ORIGINAL RESEARCH

The use and performance of BioSand filters in the Artibonite Valley of Haiti: a field study of 107 households

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A B S T R A C T

Introduction: Approximately one billion people world-wide lack access to adequate amounts of safe water. Most are in developing countries, especially in rapidly expanding urban fringes, poor rural areas, and indigenous communities.
Methods: In February and March 2005, a field study of 107 households was conducted to evaluate the use and performance of the Manz BioSand filter in the Artibonite Valley of Haiti. Approximately 2000 filters had been installed in this area over the preceding 5 years by the staff in Community Development at Hospital Albert Schweitzer, Deschappelle, Haiti. Interviews, observations, and water samplings were carried-out by two teams of Haitian enumerators, each consisting of a nurse and a filter technician. Water analyses were performed by Haitian lab technicians using the membrane filtration method to determine *Escherichia coli* counts. The enumerators and the lab technicians completed a 2 week training program before beginning the study; they worked under the direct supervision of the primary investigator. Laboratory quality was monitored by running 10% blank and 10% duplicate samples.
Results: The households contained an average of 5.4 persons. Filters had been in use for an average of 2.5 years, and participants were generally satisfied with their filter's performance. Shallow, hand-dug wells provided the only source of water for 61% of the households, with 26% using water piped from springs or deep wells, and 13% having access to both. Only 3% had plumbing in their homes. Source water from shallow wells contained an average of 234 *E. coli* cfu/100 mL. Piped sources averaged 195 *E. coli*

cfu/100 mL. Of the source water samples 26% contained 0-10 *E. coli* cfu/100 mL. Of the filtered water samples 97% contained 0-10 *E. coli* cfu/100 mL (80% with 0 cfu/100 mL, and 17% with 1-10 cfu/100 mL). Overall bacterial removal efficiency for the filters was calculated to be 98.5%. Turbidity decreased from an average of 6.2 NTU in source water samples to 0.9 NTU in the filtered water. None of the households treated the water after filtering; 91% used the filtered water only for drinking. No problems related to filter construction were observed; 13% were found to have significantly decreased flow rates (all restored by cleaning the filter). Recontamination was found to occur, with only 3% of the samples from the filters' spouts containing >10 *E. coli* cfu/100 mL and 22% of the stored filtered water samples at point-of-use containing >10 cfu/100 mL.

Conclusion: The Manz BioSand filters are an attractive option for supplying water treatment to family units in rural areas of poorly developed countries.

Key words: drinking water, rural water supply, sand filter.

Introduction

Approximately one billion people world-wide lack access to adequate amounts of safe water[1]. Most are in developing countries, especially in rapidly expanding urban fringes, poor rural areas, and Indigenous communities[1,2]. Municipal water treatment systems can be impractical in these settings. For many of these populations, inexpensive household water treatment is a reasonable alternative[3-5].

Over the past 5 years, the Manz BioSand intermittent slow sand filter has been widely-distributed for household water treatment in developing countries around the world. The Manz BioSand filter units are in use in 20 countries around the world, among them Honduras, Mexico, the Dominican Republic, India, Pakistan, Nepal and Uganda. Over 80 000 filters have been installed and it is estimated that 500 000 people are drinking water treated by the BioSand filter. The first filters were installed in Nicaragua in 1996. This article is one of the first to document their use in the reviewed scientific literature. The advantages of BioSand filter are that it can be built locally, it is easy to use and maintain, it does not require electricity, and it is relatively inexpensive.

Previous laboratory studies have shown the BioSand filter to be effective in significantly reducing the number of parasites and bacteria in the source water[6,7]. However, little data are available from field studies concerning the filter's performance and sustained use over time.

The main objectives of this study are to: (i) gather information about the general hygiene and sanitation in the households using the filter; (ii) record the users' perceptions relating to level of satisfaction with the performance of the filter; (iii) make observations about the durability and sustainability of the filter after prolonged use; (iv) collect data about the filter's efficiency in removing bacteria and reducing turbidity under typical working conditions; and (v) track the levels of *Escherichia coli* in household water from source to point-of-use.

