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MICROBIOLOGICAL TESTING OF POTABLE WATER IN NORTHWESTERN HAÏTI

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Abstract

In commune Anse Rouge situated in north western Haïti there are many natural water sources but the availability of clean water is still a problem in most villages if not all. Since 2004 there are ongoing efforts to prevent contamination of the many natural open sources by capping and to promote the use of household biosand filters.
Whether capping natural sources or disseminating bio sand filters, monitoring the water quality is important to identify the order of priority where project resource should be allocated and to evaluate the result of an activity.

The aim of this investigation was to evaluate a method for monitoring "on- field". The study showed that it is possible to analyse the level of bacterial contamination by membrane water filtration and preloaded growth plates, with a very good repeatability, despite very basic lab conditions.

The tests give a good picture of the amount of contamination on a semi quantitative level (good, bad, acceptable).

Key words – On-field testing, microbiological, water quality, Haiti, potable water

Background

Haïti is one of the poorest countries in the western hemisphere and suffered from a lack of adequate infrastructure in basically all areas even before the earthquake in January 2010. Although the region where this study was conducted, commune Anse Rouge in north western Haïti (figure 1), was not directly affected by the earthquake, there is an indirect effect as many resources allocated to the area have been relocated to address the more urgent situation in the Capital area. How big an impact this will have for Anse Rouge is at present difficult to evaluate.

A number of NGO's have been, and are, active in the provision of potable water throughout commune Anse Rouge. Ananda Marga Universal Relief Team (AMURT), in particular, has been working closely with a number of local communities to help provide them with clean drinking water, as well as various other services. AMURT has been working in this area with the village communities of Source Chaude, Platon, Zorange, Marie Rose, Lagon, Monbaya, Petit Carinage, Pointe-Des-Mangles, Fres Charles, Coridon, Bonald, Figue, Savane, Woch Kabrit, Laobe, Letang, Petit Saline and Petit Place.

AMURT first started working in the area after Hurricane Jeanne in October 2004, in participation with the World Food Program (WFP), distributing emergency food aid. After assessing the needs of the people in the area through surveys and community meetings AMURT soon began an integrated community based project focusing on the provision of drinking and irrigation water, soil preservation, reforestation, as well as the production and distribution of bio-sand water filters, funded by USAID. AMURT has been active in these areas ever since, as well as starting new projects focusing more closely on health, education, micro-finance and infrastructure related to the supply of drinking water. This latter include the protection of water sources in several villages as well as the construction of reservoirs, fountains and kiosks, and the piping of water to 18 villages.

The initial health surveys, as well as reports from the local health clinics, showed that the incidence of intestinal infection was very high in the area, and this was believed to be due to the poor quality of the drinking water. It was not possible to find any test results of the quality of the water from any of the sources. AMURT has worked closely with the Centre for Affordable Water

