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Lessons learned from fifteen drinking water treatment program evaluations in Haiti

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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 ≥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 ≥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.

Reference / Program		Context	Program scale	Intervention	Evaluation date(s)	Surveys (#)	Water quality
A	Lantagne & Clasen, 2012, 2013. Deep Springs International Léogâne	Rural and urban	2880 HH	Aquatabs (relief) or liquid chlorine (recovery) + storage containers + training	Feb.-March & Oct.-Nov. 2010	325	FCR, *E. coli,* turbidity
B	Wilner *et al.,* 2017. Deep Springs International Léogâne	Rural and urban	15,000 HH	Safe Water System (liquid chlorine + safe storage + training)	2010-2014	>90,000	TCR
C	Lantagne & Clasen, 2012, 2013. Haïti Response Coalition	Urban informal settlement	Unknown	Non-food items kits including Aquatabs	Feb.-March & Oct.-Nov. 2010	87	FCR, *E. coli,* turbidity
D	Harshfield *et al.,* 2012. Jolivert Safe Water For Families	Rural	4253 HH	Safe Water System (liquid chlorine + safe storage + training)	May-June 2010	626	FCR
E	Lantagne & Clasen, 2012, 2013. FilterPure	Urban	~350 HH	FilterPure ceramic “pot” filters + training	Feb.-March & Oct.-Nov. 2010	71	FCR, *E. coli,* turbidity
F	Rayner *et al.,* 2016a. Clean Water for Haiti	Rural	70 HH	Atabey ceramic “pot” filters	August 2014	44	*E. coli,* turbidity
G	Rayner *et al.,* 2016a. Asociacion San Lucas d’Haiti	Semi-rural	106 HH	FilterPure ceramic “pot” filters	August 2014	44	*E. coli,* turbidity
H	Lantagne & Clasen, 2012, 2013. Clean Water for Haiti	Urban	238 HH	Biosand filters + training	Feb.-March & Oct.-Nov. 2010	98	FCR, *E. coli,* turbidity
I	Rayner *et al.,* 2016a. Clean Water for Haiti	Rural	406 HH	Local concrete-casing biosand filters	August 2014	44	*E. coli,* turbidity
J	Rayner *et al.,* 2016a. Pure Water for the World	Rural, semi-rural	92 HH	Plastic-casing HydrAid® biosand filters	August 2014	45	*E. coli,* turbidity
K	Rayner *et al.,* 2016a. Sawyer filter distributor	Semi-rural	98 HH	Sawyer PointONE™ hollow fiber membrane filters	August 2014	46	*E. coli,* turbidity
L	Yates *et al.,* 2015. Oxfam America	Rural	30 sites	Chlorine dispensers (at point source)	Nov. 2011	298	FCR, *E. coli,* turbidity
M	Rayner *et al.,* 2016b. Haiti Southeast Clean Water Project	Rural	79 sites	BioDynamic in-line chlorinators	July-Aug. 2015	180	FCR, *E. coli*
N	Rayner *et al.,* 2016c. Cartier Charitable Foundation	Rural	7,500 people	Water supply network with chlorination	March-April 2016	40	FCR, *E. coli,* turbidity
O	Rayner *et al.,* 2016c. Cartier Charitable Foundation	Semi-rural	10,000 people	Water supply network with filtration, chlorination	March-April 2016	159	FCR, *E. coli,* turbidity

Abbreviations: PoU = point of use. PoC = point of collection. HH = household. TCR = total chlorine residual. FCR = free chlorine residual.

Table 2. Evaluation results: reported, confirmed, and effective use.

Program	Intervention	Reported use (%)	Confirmed use (%)	Effective use (%)
A	Safe Water System	81-86%	70-75%	46-63%
B	Safe Water System	*Total chlorine residual (TCR) in beneficiaries' drinking water: 65.3%*		
C	Aquatabs	22%	15%	13%
D	Safe Water System	46.0%	*Diarrheal reduction in children <5 years: 70%*	
E	Ceramic "pot" filter	25-72%	*Not reported*	0-20%
F	Ceramic "pot" filter	27%	20%	0%
G	Ceramic "pot" filter	50%	43%	29%
H	Biosand filter	23-53%	*Not reported*	8-28%
I	Biosand filter	80%	70%	20%
J	Biosand filter	78%	76%	34%
K	Sawyer filter	57%	54%	27%
L	Chlorine dispenser	55%	9%	5%
M	Chlorinator	68%	0%	0%
N	Chlorinator	63%	0%	0%
O	Filter + chlorinator	72-92%	0%	0%

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 (Lantagne and Clasen, 2012, 2013; Wilner *et al.*, 2017): 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).

