boolean: $x = f(\text{yes}) = 1$, $x = f(\text{no}) = 0$

6. Extent of the social gap between planners and beneficiaries? Input is continuous qualitative: $f(\text{large gap}) = 0 \leqslant x \leqslant f(\text{no gap}) = 1$

Community motivation

7. Beneficiaries willingness to pay? Input is a percentage of average household income: $f(0\%) = 0 \leqslant x \leqslant f(5\%) = 1$, $x = f(> 5\%) = 1$
8. Beneficiaries willingness to participate? Input is continuous qualitative: $f(\text{very low}) = 0 \leqslant x \leqslant f(\text{very high}) = 1$

Table 4
Further criteria determining implementability. The table outlines those questions SANEX™ asks the user. Each question represents one criterion

---

Coordination

1. Coordination among agencies involved in the implementation? Input is continuous qualitative: $f(\text{poor}) = L \leqslant x \leqslant f(\text{good}) = 1$; $L = 0$ for sewerage, $L = 1/3$ for communal toilets, $L = 2/3$ for on-site systems

Inputs

2. Electricity available? Input is boolean: $x = f(\text{no}) = 0$, $x = f(\text{yes}) = 1$
   This criterion affects the suitability of sewerage
3. Fuel available? Input is boolean: $x = f(\text{no}) = 0$, $x = f(\text{yes}) = 1$
   This criterion affects the suitability of systems that rely on emptying by trucks (e.g. septic tanks) and sewerage
4. Manufactured pipes available? Input is boolean: $x = f(\text{no}) = 0$, $x = f(\text{yes}) = 1$
   This criterion affects the suitability of systems that use water
5. Pumps available? Input is boolean: $x = f(\text{no}) = 0$, $x = f(\text{yes}) = 1$
   This criterion affects the suitability of sewerage
6. Reinforced concrete available? Input is boolean: $x = f(\text{no}) = 0$, $x = f(\text{yes}) = 1$
   This criterion affects the suitability of sewerage, aquaprivies, septic tanks and vault systems
7. Skilled local contractors available? Input is boolean: $x = f(\text{no}) = L$, $x = f(\text{yes}) = 1$; $L = 0$ for sewerage, $L = 0.5$ for alternatives with watertight concrete tanks

Impediments

8. Excavation difficulties, e.g. rocky ground, cables, etc.? Input is boolean: $x = f(\text{yes}) = 0.5$, $x = f(\text{no}) = 1$
   This criterion affects the suitability of sewerage
9. Traffic obstructions? Input is boolean: $x = f(\text{yes}) = 0.5$, $x = f(\text{no}) = 1$
   This criterion affects the suitability of sewerage
10. Disturbance of dwellers? Input is boolean: $x = f(\text{yes}) = L$, $x = f(\text{no}) = 1$; $L = 0.5$ for systems using in-house toilets, $L = 0.75$ for all other systems

T. Loetscher, J. Keller / Socio-Economic Planning Sciences 36 (2002) 267 290 277

Table 5
Further criteria determining sustainability. The table outlines those questions SANEX™ asks the user. Each question represents one criterion

Community needs

1. Is it acceptable if excreta can be seen (e.g. through a latrine hole) in the toilet facilities? Input is boolean: $x = f(\text{no}) = L$, $x = f(\text{yes}) = 1$; $L = 0$ for latrines, $L = 0.5$ for aquaprivies
2. Are odours acceptable? Input is boolean: $x = f(\text{no}) = L$, $x = f(\text{yes}) = 1$; $L = 0$ for unventilated latrines, $L = 0.5$ for ventilated latrines, aquaprivies and covered stormwater drains (some odours)
3. Is the status reflected by toilet facilities important? Input is boolean: $x = f(\text{yes}) = 0$, $x = f(\text{no}) = 1$. This criterion affects the suitability of communal toilets, latrines and aquaprivies
4. Resource recovery requirements? Discrete user input:
   $x_1 = f(\text{no requirements}) = 0$ for all resources recovery systems
   $x_2 = f(\text{on-site biogas production})$, $x_2 = 1$ for biogas digester, $x_2 = 0$ for all other resources recovery systems
   $x_3 = f(\text{on/off-site compost production})$, $x_3 = 1$ for composting toilets, $x_3 = 0.5$ for cartage and sewerage systems, $x_3 = 0$ for all other resources recovery systems
   $x_4 = f(\text{irrigation with treated sewage})$, $x_4 = 1$ for septic tanks for excreta reuse (three compartments), $x_4 = 0.5$ for sewerage and drain fields, $x_4 = 0$ for all other resources recovery systems
   $x_5 = f(\text{fish ponds})$, $x_5 = 1$ for fish ponds, $x_5 = 0$ for all other resources recovery systems

