Effectiveness and Acceptability of Smaller Biosand Filters

Anna Murray[1], Julie Napotnik[2], Maria Antonia Mendoza[3], Kristen Jellison[2], Daniele Lantagne[1]

[1]Tufts University Civil & Environmental Engineering, [2]Lehigh University Civil & Environmental Engineering, [3]Fundación Tierra

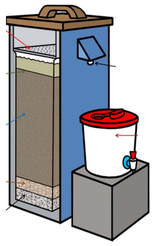
BACKGROUND

BIOSAND FILTERS:

- The biosand filter (BSF) is a household-scale, intermittently-operated slow sand filter promoted globally for household water treatment (HWTS).
- BSFs have been shown to effectively remove bacteria, protozoa, and some viruses in the laboratory, and improve the microbiological quality of household water and reduce diarrhea among users in field trials.[1-4]

TRADITIONAL DESIGN:

- **Concrete casing** with 54-cm high sand layer
  Difficult and costly/labor-intensive to build and transport.



Traditional Concrete BSF and Commercially-available Plastic BSF
(CAWST, TripleQuest, http://www.johnlongchamps.com/blog.html)

ALTERNATE DESIGNS:

- **Commercially-available plastic casings**
  Imported, easier to build/transport than concrete.
- **Locally-built 10-inch PVC BSF** (“Large BSF”)
  Has similar dimensions, but locally sourced, cheaper than imported, and easier to build/transport than concrete.
- **Locally-built 5-gallon bucket BSF** (“Small BSF”)
  Smaller, 15-cm sand depth, locally sourced, cheaper, easier to build and transport.

Laboratory testing has demonstrated comparable turbidity, *Escherichia coli* (*E. coli*), and protozoan cyst removal rates to concrete BSFs.

Figure 2: Locally-built PVC (Large) and 5-gallon Bucket (Small) Casing BSFs
(Photos by Anna Murray)

RESEARCH OBJECTIVE

The goal of this field study was to compare ACCEPTABILITY and MICROBIOLOGICAL EFFECTIVENESS of a smaller 5-gal BSF design to that of large PVC casing BSFs in Nicaraguan households.

Project Location in Nicaragua, Central America

RESEARCH METHODS

Overall Study Design

- Enrolled 52 Nicaraguan Households in three communities
- 23 Large BSFs, 29 Small BSFs

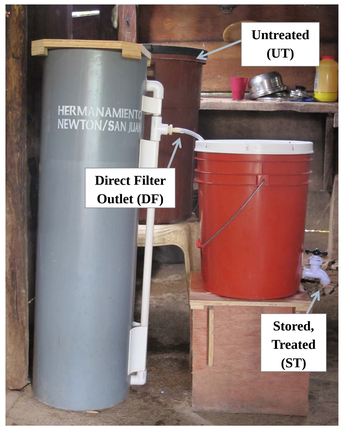
Baseline Survey → **Training & Installation** → **Unannounced Follow-ups: 2 months, 6 months, 15 months**

Household Surveys to Evaluate Acceptability:

- Acceptability questions (still using filter, like water taste, plan to keep using, and observation of treated water at time of visit)

Water Quality Testing to Evaluate Effectiveness:

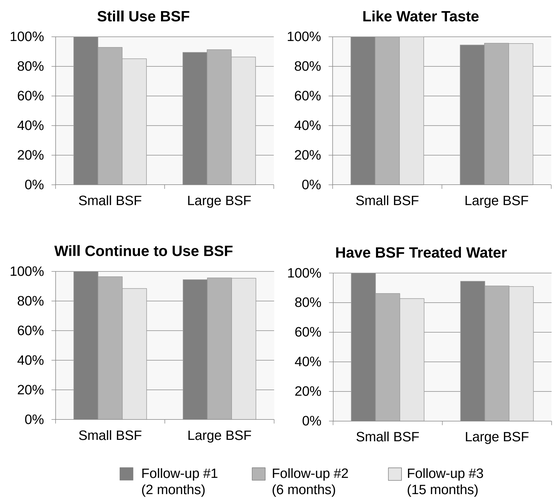
- *E. coli* enumeration by membrane filtration
- 3 samples: Untreated (UT), Directly from the filter outlet (DF), and Stored, treated water (ST).
- Geometric mean *E. coli* concentrations and percent reductions from untreated water were analyzed.



Water Sampling Locations

RESULTS: ACCEPTABILITY

Percentages of positive survey responses about filter acceptability at three follow-ups.



No statistically significant differences were observed between large filters and small filters with regard to any acceptability measure (p>0.05, Chi Squared test or Fisher´s exact test of independence).

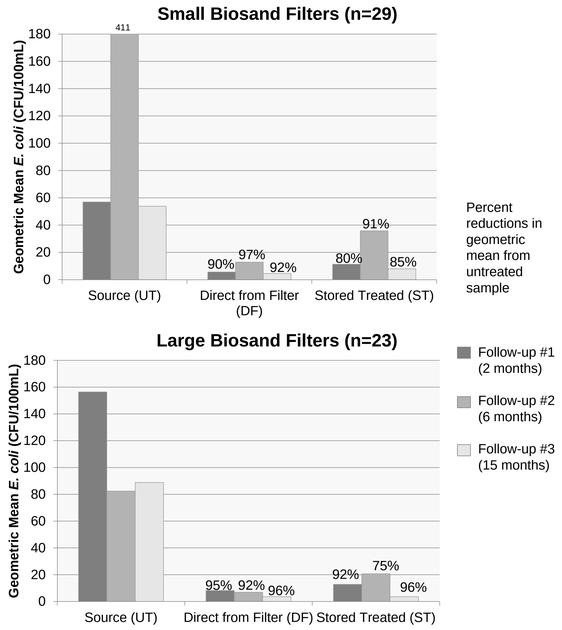
COST COMPARISON

Estimated material costs in San Juan del Sur, Nicaragua (not including labor or transportation)

- Concrete Casing BSFs: 30 USD
- Large PVC BSFs: 25 USD
- Small 5-Gallon BSFs: 19 USD

RESULTS: EFFECTIVENESS

Geometric mean *E. coli* concentrations in three samples at three follow-ups.



Median *E. coli* reductions from untreated water, with all follow-ups pooled

	Median *E. coli* Reduction from Untreated Water		p-value (Wilcoxon Rank Sum)
	Small BSFs	Large BSFs	
Direct from Filter (DF) Samples	93%	95%	0.62
Stored Treated (ST) Samples	86%	86%	0.36

CONCLUSIONS / RECOMMENDATIONS

- We did not observe differences in user acceptability or microbiological effectiveness between Small and Large BSFs
- For both filter designs, acceptability measures were high and bacterial removal rates were consistent with previously-published BSF field data.
  - As BSFs operate with size exclusion, we would expect protozoan cyst removal also to be comparable between small and large filters.
  - Viral removal depends on filter pore volume and pause time between operation, which varies with filter size and usage, and thus viral removal efficiency may vary.
- Water recontamination from filter outlet to storage has been previously identified, and remains a challenge with both BSF designs.
- Construction costs for locally-built Large PVC and Small 5-gallon BSFs are lower than that of Concrete filters, and more can be transported at one time

Smaller BSFs built from local materials appear to be equally as acceptable and effective as traditional designs, and may be cheaper and easier to build and transport. Smaller biosand filters could be promoted as a viable HWTS alternative.

FUTURE WORK

- Additional statistical analyses controlling for household demographics, WASH knowledge and behaviors, time since treatment, etc.
- Field studies with larger sample size

ACKNOWLEDGEMENTS

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