Methods

Background

The BioSand filter works in much the same way as the large-scale slow sand filtration systems which have been in use in municipal water treatment for over 150 years[8,9]. The filter cleans the water by a combination of mechanisms. Mechanical trapping is the most obvious and is related to the

size of the pore spaces created between the sand granules. Adsorption of suspended materials to the surfaces of the sand granules also plays an important role. In addition, the filter benefits from a biologically active layer, which develops spontaneously in the micro-environment existing near the interface of the sand and water. Organic nutrients from the source water are trapped in the upper 5-10 cm of the sand. Oxygen diffuses through the standing water from the air above to the biolayer, allowing aerobic respiration to occur. The community of organisms which develops in this micro-environment enhances the filter's ability to remove bacteria and parasites[6].

The filter was developed during the 1990s by Dr David Manz at the University of Calgary in Alberta, Canada. The design allowed the slow sand filtration process to be used in households because water could be added intermittently rather than depending on continuous flow. This was accomplished by routing the outflow pipe from the bottom of the container up its side to a point 5 cm above the sand. This ensures that that sand remains submerged. The Manz design is illustrated (Fig 1).

The container is made of concrete, stands 95 cm in height and 36 cm in width. It weighs approximately 150 kg empty, and 225 kg filled with the sand and water and ready to use. The flow rate is 30-40 L/h with a maximum of 60 L/h. It can be produced for approximately US$25. The filter is cleaned by stirring the top 5-10 cm of sand, thereby re-suspending the trapped particles in the standing water, which then can be removed with a cup or ladle. This process is repeated until the standing water remains clear or the proper flow rate is restored. Figure 2 is a photograph of a BioSand filter in place in a Haitian home.

Setting

The Artibonite Valley is a productive agricultural area in central Haiti. Much of the valley floor is irrigated. People commonly have access to water from hand-dug wells near their homes. Some also have access to water piped from deep-bore wells or developed springs to shared stand pipes.

Wells in the irrigated valley floor may be only 1.5-2 m deep. But in the hills above the irrigation canals the hand-dug wells are often 5-10 m in depth.

In 1999, Dr Manz visited Hospital Albert Schweitzer in Deschappelle, Haiti to instruct the staff of the Community Development Division in the construction, installation, and maintenance of the Manz BioSand filter. Community Development had received US $65 000 in grants to install filters in households in the communities around Deschappelle. The program called for the householders to pay US $12, or approximately one-third to one-half of the anticipated costs. The staff began installing the filters in late 1999. By 2004, approximately 2000 filters had been distributed in the Artibonite Valley.

Personnel

Eight local people were hired for the study. These included two teams of enumerators, each consisting of a nurse and a filter technician, two lab technicians, a data entry person and a translator. The salaries paid were commensurate with those for a similar job at the Hospital Albert Schweitzer. All information was obtained and recorded in Haitian Creole. Training of the project staff occurred over a 2 week period immediately preceding the onset of the study. The first week was devoted primarily to educational topics, and the second week was spent practicing the interviews, observations, water samplings and laboratory procedures.

Statistical analyses

It was of high importance to the study to have as large a representation from the population as possible but costs were (and usually are) an obvious limitation to this. The 107 households were determined by the investigators as a goal and represent what we felt was a reasonable sample set (5%) of the 2000 filters installed in the area.
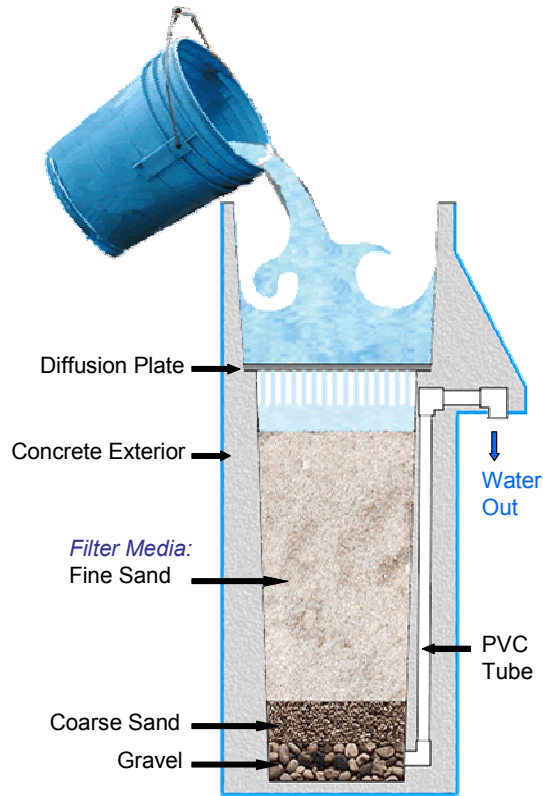
Diffusion Plate

Concrete Exterior

Filter Media:
Fine Sand

Water
Out

PVC
Tube

Coarse Sand

Gravel

Figure 1: Manz BioSand filter.