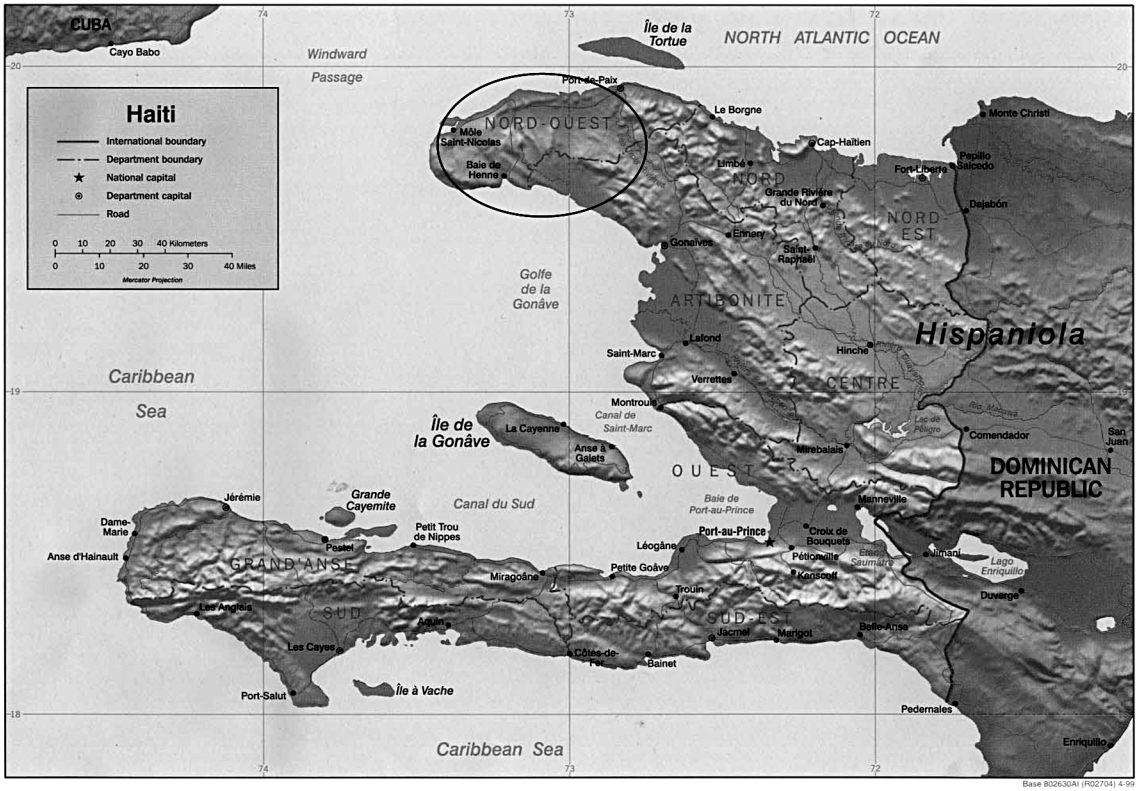

Figure 1.

Systems Treatment (CAWST, www.cawst.org) to help develop a program of locally produced biosand water filters (figure 2) to improve the quality of the drinking water throughout the zone. According to CAWST[1], biosand filters remove more than 99 % of parasites (protozoa and helminths/worms) as well as about 95 % of the bacteria.

Although the situation has improved due to the projects mentioned, the availability of clean water is a problem in most villages if not all.

In order to avoid contamination of the many natural open sources available in the commune, still more need to be capped. AMURT has since 2007, when the study described in this article was conducted, had a project to produce further bio-sand water filters throughout much of commune Anse Rouge to continue to tackle the problem of poor drinking water quality.

In both cases monitoring the water quality is important to identify the order of priority where project resource should be allocated as well as to evaluate the result of a specific activity.

So far, analyses or monitoring of the microbiological quality of the water could not be performed locally. In a few cases, samples were brought to Port au Prince for analysis at a lab there. Given the difficulty of transportation due to very bad roads even before the earthquake (7–8 h on not so smooth roads), this is not realistic on a routine basis.

Aim of this work

The aim of this investigation was to evaluate if a small membrane filter unit in combination with pre-loaded plates with growth media could be used "on- field" for monitoring of the water quality.

Experimental

Materials and equipment

Water sampling: Nasco WHIRL-PAK sterilized water sampling bags or glass jars boiled in water for 10 min.

Filtration: Stainless steel micro filter support, sterilized 0,45 µm membrane filter for 100 % coliform retention and sterilized filtration funnels all from Millipore.

Bacterial growth: SCIL1000169 Compact Dry EC nutritive growth plates from Hyserv for selective detection of E.Coli and total coliform. For the detection of colonies the media contains a colorimetric indicator that exposes E.Coli as blue colonies and other coliforms as red. Total coliforms are counted as the sum of blue and red colonies. The media inhibits growth of non-coliform bacteria.

Sterilization: Alcohol (95 % ethanol), followed by flaming for equipment made of steel. Disinfection gel (Purel) for hands. Sterile water was obtained by boiling sand filtered water for 10 minutes. The water was either cooled in the kettle where it was boiled or in an alcohol treated beaker that was rinsed twice with the boiled water to avoid residue of alcohol.

Analysis

Double samples of each water source to be analyzed were collected in two separate containers and were kept on ice in a cooler until analysis. The ambition was to analyze the sample as soon as possible after collection. Driving in the area is time consuming and as many sources as possible were visited along a given route in order to save time and fuel. When arriving home after sunset, the analysis had to be performed the next day due to lack of light. Accordingly, the analyses reported here, were performed 3–24 h after collection.

The lab bench (the top of a refrigerator, see *figure 3*) was wiped thoroughly with alcohol. The microfilter support was flushed with alcohol and flamed. Sterile water was then passed thru to eliminate backflow of alcohol. This procedure was repeated between samples from different sources but was not considered necessary between double samples from the same source.

The membrane filter was placed on the support with the grided side up and a funnel fitted to the filtration unit. In the developed "best practice" method 100 ml of sample water was filtered from one of the double samples and 20 ml diluted to 100 ml in the funnel was filtered from the other. Two ml sterile water was added to each growth plate and the membrane placed on top, making sure that no air bubbles were formed between the growth medium and the membrane. The plates were incubated at room temperature (~32°C during the day and ~26°C during the night) for 30 ± 3h.