Management ability

5. Ability of responsible authorities to manage public systems? Input is continuous qualitative: $f(\text{poor}) = 0 \leqslant x \leqslant f(\text{good}) = 1$. This criterion equally affects sewerage, aquaprivies, septic tanks, and cartage

Inputs

6. Since it is likely that inputs needed for the implementation of facilities are also required for their maintenance, the six criteria determining the availability of inputs for construction (see Table 4) are also used here. Additionally, the availability of skilled labour is assessed:

7. Local skilled labour available? Input is boolean: $x = f(\text{yes}) = 1$, $x = f(\text{no}) = 0$
   This criterion only affects sewerage

6.2 Aspire

0-1: Aspire Indicators (themes and subthemes)

	Air	Land	Water	Biodiversity	Energy	Materials
Environment	• Ambient Air Quality • Direct Emissions • Dust & Particulates • Ozone Depleters • Indirect Emissions	• Site Location • Planning Intent • Diversity/Mixed Use • Contaminated Land • Soil Conservation	• Drainage Systems • Water Pollution • Sewage Treatment & Disposal • Water Availability • Water Efficiency	• Protected Area • Nature Conservation • Aquatic Ecosystems • Forests • Drylands • Environmental Risk Management	• Energy Efficiency • Energy Sources	• Materials Efficiency • Responsible Sourcing • Whole Life Analysis
	Population	Culture	Stakeholders	Services	Health	Vulnerability
Society	• Vulnerable Groups • Population Change • Community Cohesion • Conflict Sensitivity • Displacement	• Socio-cultural Identity • Cultural & Religious Facilities • Local Heritage & Archaeology • Use of Environment • Intergenerational & Gender Practices	• Identification & Analysis • Consultation & Participation • Accountability & Grievance Mechanisms	• Energy • Mobility & Transport • Telecommunications • Education • Communal Space	• Water • Sanitation • Solid Waste • Drainage • Healthcare • Shelter • Nutrition	• Climate Change Resilience • Location & Environmental Resources • Physical Exposure & Shelter • Institutions & Social Networks • Access to Livelihoods & Finance
	Structures	Skills	Policies	Reporting		
Institutions	• National / Local Government Effectiveness • Project – Government Coordination • Corruption • Civil Society • Rule of Law	• Local Government • Private Sector • Civil Society Involvement • Research & Innovation	• Regulatory Quality • Human Rights • Health & Safety • Quality Assurance • Intellectual Property Rights	• Information Disclosure & Reporting • Monitoring & Evaluation • Media Channels • Knowledge Exchange • Replication		
	Viability	Macro	Livelihoods	Equity		
Economics	• Value for Money • Risk Management • Carbon Pricing • Operation & Maintenance • Alignment with National/Regional Strategies • Appropriate Technologies	• Vitality & Regeneration • Value Added / Multiplier Effects • Debt • Inflation Effects • Ethical Competition	• Local Sourcing • Access to Finance • Distortions to Local Economy • Employment Creation • Labour Standards • Training	• Equal Opportunities • Affordability of Services • Accrual of Benefits • Land Tenure		