Figure 2: BioSand filter in a Haitian home.

Household visits

The households visited were selected in a non-random manner. Many of the filters had been installed by the filter technicians, and the households were chosen from their memory. Others were identified by asking members of the community which households had filters. All the filters had been in use for at least one year. The visits were spread throughout the valley among ten communities within 1-2 h drive from Deschappelle.

Each household was visited at least twice. The first visit was unannounced. The enumerator's presentation at this visit was scripted. The study was explained and the user's consent to participate was obtained at this time. An appointment was then made for the second visit, scheduling 2 h for the interview, observations, and water sampling. Each participant was offered a 20 L plastic water storage bottle as compensation for their time. The primary investigator and the project coordinator accompanied the teams to each of the visits and filled-out duplicate copies of the questionnaires and observations in English. The questionnaire contained a total of 45 questions pertaining to family demographics, water source, filter use, water storage, sanitation, hygiene and health (Appendix I). The observations included 19 separate data points relating to the filter's construction and use, filtered water storage methods, sanitation facilities, and general hygiene. The flow rate of the filter was measured, and analyses to determine the free chlorine level and pH of the stored filtered water were performed at the household.

In 87 households, water was sampled at five locations from the source to the point-of-consumption: the source; the transfer bucket used to carry water from the source; the standing water in the filter; the filter's spout; and the storage container for filtered water. In twenty households, water samples were collected at only four locations, omitting the source water sample because of compromised incubator space.

The samples were collected in standard 250 mL 'Whirl-pak' sample bags (NASCO; Atkinson, WI, USA). The bags were labeled and stored in a cooler until delivered to the laboratory. The sample was refrigerated and analyses performed within 24 h of collection.

Water analysis

A laboratory area in the Community Development building was used during the study to perform the water analyses. It consisted of a work bench with sink, cabinets and refrigerator, and an adjacent office. All the laboratory supplies and equipment needed to perform membrane filtration and turbidity measurements were supplied by the Project BRAVO. Methods for water quality and bacteriology conformed to Standard Methods[10]. The culture medium was prepared weekly in the lab using Difco's modified mTEC dehydrated agar. The filter apparatus and flasks needed to perform the membrane filtration were glass and were autoclaved using a steam sterilizer. The samples were incubated in a Hach portable incubator. Samples with colony counts above 300 were considered to have too many colonies to be counted accurately; so repeat samples were obtained and diluted serially until a number less than 300 could be counted on the membrane. This occurred in 22% of the households sampled. The membrane filtration laboratory procedures followed the US EPA Standard 1603. Quality assurance was assessed by using sterile water in 10% of the samples as 'blanks', and duplicate samples from 10% of the households visited to assess variation between samples.

Turbidity was measured using the Hach 2100P turbidimeter.

Results

Questionnaires and observations

The questionnaire (Appendix I) was developed by committee, which included UNICEF and WHO personnel.

After revision and field testing, it was reduced to what was felt to be a reasonable size, one version in English and one in Creole. The 'test and validation' of the questionnaire was performed by the enumerators practicing the interview questions as part of their training. Also, the questionnaire was trial tested with households as part of the training. Finally, criteria for judging subjective observations were developed and agreed on by the two teams of enumerators, as part of their training.

One hundred and seven households were included in the study. Most of the houses had cement floors and walls, and many also had yards big enough to accommodate a hand-dug well and a latrine. Family size ranged from 1 to 15 persons, averaging 5.4 per household. The households contained a total of 71 children under the age of 6 years. Ten of these children had been sick with diarrhea within the past 2 weeks. Seven of these took 'leaf' medications, which are naturally-occurring herbal remedies. Two were seen in a clinic. None was hospitalized, and all recovered.

Sixty-one percent of the families obtained their water from hand-dug wells. Twenty-six percent had access to piped water from springs or deep wells, and thirteen percent had access to both. The average contamination of the source water samples was 202 *E. coli* cfu/100 mL. The source was within 50 m of the house in 93% of the cases (range from 3 m to 1 km).

