Travis Yates
Jelena Allen
Myriam Leandre Joseph
Daniele Lantagne

Short-term WASH interventions in emergency response

A systematic review

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Water and sanitation

3ie International Initiative for Impact Evaluation

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About this review

Short-term WASH interventions in emergency response: a systematic review was submitted in partial fulfilment of the requirements of grant SR7.1077 awarded under Systematic Review Window 7. This review is available on the 3ie website. 3ie is publishing this technical report as received from the authors; it has been partially formatted to 3ie style. Tables and figures have not been changed. 3ie will also publish a summary report of this review, designed for use by decision makers, which is forthcoming.

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Travis Yates
Tufts University

Jelena Allen
Consultant

Myriam Leandre Joseph
Consultant

Daniele Lantagne
Tufts University

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Summary

Background

Water, sanitation and hygiene (WASH) interventions are needed in nearly all emergency contexts. From natural disasters to conflict zones and disease outbreaks, the aim of emergency WASH interventions is to reduce the risk of disease by providing safe water, reducing open defecation and promoting hygiene practices.

There are increasing numbers of people affected by natural disasters and currently there are a record number of displaced persons in need. Despite regular use, emergency WASH strategies have a limited evidence-base. Delivering assistance is generally prioritized over research, which traditionally has led to 'best practice' rather than 'evidence-based' programming. Additionally, emergency WASH interventions are often adapted from development settings that may not be appropriate for the timeframe, scale and approach needed in emergency settings. An improved understanding of the efficacy and effectiveness of emergency WASH interventions is necessary to meet the increasing needs of populations impacted by emergencies.

Objectives

The objective of this review was to assess the outcomes and impacts of short-term emergency WASH interventions in low and middle-income countries (LMIC) through a systematic review process. Specific goals were to address five knowledge gaps in emergency WASH interventions:

1. What are the effects on use of service?
2. What are the effects on health-related outcomes?
3. What are the non-health related outcomes (i.e. psycho-social, quality of life, behaviour change)?
4. What are the programmatic barriers or facilitators to implementation?
5. What is the cost-effectiveness?

Methods

A systematic review process was used to capture the available research in the emergency WASH sector from published and unpublished 'grey' literature. Published literature was searched with keyword strings in nine peer-reviewed databases. Grey literature, mostly held by non-governmental organizations that respond to WASH emergencies, was collected though website searching and direct solicitation.

The scope of the review included populations affected by an emergency in a low or middle-income country and published between 1995-2016. Both quantitative and qualitative studies were eligible for inclusion.

Studies were filtered independently by two reviewers by title, then abstract and full text. Biases were assessed and information was coded and double-screened for accuracy.

Results were grouped by intervention and summarized based on reported outcomes originating from different data sources through narrative synthesis. Themes common

to each intervention were assessed and summarized within the scope of use, health and non-health factors from all three data sources. Evidence was assessed and summarized to appreciate bias, effect size and consistency among additional factors.

Results

Through searching and solicitation, 15,026 documents were identified. In total, 106 studies with 114 unique evaluations were included in the review. Within the scope of WASH, 13 specific interventions were identified, including water source treatments, household water treatment, sanitation, hygiene promotion and environmental hygiene. Twelve of these interventions were found to be theoretically able to improve WASH conditions and reduce the risk of disease transmission. Outcomes varied by intervention and evaluation method; thus direct comparison between intervention and meta-analysis was not carried out. A summary of findings for each intervention is described in Table 1.

Table 1: Summary of findings by intervention

Intervention	Summary of Findings
Saltwater Intrusion Cleaning	Evidence suggests that well pumping after a saltwater intrusion was **NOT** effective. Seasonal rains reduce salinity naturally and faster than pumping.
Well Disinfection	Pot chlorination with pressed chlorine tablets can maintain free chlorine residual (FCR) for 3-4 days in a well; pot chlorination with powdered chlorine also had some success. (Inconsistent evaluation methods)
Source Treatment – Large Scale	Bulk Water Treatment – Well-established treatment methods (not evaluated) requires well-trained staff and regular monitoring. Water Trucking – A common activity in acute emergencies. FCR and microbiological contamination were inconsistent with limited evaluations.
Source – Treatment Small-Scale	Variation in reported, confirmed and effective use – context specific. (3 case studies). Speaking with Promoter and easy access to Dispenser associated with increased use.
Household Water Treatment – Chlorine Tablets	Reported use range: 1-84%, n=9. Confirmed use range: 1-87%; n=11. Chlorine taste/smell, ease-of-use and familiarity influence use and acceptance.
Household Water Treatment (HWT) – Liquid Chlorine	Reported use ranged: 6-88%; n=6. Confirmed use ranged: 1-69%; n=6. Familiarity of liquid chlorine was beneficial; flexibility to be scaled-up from development projects.
HWT – Flocculant/ Disinfectants	Reported use ranged: 6-83%, n=3. Confirmed use ranged: 4-95%, n=6. Taste and ease of use varied, consistently preferred over other HWT options.
HWT – Filtration	Acute use (<3 months since emergency) ranged: 53-100%, n=3, Sustained use (≥3 months since emergency) ranged: 0-96%, n=7, although effective use was lower. Improved taste consistent among populations.