Table 1: ASPIRE Themes and sub-themes

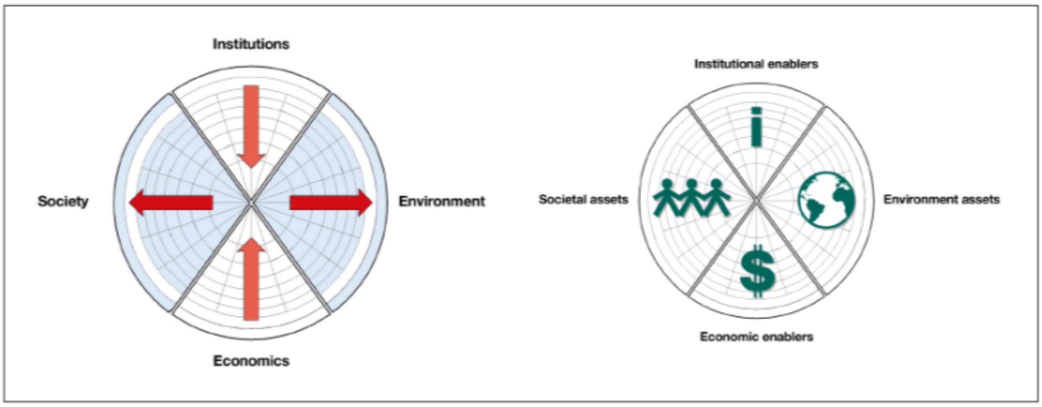
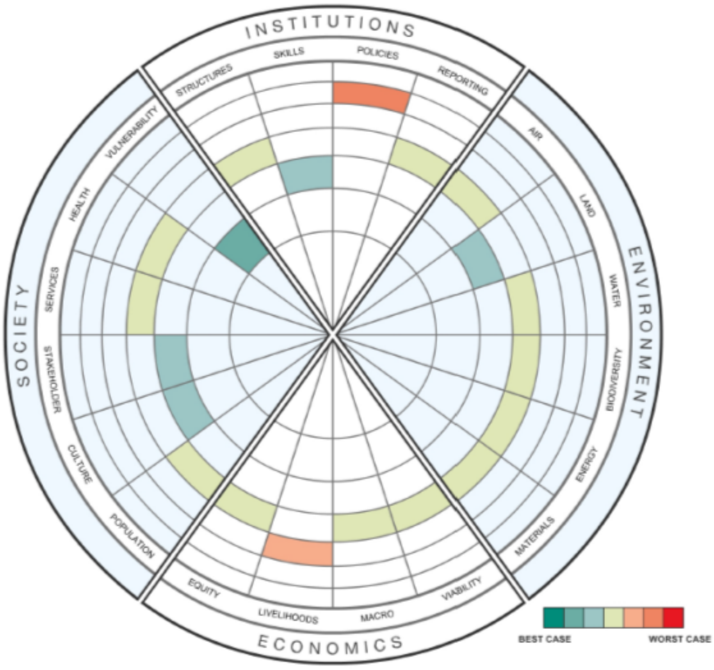