Most families (85%) had latrines in their yards. The enumerators rated these latrines as 'not clean' in 61% of the households. Five percent had toilets in their homes, and 7% had access to neither latrine nor toilet and used the bush or the canals. In 67% of the cases, the latrine was located at least 25 m from the well (range: 10-112 m). There was no garbage removal service, and most families burned their garbage or threw it out in the yard or street. Twenty percent of the families reported that they composted some of their garbage.

All of the families responded that they used soap. However, soap was observed to be present at the primary hand-washing station in only 30% of the households. The over-all hygiene was rated by the enumerators as 'generally good' in only 18% of the households, while 82% were rated as 'poor' or 'very poor' (this rating was based on definitions and parameters taught during the training).

The filters had been in use from 1 to 5 years, averaging 2.5 years. No alteration in performance related to the age was detected, and no filters were encountered that had broken. All of the filters included in the study were functioning at the time of the second visit when the water samples were collected. Four of the filters included in the study were not functioning at the time of the first visit. Three of these filters were blocked and required maintenance. In the fourth case, the filter had been sold and the new owner installed unscreened river sand after the filter was moved. The problems were corrected, and the second visit to these households was scheduled 2 weeks after the remediation. Two households were visited where the filters had been installed but were not being used, in one because of illness and in the other because of a family dispute.

In 91% of the households, the filtered water was used only for drinking. None of the households treated the water with chlorine after filtering. Eighty-five percent poured the source water directly into the filter, not allowing time for sedimentation or settling. One hundred percent of the households reported that they liked their filters, citing better quality water (49%), health protection (22%), and 'because it works well' (7%) as reasons. In 99% of the interviews, the participants answered that the filtered water appeared cleaner, tasted better, and smelled better than the source water. One hundred percent reported that the filter was easy to use, and that the children who were old enough to lift the bucket could use the filter. Ninety-nine percent said that the filter produced enough water for the entire household. Ninety-five percent felt that their family's health had improved since they began using the filter, while 5% had not noticed any change. Ninety-five percent responded that they would recommend the filter to others. Fourteen households reported that they had had problems with slow flow rates and six said that they had to obtain assistance from Community

Development to correct the problem. In all of these cases, the problem was blocking of the filter due to accumulate silt and was easily corrected by the 'swirl and dump' procedure.

In 92% of the cases, the filters were found to be well-maintained. The average flow rate for the filters was 35.4 L/h, ranging from 11-95. One of the filters was found to have a crack near the lip of the filter above the spout, but it was still being used and seemed to function well. Containers used to store the filtered water were classified as large-mouth in 37% of the households, small-mouth in 12%, and both were used in 51%. All of the containers were covered in 74% of the households, and in 26% some or none of the containers were covered. Free chlorine measurements substantiated the assertion that the water was not being treated after filtering; pH measurements ranged from 7 to 8.5.

Laboratory

The turbidity in source water ranged from 0.37 to 71.1 NTU, averaging 6.2 NTU. The filtered water samples fell to an average of 0.9 NTU (range: 0.2 - 2.3 NTU).

E. coli counts were higher in the hand-dug well water (average 234, median 53, cfu/100 mL) than in piped water from springs or deep wells (average 195, median 27, cfu/100 mL). The filtered water samples collected at the filter spout contained less than 10 cfu/100 mL in 97% of the filters (80% with 0 cfu/100 mL and 17% with 1-10 cfu/100 mL). In 3% of the samples from the filter spouts, the *E. coli* counts were greater than 10 cfu/100 mL. The colony counts on these three samples were 12, 15 and 22 cfu/100 mL. Among the source water samples, only 25% were found to be in the 'reasonable' range (0-10 cfu/100 mL), 46% were in the 'polluted' range (11-100 cfu/100 mL), and 28% were in the either the 'dangerous' (100-1000 cfu/100 mL) or 'very dangerous' (>1000 cfu/100 mL) range, according to WHO definitions for water safety[11].

E. coli counts were found to be higher in stored filtered water than in the filtered water from the spout. In 22% of the samples from the point-of-use container, the *E. coli* counts were greater than 10 cfu/100 mL, versus the 3% of the samples taken from the filter spout. Figures 3 and 4 summarize these data. The issue of recontamination of drinking water after treatment has been discussed by previous investigators[12,13] and is felt to be a serious issue. Our data showed that contamination was higher in storage containers than when the water existed in the BioSand filter unit.