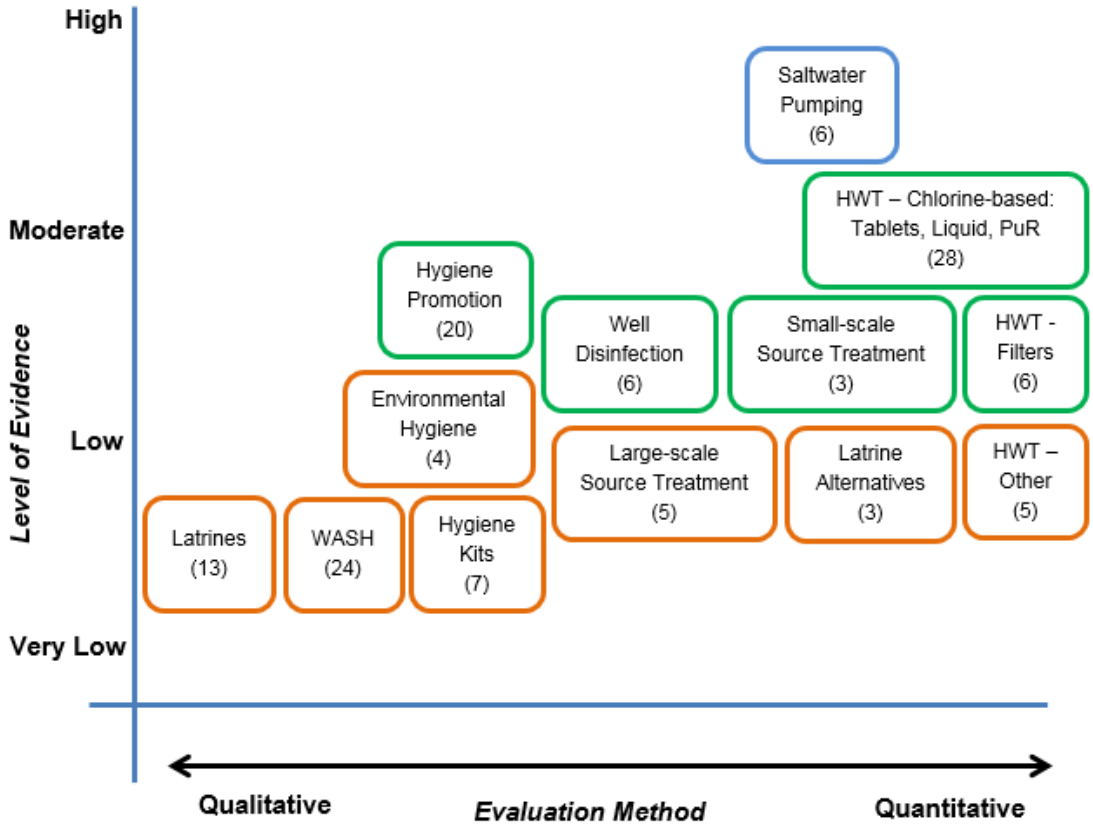
Intervention	Summary of Findings
HWT – Other	Limited evaluations and impact. Not widely used in acute emergency response, ease of use and community acceptance reported.
Sanitation – Output-Driven	Positive health aspects. Latrines: Targeting vulnerable populations increased use. Latrine alternatives: Reported use averaged: 59% (range: 8-91%); interventions promoting use in the home had higher rates of use. Ease of access, cleanliness and privacy are important non-health considerations.
Hygiene Promotion	Descriptions and documentation of disease or disease risk reductions. Personal communication and radio are preferred and trusted by the community. Community trust and ownership important factors.
Hygiene Kits	Reported use of contents is high. Quantity of materials and timeliness of distribution are key factors.
Environmental Hygiene	Unclear reduction in disease transmission risk, yet high community expectations of effectiveness. Chlorine concentration monitoring is necessary.
WASH Package	Anecdotal descriptions of disease reductions, behavior adjustments and psychosocial support; staffing and timing also important factors.

State of evidence

Interventions from 39 different countries were included, with Haiti as the most evaluated (22). Grey literature represented 50% of the included studies (57/114). The majority of studies (77%) had a high risk of bias. Interventions within each category varied and evaluations were commonly weak cross-sectional designs, with only 9% of studies (10/106) having a control group.