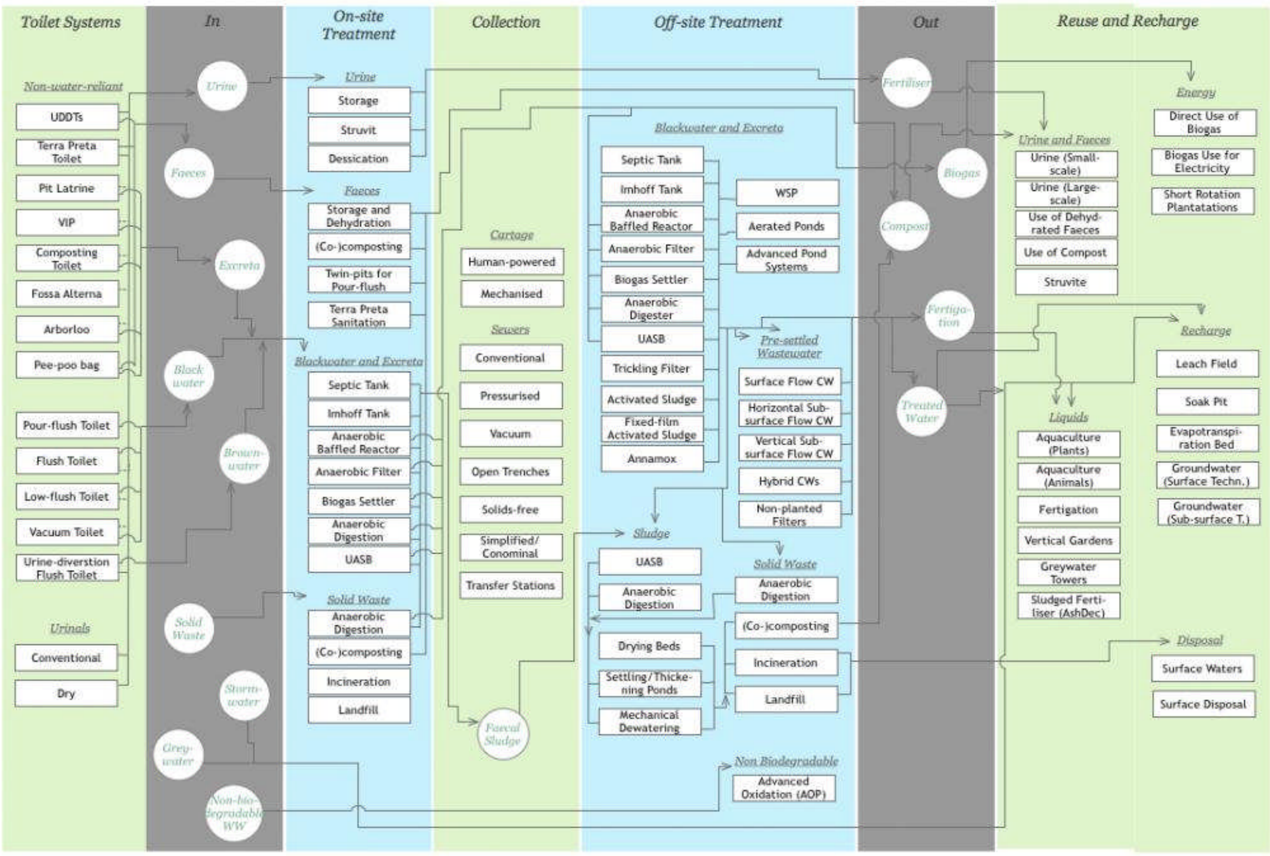
Figure 2: ASPIRE Conceptual Framework

0-2: Example of Aspire graphical output



6.3 Sustainable Sanitation and Water Management (www.sswm.info)

0-3: Overview on the different functional unit described in the SSWM toolbox and how they are interlinked. Source: SPUHLER (2010)



6.3.1 Sanitation Compendium

0-4 Positive Sanitation Attributes (from EAWAG Sanitation Compendium)

GOOD AESTHETICS, USER EXPERIENCE AND PUBLIC ACCEPTABILITY
Aesthetically pleasing and provides animal habitat
Looks like, and can be used almost like, a Cistern Flush Toilet
No real problems with odours and vectors (flies) if used and maintained correctly
Suitable for all types of users (sitters, squatters, washers, wipers)
The excreta of one user are flushed away before the next user arrives
The water seal effectively prevents odours
Water hyacinth grows rapidly and is attractive
HIGH PERFORMANCE (QUALITY, TIME)

Can be operated at a range of organic and hydraulic loading rates
Fast, and generally efficient
High reduction in BOD and solids; moderate pathogen removal
High reduction of BOD and pathogens (up to 99%)
High reduction of BOD and solids
High reduction of organics
High removal of helminth eggs possible (< 1 egg viable egg/g TS)
Moderate reduction in pathogens
Resistant to organic and hydraulic shock loads
Significant reduction in pathogens
REDUCES PUBLIC HEALTH RISKS
Low risk of pathogen transmission
May prevent unmitigated disposal
May reduce illegal dumping of faecal sludge
Provides essential service to unsewered areas
LOW RISK SUSTAINABILITY: LOW MAINTENANCE AND HIGH RELIABILITY, ROBUSTNESS AND LIFESPAN, EASY TO UPGRADE
Because double pits are used alternately, their life is virtually unlimited
Can be used immediately after construction
Easy to clean and reusable
Has a lifespan of 20 or more years (depending on conditions)
NEED FOR SPECIALIST SKILLS AND MATERIALS MINIMISED
Can be built and repaired with locally available materials
Reduces transport distance and may encourage more community-level emptying solutions
Simple technique for all users
LOW FINANCIAL, HUMAN AND NATURAL RESOURCE REQUIREMENTS
Capital costs are less than Conventional Gravity Sewers; low operating costs
Does not require a constant source of water