The *E. coli* removal efficiency was based on samples taken from the water from the source (*E. coli* in) versus samples taken from the filter spout (*E. coli* out). The removal efficiency for each filter was calculated using the following formula: (number E coli in) minus (number *E. coli* out) divided by (number *E. coli* in), expressed as a percentage. The average of the removal efficiencies for all the filters was 98.5%. Ninety-two out of the 107 filters were included in this calculation. Ten were omitted because there were zero *E. coli* in and zero *E. coli* out, four were omitted because of unusable or unreliable data, and one was omitted because of incomplete data.

Discussion

Household visits

The household visits revealed that the users of the BioSand filters tended to own their homes and their houses tended to be made of cement and have cement floors. Most had access to a latrine in their yards. Their sources of water were contaminated into the polluted or dangerous range in 71% of the cases. The overall hygiene of most of these households was rated as poor. Contamination of water during storage has been previously identified as a problem[14].
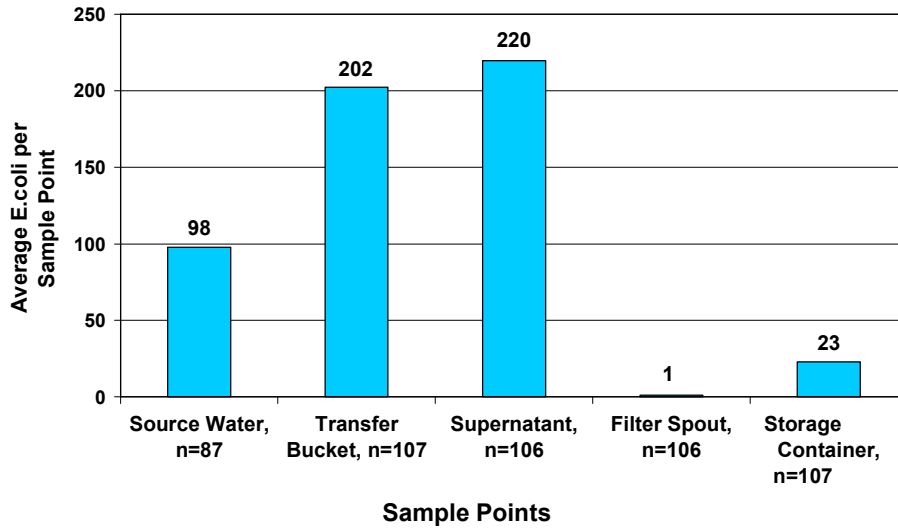
Figure 3: Removal effectiveness and recontamination using _E. coli_ as indicator.
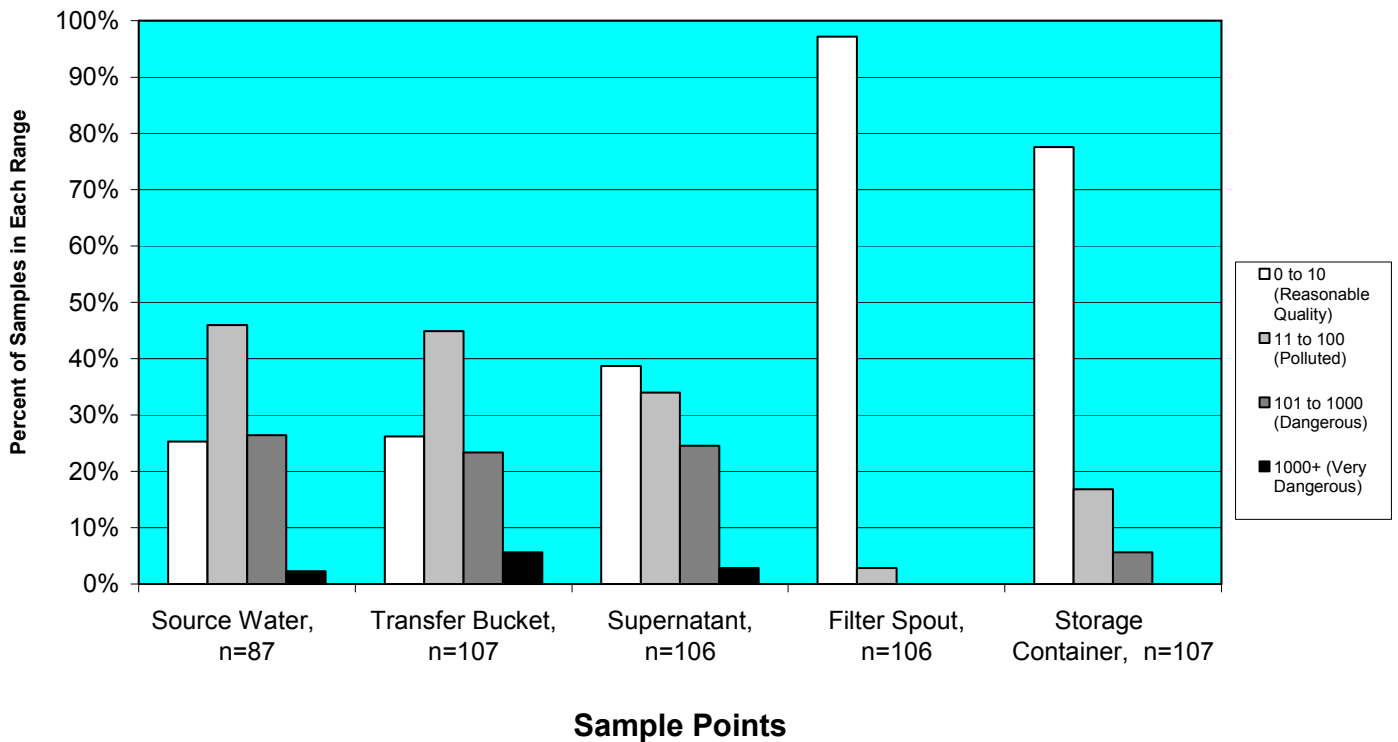