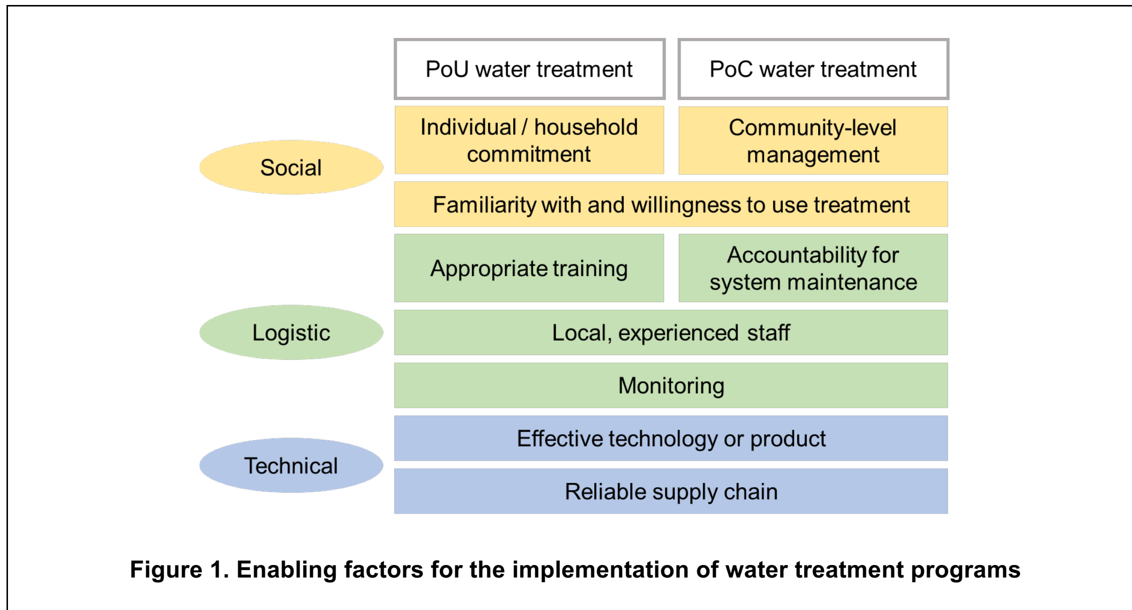

Figure 1. Enabling factors for the implementation of water treatment programs

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

CDC (2014) 'Safe Water System'. Available at: https://www.cdc.gov/safewater/ (Accessed: 15 February 2018).

Financial Tracking Services (2011) 'Response plan/appeal snapshot. Funding progress by cluster/sector.' Available at: https://fts.unocha.org/appeals/385/summary (Accessed: 15 February 2018).

Gelting, R. *et al.* (2013) 'Water, Sanitation and Hygiene in Haiti: Past, Present, and Future', *The American Journal of Tropical Medicine and Hygiene*, 89(4), pp. 665–670. doi: 10.4269/ajtmh.13-0217.

Harshfield, E. *et al.* (2012) 'Evaluating the Sustained Health Impact of Household Chlorination of Drinking Water in Rural Haiti', *The American Journal of Tropical Medicine and Hygiene*, 87(5), pp. 786–795. doi: 10.4269/ajtmh.2012.12-0010.

Lantagne, D. and Clasen, T. (2012) 'Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Results from Nepal, Indonesia, Kenya, and Haiti', *Environmental Science & Technology*, 46(20), pp. 11352–11360. doi: 10.1021/es301842u.

Lantagne, D. and Clasen, T. (2013) 'Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake', *The American Journal of Tropical Medicine and Hygiene*, 89(3), pp. 426–433. doi: 10.4269/ajtmh.13-0179.

Ministère Santé Publique et Population (2017) 'Rapport du Réseau National de Surveillance: Sites Choléra - 52e semaine épidémiologique 2017'. Available at: https://mspp.gouv.ht/site/downloads/Profil%20statistique%20Cholera%2052eme%20SE2017version%20finale.pdf.

Patrick, M. *et al.* (2013) 'Access to Safe Water in Rural Artibonite, Haiti 16 Months after the Onset of the Cholera Epidemic', *The American Journal of Tropical Medicine and Hygiene*, 89(4), pp. 647–653. doi: 10.4269/ajtmh.13-0308.

Rayner, J., Murray, A., *et al.* (2016) 'Evaluation of household drinking water filter distribution programs in Haiti', *Journal of Water, Sanitation and Hygiene for Development*, 6(1), pp. 42–54. doi: 10.2166/washdev.2016.121.

Rayner, J., Gallandat, K., *et al.* (2016) 'Evaluation of "Providing Safe Drinking Water and Sanitation to Communities in Haiti": Final Report'.

Rayner, J., Yates, T., *et al.* (2016) 'Sustained effectiveness of automatic chlorinators installed in community-scale water distribution systems during an emergency recovery project in Haiti', *Journal of Water, Sanitation and Hygiene for Development*, 6(4), pp. 602–612. doi: 10.2166/washdev.2016.068.

Rosa, G., Clasen, T. and Kelly, P. (2016) 'Consistency of Use and Effectiveness of Household Water Treatment Practices Among Urban and Rural Populations Claiming to Treat Their Drinking Water at Home: A Case Study in Zambia', *The American Journal of Tropical Medicine and Hygiene*, 94(2), pp. 445–455. doi: 10.4269/ajtmh.15-0563.

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.

WHO (2017) 'Fact sheet: Drinking water'. Available at: http://www.who.int/mediacentre/factsheets/fs391/en/.

WHO/UNICEF (2017) 'JMP: Rural and urban drinking water service levels (2000 and 2015)'. Available at: https://washdata.org.

Wilner, L. *et al.* (2017) 'Sustained use in a relief-to-recovery household water chlorination program in Haiti: comparing external evaluation findings with internal supervisor and community health worker monitoring data', *Journal of Water Sanitation and Hygiene for Development*, 7(1), pp. 56–66. doi: 10.2166/washdev.2017.035.

Yates, T. M. *et al.* (2015) 'Effectiveness of Chlorine Dispensers in Emergencies: Case Study Results from Haiti, Sierra Leone, Democratic Republic of Congo, and Senegal', *Environmental Science & Technology*, 49(8), pp. 5115–5122. doi: 10.1021/acs.est.5b00309.

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