Low capital costs; operating costs depend on the price of water
Low capital and operating costs
No electrical energy required
Small land area required
Underground construction minimizes land use
MINIMISED DEPENDENCE ON OTHER SYSTEMS AND TECHNOLOGIES
Can help reduce the volume of solid waste generated by diverting organic material into the composting unit
Can be used for the combined treatment of blackwater and greywater
Greywater can be managed at the same time
Low production sludge (and thus, infrequent de-sludging required)
Stormwater and greywater can be managed at the same time
GOOD RELATIVE PERFORMANCE
Does not have the mosquito problems of the Free-Water Surface Constructed Wetland
Excavation of dried faeces is easier than faecal sludge
Excavation of humus is easier than faecal sludge
Flies and odours are significantly reduced (compared to non-ventilated pits)
Longer life than Single VIP (indefinite if maintained)
Requires less space than a Free-Water Surface Constructed Wetland
Requires less water than a traditional Flush Toilet
Small land area required compared to Constructed Wetlands
PHYSICAL CONTEXT SUITABILITY
Good in rocky and/or flooded areas
USEFUL BY-PRODUCTS, CO-BENEFITS (SOCIAL, ENVIRONMENTAL, ECONOMIC)
Biogas can be used for energy (but usually require scrubbing first)
Can accelerate reforestation
Can reduce use of chemical fertilizers and improve water retention of soils
Can reduce erosion
Can improve the structure and water-holding capacity of soil

Construction can provide short-term employment to local labourers
Fruit or forage growing can generate income
Generation of a renewable, valuable energy source
May increase productivity of water-bodies by maintaining constant levels
May provide a 'drought-proof' water supply (from groundwater)
Potential for local job creation and income generation
Potential for use of stored faecal material as soil conditioner
Reduced need for fertiliser
Reduces depletion of ground water and improves availability of drinking water
The compost that is removed is safe to handle and can be used as a soil conditioner

0-5: Negative Sanitation Attributes (from EAWAG Sanitation Compendium)

POOR AESTHETICS, USER EXPERIENCE AND LOW PUBLIC ACCEPTABILITY
A long time required to connect all homes
Excreta require manual removal
Flies and odours are normally noticeable
Heavy to carry
Mild to strong odour when opening and emptying tank (depending on storage conditions)
Odours and flies are normally noticeable
Odours are normally noticeable (even if the vault or pit used to collect excreta is equipped with a vent pipe)
Requires education and acceptance to be used correctly
Smell may be offensive
The excreta pile is visible, except where a deep pit is used
The toilet is not intuitive; requires education and acceptance to be used correctly
Urine and faeces require manual removal
LOW PERFORMANCE (QUALITY, TIME)
Long start up time
Long storage times
Low reduction in BOD and pathogens

Low/moderate reduction in pathogens
May require long start up time
Pathogens may exist in a dormant stage (oocysts) which may become infectious if moisture is added
Pumps can usually only suck down to a depth of 2 to 3m and the pump must be located within 30m of the pit
Requires a year or more of maturation
Time consuming: can take several hours/days depending on the size of the pit
INTRODUCES PUBLIC HEALTH RISKS
Cannot pump thick dried sludge (must be manually removed or thinned with water)
May pose public health risk, depending on the quality and application
Spills may happen
HIGH RISK SUSTAINABILITY: HIGH MAINTENANCE AND LOW RELIABILITY, ROBUSTNESS AND LIFESPAN, HARD TO UPGRADE
Clogging is frequent when bulky cleansing materials are used
Difficult and costly to extend as a community changes and grows
Garbage in pits may block hose
Garbage may ruin reuse opportunities of Compost/EcoHumus
Is prone to clogging with faeces and misuse
Must be well settled - very sensitive to clogging
Prone to complicated chemical and microbiological problems
SPECIALISED SKILLS AND MATERIALS NEEDED
Cannot be built and/or repaired locally with available materials
Dosing system requires more complex engineering
Limited availability; cannot be built or repaired locally
May require some specialised parts
May require special spreading equipment
Not all parts and materials may be available locally
Requires expert design and construction supervision
Requires front-end loader for monthly de-sludging
Requires full time operation and maintenance by skilled personnel