Figure 4: Ranges of _E. coli_ by source sampled.

The questionnaire responses indicating a high degree of user satisfaction is supported by the observations that 92% of the filters appeared to be clean and well-maintained, and that 97% were functioning at the time of the unannounced first visit. The filters were found to be durable with a few having chips along the lip, and only one with a crack that resulted in a leak. This filter continued to be used because the crack was above the resting water level, and the filter leaked only when source water was added. The height of water above sand, the supernatant level, was observed to be within the range of 2.5-7.5 cm in 100% of the filters, implying regular use.

Measurements of the flow rates revealed that the average flow rate for the filters was within normal range. However, 28% of the filters had flow rates below normal, and many of the users indicated that they did not know how to perform the maintenance procedure to restore flow. Shallow wells especially produced water with high turbidity levels due to suspended particles. The filter effectively removed the suspended particles, reducing the average turbidity from 6.2 to 0.9 NTU. The trapping of the suspended particles results in decreased pore size, and thus decreased flow rate. Thirteen percent of the participants reported that they had problems with decreased flow, and 6% reported that they have needed assistance from Community Development to restore normal flow rate. Thirty-six percent of the households reported that they had not been visited by the staff of Community Development since their filter was installed.

Laboratory results

The filters were found to have an average *E. coli* removal efficiency of 98.5%, and the filters were found to produce water in the safe or reasonable range in 97% of the cases. Still, 20% of the samples from the filter spout were above the WHO limit of zero *E. coli*/100 mL for 'safe' water.

In this study, recontamination was found to occur in a significant number of households. The number of samples from the storage containers with more than 10 *E. coli* cfu/100 mL was seven times higher than it was in the samples taken from the spout. The provision of safe drinking water seems to depend as much on good hygiene and cleanliness of water storage containers as it does on water filtration technology

Conclusions

The data support the following conclusions:
1. Perceptions of the participants regarding quality of water, ease of use, and quantity of clean water produced indicate high levels of overall satisfaction.
2. Observations revealed that the filters were durable, and that most were well-maintained, functioning properly after an average of 2.5 years of use.
3. The turbidity measurements showed that the filters functioned well to reduce turbidity.
4. The water analyses showed that the filters are effective in removing significant *E. coli* bacteria.
5. A more significant issue than the filter's bacteria removal efficiency may be the incidence of re-contamination.
6. Disinfection of the stored filtered water is recommended to ensure that it remains in a safe or reasonable range with respect to bacterial contamination.
7. Education about water-borne diseases, methods of safe water storage, and methods of disinfecting the stored filtered water should accompany the installation of the filter.

