DACAAR

WATER EXPERTISE AND TRAINING CENTRE

Action Research on Small Community Size Intermittently-operated Slow Sand Filter (ISSF) in Qarghayee Girls High School, Laghman

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1. Background

Established in 1984, DACAAR is an apolitical, non-governmental, non-profit development organization that supports vulnerable people in rural areas of Afghanistan achieve improved livelihood through community driven interventions and sustainable activities. It operates according to its current competence or thematic areas of Water, Sanitation and Hygiene (WASH), Natural Resources Management (NRM), Women Empowerment (WE), and Small Scale Enterprise Development (SSED). In addition to these, DACAAR is a partner in the National Solidarity Program (NSP).

DACAAR's interventions primarily target returnees, internally displaced persons (IDPs), and their host communities with particular focus on the most vulnerable such as female, disabled and youth headed households. DACAAR's interventions have benefitted approximately 10 million Afghans across 29 of Afghanistan's 34 provinces since its establishment.

DACAAR's main office is located in Kabul. Projects are currently implemented in 12 provinces of Afghanistan through six regional offices located in; East (Jalalabad), Central (Kabul), North-east (Taloqan), North (Mazar), North-west (Maimana) and West (Herat).

DACAAR has more than two decades of experience in implementing WASH activities in Afghanistan and has established more than 43,000 public water points and 129,000 latrines across Afghanistan.

In partnership with CAWST, one of DACAAR's key programs is as a Water Expertise and Training Centre (WET Centre) established in July 2010 to provide water and sanitation training to WASH stakeholders, technical consulting to newly forming or existing WASH programs and action research.

DACAAR WET Centre has an equipped drinking water quality testing laboratory that was established in 2003 when there was no water quality testing lab at national level. The field kits-based laboratory has all the required lab equipments for testing physical, bacteriological and chemical qualities of water. The laboratory provides water quality testing services to DACAAR WASH projects and external clients.

DACAAR is a model organization in implementing rural water supply and introducing household water treatment technology in Afghanistan. Therefore, the DACAAR WET Centre decided to launch an action research on an intermittently-operated slow sand filter (ISSF) designed for use in schools or in institutions such as a health facility. Furthermore, this technology can be applicable for a private residence and small villages.

The Small Community Size Intermittently-operated Slow Sand Filter is a filtration system originally developed by Clear Cambodia and Samaritan's Purse Cambodia. It has been introduced in Cambodian schools. The water filtration is a similar principle to the household-sized concrete biosand filter. The removal mechanisms such as mechanical trapping, predation, absorption and natural death are the same. A significant difference is that it uses a float valve to maintain a constant hydraulic head of water above the sand during the run period. This arrangement provides a means to feed the water from the raw source water storage tank into the filter tank at a rate that matches the filtration rate in the filter. This allows much more water to be filtered through a single sand filter by operating over a longer period of time, such as overnight or over the school weekend. This long filtration run times, combined with the much larger filter container area, approximately 0.6 m^2 versus 0.06 m^2 for

the concrete biosand filter (BSF), will provide 1000+ litres of filtered water per day (2000+liters per 24 hours), sufficient for very small communities or institutions and schools.

2. Rationale of the Research

DACAAR is a pioneer to introduce household water treatment in Afghanistan. WET Centre has a four-day implementation of the biosand filter project training workshop which is organized annually to train different government and non-government organizations' staff. In the rural communities, it is common to find rural water points that have failed long before the end of their planned lifetime. The regular use of household water treatment technology gives a safeguard to protect the health of children, elders, women and all family members.

DACAAR has been promoting health and hygiene education including chlorine, concrete biosand filters and hand washing practices. It would be good to provide different household water treatment technology options to the community people so that they have opportunity to adopt technology based on their own interest and choices. Therefore, WET Centre decided to install Small Community Size Intermittently-operated Slow Sand Filter (the ISSF) in schools and/or in health facilities as a model to be replicated by other agencies working in WASH in schools in Afghanistan.