HIGH FINANCIAL, HUMAN AND NATURAL RESOURCE REQUIREMENTS
Constant source of electricity is required
Costs to empty may be significant compared to capital costs
High capital and low to moderate operating costs (depending on parts and maintenance)
High capital costs and moderate operating costs
High capital costs; operating costs depend on the price of water
Labour intensive
Labour intensive removal
Labour-intensive maintenance
Moderate-high capital and variable operating costs depending on the price of land, electricity
Non-beneficial use of a resource
Requires a constant source of water (can be recycled water and/or collected rain water)
Requires a large area (on a per person basis)
Requires abundance of fresh water
Requires constant source of ash, sand or lime
Requires constant source of cover material (soil, ash, leaves, etc.)
Requires constant source of electricity and constant wastewater flow
Requires large land (pond) area
Requires large land area
Variable capital cost depending on the price of land
HIGHLY DEPENDENT ON OTHER SYSTEMS AND TECHNOLOGIES
Digested sludge and effluent still requires treatment
Effluent/sludge requires secondary treatment and/or appropriate discharge
Effluent might require further treatment/disinfection before discharge
Leachate requires secondary treatment and/or appropriate discharge
Men usually require a separate urinal for optimum collection of urine
Pre-treatment is required to prevent clogging
Sludge requires secondary treatment and/or appropriate discharge

POOR RELATIVE PERFORMANCE
Difficult to maintain proper hydraulic conditions (upflow and settling rate must be balanced)
Higher capital cost than Single VIP; reduced operating costs if self-emptied
Requires repairs and removals of blockages more frequently than a Conventional Gravity Sewer
PHYSICAL CONTEXT CONSTRAINTS
Gas production below 15°C is not economically feasible
May have difficulties with access
RISKS/LIMITATIONS OF BY-PRODUCTS (SOCIAL, ENVIRONMENTAL, ECONOMIC)
Can become an invasive species if released into natural environments
Discharge of nutrients and micropollutants may affect natural water bodies and/or drinking water
Does not replace fertilizer (N, P, K)
Fish may pose a health risk if improperly prepared or cooked
Introduction of pollutants may have long-term impacts
May negatively affect soil and groundwater properties
Micropollutants may accumulate in the soil and contaminate groundwater
Requires a use/discharge point for urine and faeces
Urine is heavy and difficult to transport

6.3.2 WASHCHOICES

Examples Technology Profiles

Key Phrases used in the Table below:	
Very Appropriate	This approach or technology is likely to work very well
Appropriate	This approach/technology is likely to work
Somewhat Appropriate	This approach/technology is somewhat likely to work
Neutral	This technology may be inappropriate, not applicable, or neutral.
Should never be used	This technology or approach is not likely to succeed under these conditions

6.4 Example sanitation technology profiles in WASHCHOICES

Indicator	Number	Description	Dry Toilet Single Pit Latrine Arborloo	Dry Toilet Double VIP Latrine Compost
	1	Unweighted/Neutral Feature	Neutral	Neutral
	2	Appropriate for a single Household	Very Appropriate	Appropriate
	3	Appropriate for a whole community	Neutral	Somewhat Appropriate
	4	Appropriate for less than 100 users	Somewhat Appropriate	Appropriate
	5	Appropriate for more than 100 users	Neutral	Appropriate
	6	Appropriate where households in the community have limited land	Neutral	Appropriate
	7	Appropriate where households in the community have available land	Very Appropriate	Neutral
	8	Appropriate where community has limited land	Neutral	Somewhat Appropriate
	9	Appropriate where community has available land	Very Appropriate	Appropriate
	10	Appropriate for fewer than 5 users	Very Appropriate	Very Appropriate

Indicator	Number	Description	Dry Toilet Single Pit Latrine Arborloo	Dry Toilet Double VIP Latrine Compost
	11	Appropriate for 5-10 users	Somewhat Appropriate	Appropriate
	12	Appropriate for more than 10 users	Neutral	Somewhat Appropriate
	13	Appropriate where households have limited land	Neutral	Appropriate
	14	Appropriate where households have available land	Somewhat Appropriate	Appropriate
	15	Appropriate where water is limited	Somewhat Appropriate	Very Appropriate
	16	Appropriate where water is available	Appropriate	Appropriate
	17	Appropriate where water is plentiful	Very Appropriate	Appropriate
	18	Appropriate where water access is inconsistent	Somewhat Appropriate	Very Appropriate
	19	Appropriate where water access is consistent	Somewhat Appropriate	Neutral
	20	Appropriate for dispersed settlements	Very Appropriate	Neutral
	21	Appropriate for nucleated settlements	Somewhat Appropriate	Appropriate