On the basis of this trial, the Manz BioSand filters are an attractive option for supplying water treatment to family units in rural areas of poorly developed countries. The efficiency of water improvement through reduction of bacterial numbers, coupled with the low cost and low technology of these units was seen to be a significant attribute to reducing the risk of water borne disease and improving general medical health. We would recommend further trials of this technology. We feel that any

shortcomings of the BioSand filter are likely best addressed by user education about the operation and maintenance and proper monitoring of the filter media (fine sand) preparation and installation and of fundamental hygiene practices but that the basic principles of the technology are sound.

Acknowledgements

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Appendix I: Questionnaire used in Artibonite study

Ref #	
GPS #	
(UTM)	

Project BRAVO
Long Term Users Questionnaire

Date of Visit: …………………………….
Enumerators: …………………………….
…………………………….

Contact visit topics

Introduction – enumerator, CAWST, HAS		Confidentiality	
Explain study goal		Shared results	
Does your filter work well		Are you interested?	
Questionnaire		Consent form	
Observations		Photos	
Sampling		2 buckets	
Measurements		Stored water	
Time needed to do visit		Next meeting	
Bottle		Time recap	

Respondent Name:…………………………...
Role in Family: …………………………….
Address: …………………………….
Community: …………………………….
Next visit date: …………… Time: ………..
Comments..………………………………………..

Project BRAVO - Household Survey Questionnaire for Long Term User Visit, January 29, 2005

1. Date and respondent

Date of survey	
Name of respondent	
Role in family	

Signed consent form	
2 buckets water	
stored water available	

2. How many people live in this house?

Number	

3. In your household, what are the ages of the children?

	Names of children	# of children that age
Children aged less than 1 year:		
Children aged 1 – 5 years:		
Children aged 6 years or more:		

4. Have any of your children aged 5 and under been sick in the past 2 weeks?

Yes	1	
No	2	→ *skip to question10*

5. What did they have?

Diarrhea	1	
Other	2	→ *skip to question 10*

6. How many children had diarrhea?

# of children

7. How many days did they have diarrhea?

Child 1	# of days		Child 3	# of days	
Child 2	# of days		Child 4	# of days	

8. Did they take any medicine for the diarrhea?

Yes (specify)	1
No	2

9. Did they see a doctor?

Yes (specify)	1
No	2

A. Water Questions

10. What are your sources of water?

Well	1	
Piped	2	
Canal, river or stream	3	
Rain	4	
Other (specify)	6	

11. What is your favourite source?

Well	1	
Piped	2	
Canal, river or stream	3	
Rain	4	
Other (specify)	6	

12. Why do you like it better?

Closer	1	
Better quality	2	
Other (specify)	6	

13. How much water do you use every day?

Quantity:

14. How long does it take to get water?

Time to go, get water and return:

15. How far do you have to go?

Distance:

16. What water do you drink when you're not at home?

Buy water	1		→ cost per week:
Drink from canal, river or stream	2		
Drink from well	3		
Bring water from home	4		
Other (specify)	6		

17. Do you think that water is clean?

Yes	1	
No	2	
Don't know	6	

18. Do your kids have good water at school?

Yes	1	
No	2	
No kids in school	3	
Don't know	6	

B. BioSand Filter Questions

19. How long have you had your filter? _____

19a. Has anyone from HAS visited you since you`ve had the filter?

Yes	1	
No	2	

19b. What are all the purposes you use filtered water for?

Drinking	1	
Food preparation	2	
Bathing and washing hands	3	
Other (specify)	6	

20. Do you do anything with the water before you put in into the filter?

Let it settle	1	
Raket	2	
Pour it through cloth	3	
No	4	

21. Tell us about the taste of filtered water – is it better, worse or the same as before you filter it?

Better	1	
Worse	2	
About the same	3	

22. What about its smell?

Better	1	
Worse	2	
About the same	3	

23. What about its appearance?

Better	1	
Worse	2	
About the same	3	

24. Since you started using the filter, do you think your family's health has improved, stayed the same, or become worse?

Better	1	
Worse	2	
About the same	3	

Comments: …………………………………………………………………..