In some cases, were the sample was taken directly from a natural source and expected to be heavily contaminated, 2 ml of the sample (instead of 2 ml sterile water), corresponding to dilution 1:50, was added directly to the compact dry plate and no filtration was performed. The plates were incubated as above.

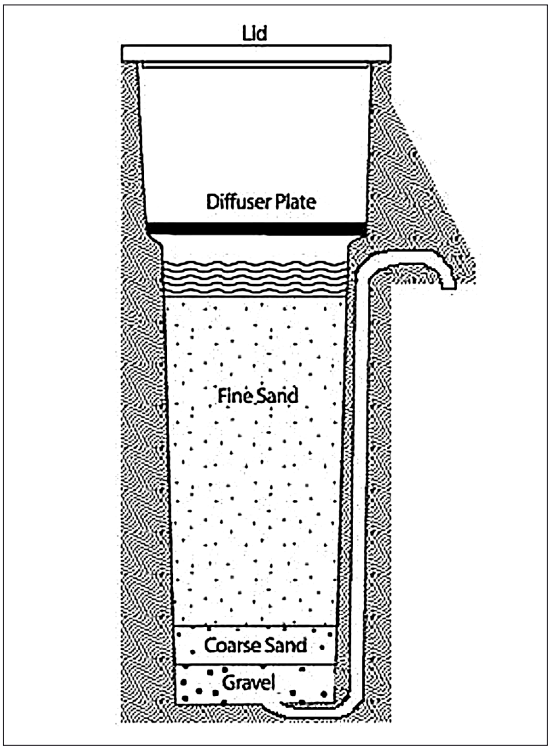

Figure 2. *The Biosand filter is an innovation on traditional slow sand water filters, specifically designed for intermittent or household use. The filter can be produced locally anywhere in the world because it is built using materials that are readily available.*

Figure 3. *The "lab".*

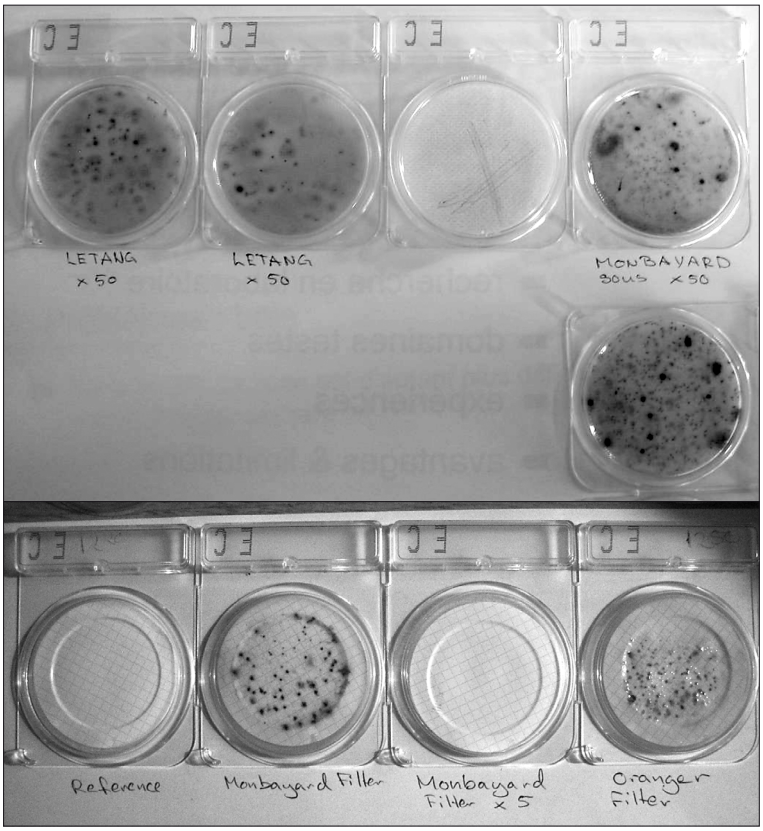

Figure 4. *Example of results after incubation on growth media.*

Results and Discussion

According to WHO's guidelines for Drinking-Water Quality[2], pathogens should be completely absent if the water is to be considered as no threat to the health. When monitoring the microbiological quality of drinking water it is of course desirable to determine the complete spectra of harmful microbes divided into the four groups: bacteria, viruses, helminths and protozoa. Such an evaluation is resource demanding and requires access to a well equipped and proper microbiology lab. At present this is not feasible in Commune Anse Rouge, where all equipment has to be brought from the Capital or from abroad. Instead E.Coli (indicator bacteria recommended by WHO) and total Coliforms were chosen to be monitored as indicators of the presence of harmful microbes. E.coli is normally present in the intestines of people and animals. The presence of this bacterium indicates that the source is exposed to sewage or mammalian fertilizers in some form. In such case, one cannot exclude the presence of infectious bacteria or viruses.