Indicator	Number	Description	Dry Toilet Single Pit Latrine Arborloo	Dry Toilet Double VIP Latrine Compost
	22	Appropriate for dense settlements	Should never be used	Appropriate
	23	Appropriate where land is flat or undulating	Appropriate	Appropriate
	24	Appropriate where land is sloped	Neutral	Neutral
	25	Appropriate where water table is very shallow	Appropriate	Appropriate
	26	Appropriate where water table is deep	Appropriate	Very Appropriate
	27	Appropriate where flooding is not a problem	Appropriate	Very Appropriate
	28	Appropriate where it floods infrequently	Appropriate	Neutral
	29	Appropriate where it floods often	Neutral	Neutral
	30	Appropriate where soil is sandy or loamy (easy to dig)	Very Appropriate	Appropriate
	31	Appropriate where soil is full of clay (difficult to dig)	Neutral	Somewhat Appropriate
	32	Appropriate where soils are not rocky	Appropriate	Appropriate
	33	Appropriate where soils sometimes have rocks	Appropriate	Appropriate
	34	Appropriate where soils are very rocky	Neutral	Neutral
	35	Appropriate where pipes, concrete, services are readily available	Neutral	Very

Indicator	Number	Description	Dry Toilet Single Pit Latrine Arborloo	Dry Toilet Double VIP Latrine Compost
				Appropriate
	36	Appropriate where pipes, concrete, services are somewhat available and affordable	Appropriate	Appropriate
	37	Appropriate where pipes, concrete, services are not available or affordable	Very Appropriate	Somewhat Appropriate
	38	Appropriate where soil, ash, or leaves are readily available	Very Appropriate	Appropriate
	39	Appropriate where soil, ash, or leaves are somewhat available	Somewhat Appropriate	Somewhat Appropriate
	40	Appropriate where soil, ash, or leaves are not available	Should never be used	Should never be used
	41	Appropriate where ease of maintenance is a priority to users	Very Appropriate	Neutral
	42	Appropriate where users state Reducing Smell is a priority	Appropriate	Very Appropriate
	43	Appropriate where users state Reducing flies is a priority	Neutral	Very Appropriate
	44	Appropriate where users state that water-washing is preferred for anal cleansing	Neutral	Somewhat Appropriate
	45	Appropriate where users state wiping is preferred for anal cleansing	Appropriate	Very Appropriate

Indicator	Number	Description	Dry Toilet Single Pit Latrine Arborloo	Dry Toilet Double VIP Latrine Compost
	46	Appropriate where a strong community organisation exists	Neutral	Appropriate
	47	Appropriate where no community organisation exists	Neutral	Somewhat Appropriate
	48	Appropriate where community organisations have promoted behavioural change	Neutral	Appropriate
	49	Appropriate for households with adults	Appropriate	Neutral
	50	Appropriate in areas where a local sanitation expert is available	Neutral	Appropriate
	51	Appropriate for households with limited financial resources	Very Appropriate	Neutral
	52	Appropriate for households which spend a significant portion of their income on WASH	Neutral	Somewhat Appropriate
	53	Appropriate for households that are engaged in agriculture	Very Appropriate	Appropriate
	54	Appropriate in areas where most agriculture/horticulture is done by individuals (rather than industry or co-ops)	Very Appropriate	Somewhat Appropriate
	55	Appropriate in areas where most agriculture/horticulture is cooperative (rather than individual farmers or industry)	Neutral	Appropriate
	56	Appropriate in areas where most agriculture/horticulture is industrial (rather than individual farmers or co-ops)	Neutral	Very Appropriate
	57	Appropriate for households with savings or loan resources available	Neutral	Appropriate

Indicator	Number	Description	Dry Toilet Single Pit Latrine Arborloo	Dry Toilet Double VIP Latrine Compost
	58	Appropriate in areas where Govt Subsidy, Microfinance, Community Bonds are available	Neutral	Appropriate