25. Does the filter produce enough clean water for the entire household?

Yes	1	
No	2	

26. Do the children know how to use the filter?

Yes	1	
No	2	
No children in house	6	

27. Have you had any problems with the filter?

Yes, *(specify):* _____	1	
No	2	→ *Skip to question 29*

28. Do you ever require help to fix the filter?

Yes, *(how often and what needed to be fixed):* _____	1	
No	2	

29. Is it easy to use the filter?

Yes	1	
No	2	

30. Do you like the filter?

Yes, because:	1	
No, because:	2	

31. Would you recommend the filter to others?

Yes	1	
No	2	

32. Do you treat the water after filtering it?

Yes	1	
No	2	→ *skip to question 42*

33. What do you use?

Chlorox	1	
Boiling	2	
Sun	3	
Other	6	

34. What do you use this treated water for?

Drinking	1	
Food preparation	2	
Bathing and washing hands	3	
Other	6	

35. Can you tell us about the taste of the water after you add chlorine; is it better, worse or the same?

Better	1	
Worse	2	
About the same	3	

36. What about the smell?

Better	1	
Worse	2	
About the same	3	

37. What about the appearance?

Better	1	
Worse	2	
About the same	3	

38. Is it easy to treat the water with chlorine?

Yes	1	
No	2	
Don't know	8	

39. Do you like using chlorine?

Yes, because:	1	
No, because:	2	

40. Do you store water in the household?

Yes	1	
No	2	→ *skip to question 42*

41. What method do you use to take the water out of the containers? *(Check one)*

Tap	51	
Dp	52	
Pour	53	
Other *(Write this down)*	55	

C. Sanitation and Health Questions

42. Where does your family defecate?

Toilet	1	
latrine	2	
Bucket	3	→ *Skip to question 44*
In the open	4	→ *Skip to question 44*
Canal	5	→ *Skip to question 44*
Other (specify)	6	→ *Skip to question 44*

43. Do you share with other households?

Number of households =	
Not shared	1

44. What does your family use soap for?

Wash hands (specify when):	1	
Washing clothes	2	
Washing body	3	
Other (specify):	6	

45. What do you do with your garbage?

Burned	1	
Latrine	2	
Thrown out	3	
Buried	4	
Fed to animals	5	
Other (specify)_____	6	

Thank the person interviewed for her / his time!

Other comments or observations

_____
_____
_____
_____
_____

Observations

BioSand Filter

46. Filter observations:

Is the filter located inside or outside of the house?	Inside	41	
	Outside	42	
Does the filter appear to be level (not tilted)	Appears to be level	43	
	Appears to be tilted	44	
Is there a valve on the spout?	Yes	45	
	No	46	
Does the filter appear clean (outside, inside and spout)	Yes	47	
	No	48	
Is the lid in place?	Yes	49	
	No	50	
Is the diffuser plate in place?	Yes	51	
	No	52	
Is there food stored inside the filter?	Yes	53	
	No	54	

47. Write down any problems with the **quality of construction**

Leaks	51	
Lid or diffuser plate	52	
Concrete body	53	
Other (specify)	54	
No problems	55	

48. Height of water above the sand

Height in inches	

Water Storage Say: May I see your water storage container?

49. Are there containers to store water in the house?

Yes	1	
No	2	

50. What type of containers are these?

Narrow mouthed	1	
Wide mouthed	2	
Of both types	3	

51. Are the containers covered?

Yes, all are covered	1	
No, none are covered	2	
Some are covered	3	

52. Do the containers appear clean?

Yes	1	
No	2	

Sanitation   Say: Can I see your toilet?

53. Where is the toilet located?

In house	1	
In yard	2	
Outside yard – Private	3	
Outside yard – Public	4	
No toilet	5	

54. How far is the sanitation facility from: # of steps

House	
Well	
Creek, river or other source	

55. Is the toilet clean?

Yes	1	
No	2	

Hygiene   Say: May we see where you wash your hands?

56. Place where they wash their hands normally ?

Yes, inside or next to sanitation facility	1	
Yes, inside or next to kitchen	2	
Yes, inside living quarters	3	
Yes, outside in yard	4	
Washbasin – variable	5	

57. Do you see the following where the family washes their hands:

Water	1	
Soap	2	
Towel	3	
Nothing	4	

58. Evaluate general hygiene of house

Generally good household hygiene	1	
Generally poor household hygiene	2	
Very poor household hygiene	3	

Ref #	
GPS #	

Household Visit Data Form

Date: _____

	Quantity	Units
pH		-----
Free chlorine		mg/L
Height of water		inches

	Minutes	Seconds
Flow rate		

All successful samples? Yes No

If no, why?

_____
_____

For Bill

	Amount	Units
Turbidity		NTU
Colony count		colonies

_____