3. ResearchTopic:

Performance Evaluation of the Small Community Size Intermittently-operated Slow Sand Filter (ISSF)

4. Objectives of the Study:

The biosand filter (BSF) in concrete boxes for households has been studied extensively but the Community Size Intermittently-operated Slow Sand Filter is a concept that has only recently been developed and requires further study. The main purpose of this action research is to demonstrate the effectiveness of the Small Community Size Intermittently-operated Slow Sand Filter to remove contaminants from the water and develop experience in the construction, installation and operation of the filter. The specific objectives of this study include:

1. To identify the removal efficiency of E-coli bacteria and turbidity of source water using the Small Community Size Intermittently-operated Slow Sand Filter over time.
2. To compare the performance of the ISSF filters with the performance of the CAWST version10 (v10) BSF by setting-up one or two BSFs for the action research in the same locations as the ISSF filters and using the same water source.
3. To identify the effectiveness of the swirl and dump method for the maintenance of the ISSF filter.
4. To document the methods and costs involved in building, installing and operating the filters.
5. To disseminate the finding of research on the efficiency of Small Community Size Intermittently-operated Slow Sand Filter to other WASH related organizations in a learning exchange.

5. Methodology

Eight hundred litre capacity plastic tank (of 85cm diameter) was installed with 7 centimetre separating gravel, 13cm drainage gravel and 76cm filtration sand (fine sand) with 5cm standing water level and 20.5cm reservoir water column. (see Annex 15.1 and 15.2) .The source water was from stream pumping to a reservoir through a water pump system.

The following steps were applied on the research methodology:

Step-1: Market assessment for materials locally in Jalalabad and Laghman

- Listed the materials required for the filter.
- Searched market for availability of plastic tanks and other necessary materials.
- Identified roughly the cost of mentioned materials and was matched with the available budget.

Step-2: Selection of site for ISSF and BSF filter installation

- Collected water samples from schools and health facilities in Kabul, Kapisa and Nangarhar and assessed the feasibility of installation for Small Community Size Intermittently-operated Slow Sand Filter such as space for reservoir, filter and storage tanks, availability of abundant water and water pumping system.
- Analysed the collected samples for bacteriological and physical qualities and indentified sites with high bacterial and physical contamination.
- Selected the Qarghayee Girls High School (Qarghi District, Laghman province) which had the worst situation in respect to bacteriological and physical quality of water.
- Discussed with the headmaster and respective education directorate the purpose and importance of the research and got their approval.

Step-3: Procurement of materials and construction of filter

- Procurement of materials required for Small Community Size Intermittently-operated Slow Sand Filter was done in Jalalabad as many of the materials for fabrication of filter was not available at the site of filter installation.
- Constructed or fabricated the Small Community Size Intermittently-operated Slow Sand Filter.
- Procured and prepared sand and gravel for filter installation.
- Installed the gravel and sand filtration media according to the biosand filter principle.
- Fabricated and installed one V10 BSF in the same location.
- Trained a person at school on how to use and maintain the filter.

Step-4: Water quality analysis

- Samples from source water and filtered water were collected on weekly basis for both filters; Biosand Filter and Intermittently-operated Slow Sand Filter.
- Bacteriological and physical water quality tests of source water and filtered water for both filters were done once a week for almost 2 months.
- A lab technician was assigned to regularly collect and analyze the water samples from source water, CAWST version 10 BSF and ISSF filtered water.
- All water quality testing findings were recorded in readily made format and kept for the analysis.

Step-5: Reporting

- Mid-term progress report was submitted to the WET Centre Manager and head of program. The details of all aspects of the ISSF filtration system as it was constructed for this research were provided with the mid-term progress report.
- Final report including filter fabrication, research methodology, water quality testing details and research outcome and recommendations will have been provided after the completion of research study.

6. Staffing

Two people (Shir Ahmad and Shir Habib) were responsible for purchasing, transportation of materials, fabrication and installation of the filters. One person (Lab Technician) was assigned to collect and analysis the water samples from ISSF, BSF and source water. Performed water quality tests and documented the data.