As a reference, the Swedish governmental directives for potable water[3] state that good quality should contain no detectable levels of E.Coli and maximum 50 coliforms in 100 ml water. An acceptable quality level is <10 E. Coli and < 50 coliforms per 100 ml. When 100 ml water contains more than 10 E.Coli or 500 coliforms, the water is considered undrinkable.

The results of the analyses of E.Coli and total coliforms are depicted in table 1. The samples are collected from natural (open) sources, water fountains, wells or biosand filtered water. There were many practical issues connected to this study that make the results uncertain. For some samples the transportation time was long and although they were kept on ice, bacterial growth in the sampling bag cannot be excluded. The same applies to samples that had to be analysed the next day when arriving home after dark. Samples incubation under standard procedures should be performed at 37°C during 24 hours. Due to lack of equipment the incubation was done at room temperature (26–33°C) and the time could vary, as much as 6 h between samples, as reliable sample reading was dependent on daylight.

Microbiological tests are normally conducted in a laboratory reserved for the purpose, where all surfaces are kept clean and all equipment sterilised before use in

Table 1. *Results of microbiological testing of water from various sources.*

Sampling Place	E.coli/100ml	Tot Coliforms /100ml	Rating	Peoples opinion
Reference 1	0	0	clean	–
Letang, open source	50	uncountable	Bad	Bad
Savane, well	0(<50)	250	Accept.	Bad
Coridon, kiosk (captage)	500?	>>500	Bad	Unknown
Petit Carinage, pump	0(<50)	0(<50)	Good	Unknown
Montbayard, open source	>100	uncountable	Bad	Bad
Montbayard, biosand filter	4	60	Accept	Good
Oranger, biosand filter	5	100	Accept	Unknown
Sous Chod, biosand filter	0	0	Good	Good
Tete de Beuf, source	100	>500	Bad	Good
Reference 2	0	0	clean	–

order to avoid contamination. The testing part of this study was conducted in the corner of a kitchen. Between analyses regular kitchen activities were carried out and the room was used for storage of various items. Although none of the regular activities were going on at the same time as sample preparation and the "lab bench" and equipment were meticulously cleaned, air borne contamination was not possible to control. Despite these far from ideal sample preparation and incubation conditions, the repeatability between double samples was without exception very good and shows that the method as such is reliable. However, given the very coarse sample treatment and analysis conditions, the results should only be considered as semi-quantitative. Accordingly the column rating the source as good, acceptable or bad is of greater interest than the colonies count.

It should also be noted that the results only reflect the contamination level of the sample source at the time of the sample collection.

Human and mammalian influence, rain and seasonal variations may change the contamination significantly and rapidly.

In the case of biosand filters, handling of the filter and the amount of usage will also have an impact on the contamination removal efficiency.

Conclusion

This study shows that it is possible to analyse the level of bacterial contamination by membrane water filtration and preloaded growth plates, with a good repeatability, despite very basic lab and analysis conditions.

The tests give a good picture of the amount of contamination on a semi quantitative level (good, bad, acceptable), but should by no means be used for quantitative bacterial count.

This makes the analysis method a useful tool for a coarse monitoring of water quality when handled correctly. If possible, repeated sampling and analysis is recommended at intervals as the analysis results only shows the water quality standard at the time of the analysis.

Sample handling from the point of collection until sample preparation is believed to be the greatest source of error in the reported results due to the conditions described. Since the main goal of this study was to evaluate the method and to get a "general feeling" of the water quality in the area, testing of water from many different sources was beneficial. For more extensive studies on the water quality in preparation for or evaluation of a specific project, it is recommended to perform the analysis as soon after sample collection as possible.

Biosand filters are known (CAWST 2007) to remove more than 99 % of parasites (protozoa and helminths/worms) as well as about 95 % of the bacteria. The exact amount of bacterial removal could not be determined in this study. However, it could be seen that the filters remove some bacteria but are insufficient if the source is heavily contaminated. CAWST accordingly recommends post treatment by chlorination or UV treatment in their instructions to filter users.

Aknowledgement

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References

1 Centre for Affordable Water and Sanitation Technology (CAWST), http://www.cawst.org/ (2007) personal e-mail communication

2 World Health Organisation (2004) Guidelines for Drinking-Water Quality 3rd edition, WHO Geneva

3 Socialstyrelsen Sweden (2005) författningssamling SOSFS 2005:20