Lessons learned from fifteen drinking water treatment program evaluations in Haiti

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Lessons learned from fifteen drinking water treatment program evaluations in Haiti

K. Gallandat & D. Lantagne (USA)

Providing safe drinking water is a priority in emergencies. The 2010 earthquake in Haiti and subsequent cholera outbreak thus led to the implementation of numerous point-of-collection (PoC) and point-of-use (PoU) water treatment programs. We propose to present a synthesis of lessons learned from fifteen evaluations conducted in Haiti between 2010 and 2016, including four PoC and eleven PoU water treatment programs, to better understand which strategies have helped make programs effective and sustainable. Overall, it appears that PoU water treatment technologies were more effective than PoC water treatment programs in the Haitian context. Additionally, evaluation results suggest that programs achieving sustained effectiveness were those that: 1) promoted technologies that were effective and familiar to beneficiaries; 2) had reliable supply chains for water treatment products; 3) worked with local partners; and, 4) included monitoring.

Background

Worldwide, while 71% of the population use a safely managed drinking water service, approximately 844 million people still lack access to a basic drinking water service and at least 2 billion people rely on faecally contaminated water sources, a situation that is estimated to cause over half a million deaths each year (WHO, 2017). In Haiti, in 2015, almost 50% of people living in rural areas and 14% in urban areas still relied on unimproved drinking water sources, a situation that strongly contrasts with the regional average of 96% access to at least a basic water service for Latin America and the Caribbean (WHO/UNICEF, 2017). The earthquake that struck the country on January 12, 2010, killing an estimated 220,000 people and severely damaging infrastructure is likely to have contributed to this observed discrepancy (UN Secretary General, 2011; Gelting et al., 2013).

Providing safe drinking water is a priority in emergency response and became even more crucial in Haiti with the cholera outbreak that begun in October 2010, causing about 700,000 cases and 8,500 deaths in the first three years (Ministère Santé Publique et Population, 2017). The humanitarian response to the combined Haitian emergencies led to more than 50 million US dollars investments in water, sanitation, and hygiene (WASH) interventions between 2011 and 2012, and over 100 non-governmental organizations (NGOs) implementing WASH programs were identified in Haiti in 2011 (Financial Tracking Services, 2011; Gelting et al., 2013). Water treatment programs in this context included both point-of-collection (PoC) and point-of-use (PoU) approaches to delivering safe drinking water, which is in line with the Haitian national strategy developed in the aftermath of the earthquake and cholera outbreak for improving WASH services (Gelting et al., 2013).

The goal of this work was to synthesize lessons learned from fifteen drinking water treatment program evaluations completed in Haiti between 2010 and 2016 in order to improve our understanding of which strategies have helped make such programs effective and sustainable in the phase of transition from relief to recovery.
Methods
We performed a review of fifteen drinking water treatment program evaluations conducted in Haiti between February 2010 and April 2016, including four PoC and eleven PoU water treatment programs. Evaluation metrics included the following:

- **Reported use**: percentage of the surveyed population who self-reported having stored drinking water at the time of the survey and treating that water with the evaluated treatment method or technology;
- **Confirmed use**: percentage of the surveyed population who met the criteria for reported use and had \( \geq 0.2 \) mg/L free chlorine residual (FCR) in their stored drinking water or showed a filter with water in it, depending on the evaluated treatment method or technology;
- **Effective use**: percentage of the surveyed population who met the criteria for reported use and whose microbiological water quality was improved from \( \geq 1 \) CFU/100 mL *Escherichia coli* (*E. coli*) in untreated water to \(< 1\) CFU/100 mL *E. coli* in their treated stored drinking water.

Evaluation results were extracted from each publication or report into a spreadsheet (Microsoft Excel 2016, Redmond, VA, USA) to facilitate comparisons and qualitatively screen for common themes, and prepare synthetic tables.