7. Budget

The following is the expenses (in AFN) for construction and installation of ISSF in Qarghayee Girls High School, Laghman.

Items	Unit Cost	Quantity	Total	Remarks
Plastic water tank (reservoir) 2000L	8,900	1	8,900	
Plastic water tank (Storage) 3000L	9,800	1	9,800	
Plastic water tank (BSF) 1000L	3,400	1	3,400	
Pipe and fittings (24m PE Pipe 1", 8m PE Pipe 3/4", 3 Gate valve 3/4", 5 Tap 1/2", 4 PE Elbow threaded 1/2"x3/4", 7 PE Elbow 3/4"x3/4", 2 PE Elbow threaded 1", 1 PE Plug 3/4", 8 PE Socket 1", 5 GI clamps 1", 1 PE Union 1", 1 GI Nipple 1", 1 Foot valve 1", 2 Tapeline)	different	different	12,470	
Float Valve 3/4"	420	1	420	
Wages for digging infiltration well nearby canal and concrete rings cost			4, 930	
Electric water pump	2,500	1	2,500	
Electricity wire and switch for water pump	340	1	340	
Diffuser	260	1	260	
Concrete apron for ISSF	14,085	1	14,085	
Filtration sand	1,400	Lot	1,400	
Gravel	1,510	Lot	1,510	
Washing of filter media sand	3,000	Lot	3,000	
Shelter for ISSF stand	37,000	1	37,000	
Labour	350	6 days	2,100	
Transportation of materials to the site	2,000	One time	2,000	
Total			**104,115**	

Note: WET Centre staff time cost, and 11 times staff travel cost for construction and water quality testing between Kabul Office and the school in Laghman, and cost for water quality testing are not included in the budget.

8. Design

The design of the Intermentently-operated Slow Sand Filter was done very technically by the water expertise and training centre manager and some information was taken from design done by CAWST, for details such as amount of gravel, sand and height of filter tanks and etc refer to annex 15.1.

9. Water quality Tests' Results

9.1. Biosand Filter

9.1.1. Bacteria Removal Efficiency

Bacterial Removal Efficiency was 98%

The bacterial removal from source water was very good and on the sixth test there was no bacteria found in the filtered water, while the source water had bacteria more than 250 cfu/100ml. Refer to table # 1 for details.

Table #1: Bacterial comparison of source and filtered water (BSF)

Statistics	Bacteria in BSF Filtered Water	Bacteria in Source Water
Maximum	13	250
Minimum	0	250
Average	5.1	250

9.1.2. Turbidity Removal Efficiency

Turbidity Removal Efficiency was 97.27%

The turbidity of filtered water was much better than the source water; average filtered water turbidity was 1.2 NTU, while the average turbidity of source water was17.8 NTU. Refer to table # 2 for details.

Table # 2: Turbidity comparison of source and filter water (BSF)

Statistics	Filtered of BSF Water Turbidity	Source Water Turbidity
Maximum	3.78	38.5
Minimum	0.14	3.1
Average	1.2	17.8

9.2. ISSF

9.2.1. Bacteria Removal Efficiency

Bacterial Removal Efficiency was 98%

The bacterial removal from source water was very good and on the fifth test there was no bacteria found in the filtered water, while the source water had bacteria more than 250 cfu/100ml. It means that the ISSF got matured one week ahead of BSF. Refer to table # 3 for details.

Table # 3: Bacterial comparison of source and filter water (ISSF)

Statistics	Bacteria of ISSF Filtered Water	Bacteria in Source Water
Maximum	10	250
Minimum	0	250
Average	4.3	250

9.2.2. Turbidity Removal Efficiency

Turbidity Removal Efficiency was 97%

The turbidity of filtered water was much better than the source water; average filtered water turbidity was 0.5 NTU while the source water turbidity was 17.8 NTU. Normally, the turbidity of drinking water should be lower than 5 NTU according to the Afghanistan National Drinking Water Quality Standard.