6.5 Water source options – a comparison

Water source options – a comparison

– most preferable – preferable – least preferable

	Water source	Capital cost	Running cost	Yield	Bacteriological water quality	Situation in which technology is most applicable
	Spring protection	Low or medium if piped to community	Low	High	Good if spring catchment is adequately protected	Reliable spring flow required throughout the year
	Sand dams	Low – local labour and materials used	Low	Medium/High – depending on method used to abstract water. Water can be abstracted from the sand and gravel upstream of the sand dam via a well or tubewell	Good if area upstream of dam is protected	Can be constructed across seasonal river beds on impermeable bedrock
	Sub surface dams	Low – local labour and materials used	Low	Medium/High – depending on method used to abstract water. Water can be abstracted from the sand, gravel or soil upstream of the sub-surface dam via a well or tubewell	Good if area upstream of dam is protected	Can be constructed in sediments across seasonal river beds on impermeable bedrock
	Infiltration galleries	Low – a basic infiltration gallery can be constructed using local labour and materials	Low	Medium/High – depending on method used to abstract water	Good if filtration medium is well maintained	Should be constructed next to lake or river
	Rainwater harvesting	Low – low cost materials can be used to build storage tanks and catchment surfaces	Low	Medium – dependent on size of collection surface and frequency of rainfall	Good if collection surfaces are kept clean and storage containers are well maintained	In areas where there are one or two wet seasons per year
	Hand-dug well capped with a rope pump	Low	Medium – spare parts required for pump	Medium	Good if rope and pump mechanisms are sealed and protected from dust. Area around well must be protected	Where the water table is not lower than six metres – although certain rope pumps can lift water from depths of up to 40 metres
	Hand-dug well capped with a hand pump	Medium	Medium – spare parts required for pump	Medium	Good if area around well is protected	Where the water table is not lower than six metres
	Tube well or borehole capped with a hand pump	Medium – well drilling equipment needed. Borehole must be lined	Medium – hand pumps need spare parts	Medium	Good if area around borehole/tubewell is protected	Where a deep aquifer must be accessed
	Gravity supply	High – pipelines and storage/flow balance tanks required	Low	High	Good if protected spring used as source	Stream or spring at higher elevation – communities served via tap stands close to the home
	Borehole capped with electrical/ diesel/solar pump	High – pump and storage expensive	High – fuel or power required to run pump. Fragile solar cells need to be replaced if damaged	High	Good if source is protected	In a small town with a large enough population to pay for running costs
	Direct river/lake abstraction with treatment	High – intake must be designed and constructed	High – treatment and pumping often required. Power required for operation	High	Good following treatment	Where large urban population must be served
	Reverse osmosis	High – sophisticated plant and membranes required	High – power required for operation. Replacement membranes required	High	Good	Where large urban population must be served
	Household filters	High – certain filters can be expensive to purchase/produce	Filters can be fragile. Replacement filters can be expensive or difficult to source	Low	Good as long as regular maintainance is assured	In situations where inorganic contaminants are present in groundwater sources or protected sources are not available
	SODIS (solar disinfection)	Low – although clear bottles can be difficult to source in remote areas.	Low	Low	Good	In areas where there is adequate sunlight – water needs to be filtered to remove particulate matter that may harbour pathogens before SODIS can be carried out effectively. SODIS is not appropriate for use with turbid water

WaterAid

www.wateraid.org/technology

Registered charity numbers 288701 (England and Wales) and SC039479 (Scotland)

Who is involved in WASHTech?

WASHTech is a consortium research project comprising national and international NGOs, academic institutes and training centres in Africa and Europe.

WASHTech in Africa is spearheaded by the following institutions:

In Burkina Faso:

- Centre Régional pour l'Eau Potable et l'Assainissement à faible coût (CREPA), Burkina Faso
- WaterAid Burkina Faso

In Ghana:

- Training, Research and Networking for Development (TREND), Ghana
- Kwame Nkrumah University of Science and Technology (KNUST), Ghana
- WaterAid Ghana

In Uganda:

- Network for Water and Sanitation (NETWAS), Uganda
- WaterAid Uganda

European partners include:

- IRC International Water and Sanitation Centre (The Netherlands)
- Cranfield University (United Kingdom)
- Skat Foundation (Switzerland)
- WaterAid (United Kingdom)

WASHTech is coordinated by IRC International Water and Sanitation Centre in The Hague.

The Water, Sanitation and Hygiene Technologies (WASHTech) is a project of the European Commission's 7th Framework Programme in Africa

This publication is the result of research funded by the European Union Seventh Framework Programme FP7-Africa-2010 under Grant Agreement Number 266200