Results and discussion
**Included programs and evaluations**
Fifteen program evaluations were included in our analysis (Table 1). Evaluated programs were reaching from 70 to 15,000 households, in rural (9), semi-rural (4) and urban (5) settings. Eleven programs promoted household water treatment technologies such as chlorine tablets (n=2), liquid chlorine (2), ceramic pot filters (3), biosand filters (2), and hollow fiber membrane filters (1). Chlorine distribution occurred in three out of four instances as part of a “Safe Water System”, an intervention that consists in providing chlorine, a safe water storage container, and behaviour change communication to improve WASH practices (CDC, 2014). Four additional evaluations assessed centralized water treatment interventions, including chlorine dispensers (1) and automatic chlorinators (3). Chlorine dispenser programs include three components: hardware installed next to a water source that dispenses chlorine, a promoter who refills the dispenser and provides training to community members, and a supply chain for chlorine (Yates et al., 2015). Automatic chlorinators are gravity-fed tablet-feeders installed inline in a piped water supply system and can theoretically operate for weeks without maintenance (Rayner, Yates, et al., 2016).

**Programs effectiveness**
Considering effectiveness results from all selected evaluations (Table 2), it appears that:

- Reported use was higher than effective use;
- Maintenance and/or chlorine supply were particularly challenging for PoC treatment systems;
- Among PoU water treatment options, effective use was highest for Safe Water Systems;
- No clear trends were detected between rural and urban areas based on the selected evaluations;

Each of these observations and lessons learned from successful programs are discussed below.

Reported use across all evaluations ranged from 22% to 92% and was consistently higher than confirmed use (0-92%) and effective use (0-63%) (Table 2). A known limitation of reported use as an evaluation outcome is that it is likely to overestimate actual use of water treatment technologies due to overreporting of “good practices” (Rosa, Clasen and Kelly, 2016). This is highlighted by the systematic discrepancy between reported and confirmed use in evaluation results (Table 2).

Effective use was 13-63% for Safe Water Systems, 8-34% for biosand filters, 27% for hollow fiber membrane filters, 0-29% for ceramic “pot” filters, and 0-5% for PoC chlorination, thus higher for PoU than for PoC treatment options (Table 2). Chlorinators and chlorine dispensers were found to be lacking chlorine tablets or solution in all evaluations (Yates et al., 2015; Rayner, Gallandat, et al., 2016; Rayner, Yates, et al., 2016) and, in some cases, damaged so they would possibly not have been functional even with chlorine supply (Rayner, Gallandat, et al., 2016; Rayner, Yates, et al., 2016). Evaluation results thus suggest that, for PoC water treatment programs to be effective and sustainable, a reliable supply chain for water treatment consumables and hardware replacement parts as well as appropriate community-level management and accountability mechanisms are needed, and this appeared particularly challenging to realize in the Haitian context, possibly due to a political system weakened at all levels by successive emergencies. It is also likely that more capacity building is needed to create an enabling environment for PoC water treatment projects in Haiti (Gelting et al., 2013).
Table 1. Programs and evaluations characteristics.