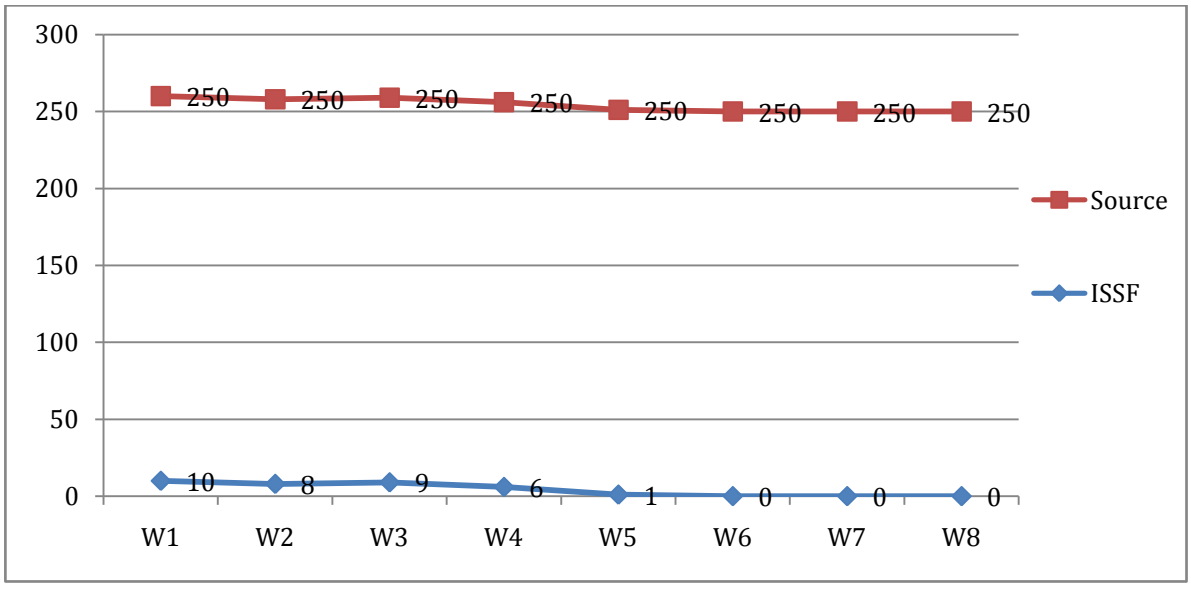
Table # 4: Turbidity comparison of source and filter water (ISSF)

Statistics	Turbidity of ISSF Filtered Water	Turbidity of Source Water
Maximum	0.81	38.5
Minimum	0.08	3.1
Average	0.5	17.8

10. Result Comparison of the Filters

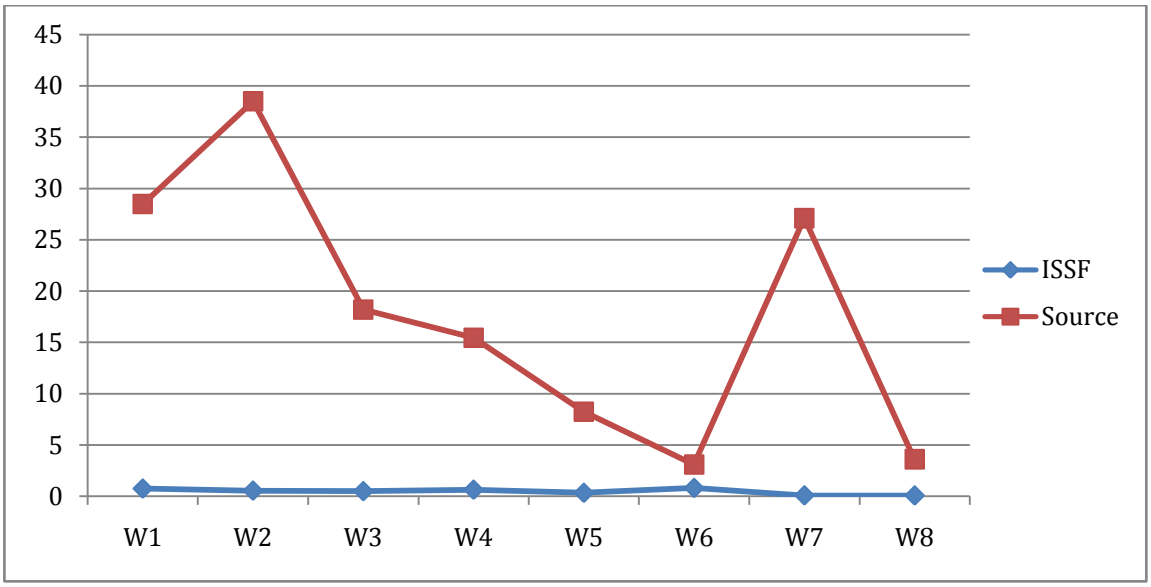
Normally, the BSF become mature after 30 days of usage, in respect to this convention it is clear that the biosand filter bacterial efficiency was very good but a bit slower than the ISSF as on fifth test there was no bacteria found in ISSF filtered water, while on sixth test there was no bacteria found in BSF filtered water. Refer to the following chart for trend of bacterial removal.

Chart# 1: Trend of bacterial removal of ISSF



Turbidity removal was very close to each other as on the first test the turbidity of source water was 28.5 NTU, BSF's filtered water was 0.58 NTU and ISSF's filtered water was 0.75 NTU. Refer to the chart#2 for trend of turbidity removal.

Chart #2: Trend of turbidity removal of ISSF



Refer to table # 5 for details. It is to mention that the turbidity of source water was changeable due to the weather condition, if there was raining the turbidity was to be increased due to small flooding.

Table # 5: Comparison of source, BSF and ISSF water quality

Statistics	Source Water		ISSF Water		BSF Water	
	Bacteria	Turbidity	Bacteria	Turbidity	Bacteria	Turbidity
Maximum	250	38.5	10	0.81	13	3.78
Minimum	250	3.1	0	0.08	0	0.14
Average	250	17.8	4.3	0.5	5.1	1.2

11. Operation and Maintenance.

As the flow rate at the beginning of the research of ISSF was 900 ml/minute and BSF was 340 ml/minute and at the end of the research, the flow rate of ISSF decreased to 670 ml/minute and BSF decreased to 200 ml/minute. Therefore, operation and maintenance of the filters was required. It was communicated with school head master to introduce a person to be responsible for operation and maintenance of the filter in the future. He introduced administrative assistant who was trained by water expertise and training centre's senior trainer and lab technician in a practical session to handle the O&M issues in future.

12. Challenges

Since the filter was installed far away from Kabul at a school in Laghman province, therefore the access to the site was time consuming and costly as well. The filter was supplied with water from a stream pumping through electric water pump, but sometimes they had problem with electricity and could not pump water into the filter on time. Another challenge was that we put wooden plate on stand of the filter and since the filter and reservoirs were have they have been tilted. The problem was fixed by putting another small metal stand under the wooden plate.

13. Conclusion

Small Community Size Intermittently-operated Slow Sand Filter was effective in removal of bacteria and turbidity from the source water. The result of both filters was very close to each other in term of bacterial and turbidity removal from source water. Even though, the ISSF filter was a bit faster in bacterial removal. While turbidity removal for the both filter was very close such as average turbidity removal for BSF was 1.2 NTU and ISSF was 0.5 NTU which is very close figures to each other and both of the filters could provide acceptable water in respect to WHO guideline.

14. Recommendations

Based on the findings of this study and findings of study conducted in Nasaji Girls High School, it is strongly recommended to pilot and scale up implementation of the Small Community Size Intermittently-operated Slow Sand Filter to the whole country. ISSF to be fabricate and installed in places where there are abundant surface water and no access to safe sources of drinking water such as schools, clinics and for small communities. It is especially recommend installing the ISSF in those schools which don't have access to safe water source and have abundant surface water and city power to pump water to a reservoir from the stream or river.

15. Annex

15.1. Complete Design of ISSF

15.2. Installation Diagram of Water Tank of ISSF

15.3. Summary of Water Analysis of BSF, ISSF and Source Water