<table>
<thead>
<tr>
<th>Reference / Program</th>
<th>Context</th>
<th>Program scale</th>
<th>Intervention</th>
<th>Evaluation date(s)</th>
<th>Surveys (#)</th>
<th>Water quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>B Wilner et al., 2017. Deep Springs International Léogâne</td>
<td>Rural and urban</td>
<td>15,000 HH</td>
<td>Safe Water System (liquid chlorine + safe storage + training)</td>
<td>2010-2014</td>
<td>&gt;90,000</td>
<td>TCR</td>
</tr>
<tr>
<td>D Harshfield et al., 2012. Jolivert Safe Water For Families</td>
<td>Rural</td>
<td>4253 HH</td>
<td>Safe Water System (liquid chlorine + safe storage + training)</td>
<td>May-June 2010</td>
<td>626</td>
<td>FCR</td>
</tr>
<tr>
<td>F Rayner et al., 2016a. Clean Water for Haiti</td>
<td>Rural</td>
<td>70 HH</td>
<td>Atabey ceramic “pot” filters</td>
<td>August 2014</td>
<td>44</td>
<td>E. coli, turbidity</td>
</tr>
<tr>
<td>G Rayner et al., 2016a. Asociacion San Lucas d’Haiti</td>
<td>Rural, semi-rural</td>
<td>106 HH</td>
<td>FilterPure ceramic “pot” filters</td>
<td>August 2014</td>
<td>44</td>
<td>E. coli, turbidity</td>
</tr>
<tr>
<td>I Rayner et al., 2016a. Clean Water for Haiti</td>
<td>Rural</td>
<td>406 HH</td>
<td>Local concrete-casing biosand filters</td>
<td>August 2014</td>
<td>44</td>
<td>E. coli, turbidity</td>
</tr>
<tr>
<td>J Rayner et al., 2016a. Pure Water for the World</td>
<td>Rural, semi-rural</td>
<td>92 HH</td>
<td>Plastic-casing HydrAid® biosand filters</td>
<td>August 2014</td>
<td>45</td>
<td>E. coli, turbidity</td>
</tr>
<tr>
<td>K Rayner et al., 2016a. Sawyer filter distributor</td>
<td>Semi-rural</td>
<td>98 HH</td>
<td>Sawyer PointONE™ hollow fiber membrane filters</td>
<td>August 2014</td>
<td>46</td>
<td>E. coli, turbidity</td>
</tr>
<tr>
<td>L Yates et al., 2015. Oxfam America</td>
<td>Rural</td>
<td>30 sites</td>
<td>Chlorine dispensers (at point source)</td>
<td>Nov. 2011</td>
<td>298</td>
<td>FCR, E. coli, turbidity</td>
</tr>
<tr>
<td>M Rayner et al., 2016b. Haiti Southeast Clean Water Project</td>
<td>Rural</td>
<td>79 sites</td>
<td>BioDynamic in-line chlorinators</td>
<td>July-Aug. 2015</td>
<td>180</td>
<td>FCR, E. coli</td>
</tr>
<tr>
<td>N Rayner et al., 2016c. Cartier Charitable Foundation</td>
<td>Rural</td>
<td>7,500 people</td>
<td>Water supply network with chlorination</td>
<td>March-April 2016</td>
<td>40</td>
<td>FCR, E. coli, turbidity</td>
</tr>
<tr>
<td>O Rayner et al., 2016c. Cartier Charitable Foundation</td>
<td>Semi-rural</td>
<td>10,000 people</td>
<td>Water supply network with filtration, chlorination</td>
<td>March-April 2016</td>
<td>159</td>
<td>FCR, E. coli, turbidity</td>
</tr>
</tbody>
</table>

Abbreviations: PoU = point of use. PoC = point of collection. HH = household. TCR = total chlorine residual. FCR = free chlorine residual.
Among PoU water treatment programs, the highest observed effective use rates were achieved with Safe Water Systems and biosand filters (Harshfield et al., 2012; Lantagne and Clasen, 2012, 2013; Rayner, Murray, et al., 2016; Wilner et al., 2017), whereas high breakage rates and absence of supply chain limited use and effectiveness of ceramic “pot” filters (Lantagne and Clasen, 2013; Rayner, Murray, et al., 2016).

Among PoU water treatment interventions, the success of the program run by Deep Springs International (DSI) in Léogâne stands out and provides “an example of linking a development program to relief and rehabilitation and back to development” (Wilner et al., 2017). DSI adopted indeed an adaptive product distribution strategy, from sale of liquid chlorine bottles to free distribution of chlorine tablets in response to the emergencies, back to sale of liquid chlorine bottles (Wilner et al., 2017). Two evaluations of this program conducted 3-8 weeks after the earthquake and 10 months later found consistently high confirmed use of the distributed chlorine products (70-75%) (Lantagne and Clasen, 2013). Other reasons identified as likely to explain the effectiveness of DSI’s chlorine distribution program include chlorine effectiveness for water treatment, familiarity and willingness to use chlorine in the target population, appropriate training on how to use chlorine, local and consistent staffing, and continuous monitoring. Promoting an effective technology, providing appropriate training, having staff with experience in the local context, and carrying out monitoring have also been identified as factors related to the success of other PoU water treatment programs (Rayner, Murray, et al., 2016).

From the selected evaluations, no clear trend appears when comparing effectiveness in rural and urban areas (Tables 1, 2). All PoC water treatment programs that were included in this analysis were implemented in rural areas, however, it is unclear whether this contributed to the observed low effectiveness of these programs.

Considering all selected evaluations and their conclusions, it appears that social, logistic, and technical factors influence effectiveness and are needed to enable successful implementation of water treatment programs (Figure 1).

### Limitations

This synthesis is limited by the selection of evaluations, the fact that only four evaluations out of fifteen assessed PoC water treatment systems, and the cross-sectional nature of most evaluations, with the notable exception of the 4-year-long internal monitoring results from the DSI program (Wilner et al., 2017). Despite these limitations, we believe that selected studies provide a good overview of the strengths and weaknesses of water treatment programs implemented in Haiti in recent years and our findings are consistent with existing literature (Patrick et al., 2013).

<table>
<thead>
<tr>
<th>Program</th>
<th>Intervention</th>
<th>Reported use (%)</th>
<th>Confirmed use (%)</th>
<th>Effective use (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Safe Water System</td>
<td>81-86%</td>
<td>70-75%</td>
<td>46-63%</td>
</tr>
<tr>
<td>B</td>
<td>Safe Water System</td>
<td>Total chlorine residual (TCR) in beneficiaries’ drinking water: 65.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Aquatabs</td>
<td>22%</td>
<td>15%</td>
<td>13%</td>
</tr>
<tr>
<td>D</td>
<td>Safe Water System</td>
<td>46.0%</td>
<td>70-75%</td>
<td>20-33%</td>
</tr>
<tr>
<td>E</td>
<td>Ceramic &quot;pot&quot; filter</td>
<td>25-72%</td>
<td>Not reported</td>
<td>0-20%</td>
</tr>
<tr>
<td>F</td>
<td>Ceramic &quot;pot&quot; filter</td>
<td>27%</td>
<td>20%</td>
<td>0%</td>
</tr>
<tr>
<td>G</td>
<td>Ceramic &quot;pot&quot; filter</td>
<td>50%</td>
<td>43%</td>
<td>0%</td>
</tr>
<tr>
<td>H</td>
<td>Biosand filter</td>
<td>23-53%</td>
<td>Not reported</td>
<td>8-28%</td>
</tr>
<tr>
<td>I</td>
<td>Biosand filter</td>
<td>80%</td>
<td>70%</td>
<td>20%</td>
</tr>
<tr>
<td>J</td>
<td>Biosand filter</td>
<td>78%</td>
<td>76%</td>
<td>34%</td>
</tr>
<tr>
<td>K</td>
<td>Sawyer filter</td>
<td>57%</td>
<td>54%</td>
<td>27%</td>
</tr>
<tr>
<td>L</td>
<td>Chlorine dispenser</td>
<td>55%</td>
<td>9%</td>
<td>5%</td>
</tr>
<tr>
<td>M</td>
<td>Chlorinator</td>
<td>68%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>N</td>
<td>Chlorinator</td>
<td>63%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>O</td>
<td>Filter + chlorinator</td>
<td>72-92%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 2. Evaluation results: reported, confirmed, and effective use.
Conclusions
We provided a synthesis of fifteen drinking water treatment program evaluations conducted in Haiti between 2010 and 2016, in the aftermath of the earthquake and cholera outbreak. Evaluated programs promoted PoC or PoU water treatment approaches, were implemented in a variety of rural and urban settings, and operated at different scales. Overall, we found that the promotion of PoU water treatment options was more effective and sustainable than PoC water treatment programs in the Haitian context. Additionally, evaluation results suggest that PoU water treatment programs achieving sustained effectiveness are those that:

- Promoted technologies that were effective and familiar to beneficiaries;
- Had reliable supply chains for water treatment products and/or replacement parts;
- Worked with local partners or experienced staff;
- Included monitoring and/or follow-up on program activities.

While the focus of this work was on the Haitian context, lessons learned can likely be applied to different countries facing similar challenges and we recommend considering the above factors for the implementation of drinking water treatment programs.

Longer-term longitudinal studies – which could stem from internal program monitoring – are needed to better assess the sustainability of water treatment interventions in the Haitian post-emergency context.

References


UN Secretary General (2011) ‘Humanitarian assistance, emergency relief, rehabilitation, recovery and reconstruction in response to the humanitarian emergency in Haiti, including the devastating effects of the earthquake’. Available at: http://repository.un.org/handle/11176/290679.


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