Overall, the evidence remains low and lacking. The quality of evidence is shown against the methodology identified within each intervention in Figure 1. The level of evidence was determined by the study designs, biases, effect size, consistency and generalizability. Water interventions had more evaluations, better evidence and were assessed more quantitatively. Hygiene, sanitation and WASH Package interventions had lower quality and had more qualitative evaluations. Evidence *against* pumping wells contaminated with saltwater was the only intervention with a high level of evidence with consistent recommendations.

Figure 1: State of evidence



(#) is the number of interventions per category, n=130 (16 documents included in more than one intervention)

Some of the most commonly implemented WASH interventions in emergencies were not well documented or were under-researched. Additional research is needed for: bucket chlorination, bulk water treatment, handwashing, household spraying, water trucking, environmental clean-up and formal economic analysis of all WASH interventions. With some interventions, bulk water treatment for example, efficacy of the treatment is not doubted; however, the consistency and impact at the household level could be further explored.

Discussion

To determine the efficacy and effectiveness of emergency WASH interventions, we investigated five research objectives:

Objective 1: Use of interventions in emergency WASH emergency

Emergency WASH interventions are implemented in a variety of contexts and there is no intervention that is universally applicable in all circumstances. Through this review, 13 WASH interventions were identified, 12 were theoretically able to improve WASH conditions and reduce the risk of disease transmission. Well pumping to reduce salinity after a coastal flood was the only intervention that had evidence that it did not improve WASH conditions. Additionally, although there was less evidence, household spraying was also suspected to be ineffective with negative social effects.

For the remaining interventions, effectiveness varied and outcomes were conditional based on the emergency context, program implementation and social preferences.

Objective 2: Health impact in emergency WASH interventions

Evidence that WASH interventions reduce the disease burden in an emergency is limited, but described through: reduced disease risk and reduced transmission risk.

Reduced Disease Risk – Interventions directly measuring a health impact were few and mostly in HWT - PuR, chlorine tablet, solar disinfection (SODIS) and safe storage - and assessed as low or very low quality of evidence as there were only one to two evaluations for each intervention type. While a disease risk reduction was observed in all interventions, often significantly, the limited number of studies restricted broader application of results. Additionally, latrine use and a community led total sanitation (CLTS) intervention also documented reduced disease risk, but were also very low quality evidence.

Reduced Transmission Risk – Interventions that evaluate the risk of transmission through non-health indicators were more often evaluated in emergencies. Interventions documenting free chlorine residual in drinking water are known to reduce disease transmission and had moderate quality of evidence, including: well disinfection, Dispensers and HWT (liquid chlorine, chlorine tablets and PuR). Environmental hygiene interventions using chlorine to clean jerricans reduced short-term transmission risk with measurable FCR but had low quality of evidence.

Objective 3: Impact of non-health related outcomes

In the review, five community perceptions and preferences that affect the success of emergency WASH interventions were established.

Taste and Smell – Aesthetic changes to water taste and smell from HWT product use can hinder use (particularly with chlorine-based HWT products) or encourage use in certain populations.

Preferred Communication – Radio and face-to-face communication were consistently reported as “most trusted” and/or “most valued.”

Overestimation of Effectiveness – Community perception overestimates the outcomes and impacts of some WASH interventions, particularly interventions with less community involvement.

Trust/Fear – Social mobilization and open communication between the community members and responders can build trust and community cohesion. By listening to communities’ concerns (i.e. fears, stigmas), responders can adapt and improve programs.

Ease of Use – Communities preferred interventions that were simple and easy to use, which require minimal steps and behavior change.

Objective 4: Program design and implementation characteristics associated with more effective programs

Six program design and implementation characteristics were identified in the review as associated with more effective programs; these include, simplicity, timing, experienced staff, communication, being community driven and having linkages to development programs.

Simplicity – Some of the simplest interventions, including household water treatment (basic filters, safe water storage with the provision of jerricans) and jerrican disinfection had reported high use and positive health impact. These incremental improvements required little to no promotion and reduced the risk of disease. The success of simple interventions is attributed to the fact little behavior change is required by the beneficiaries.

Timing – Prepositioned stock, quick release of funding and early triggers for rapid scale up were important factors leading to an effective response, particularly with hygiene kit distribution and HWT interventions.

Experienced Staff – Experienced staff that could rapidly scale up appropriate interventions were identified as critical to success in Dispensers and WASH Package programs.

Communication – Multiple modes of communication that reinforce key messages, with strong radio and face-to-face components and simple clear instructions, were found to be most preferred by communities.

Community driven – Engagement in the community empowers and builds trust. Community driven interventions can increase awareness, trigger behavior change and find local solutions (i.e. CLTS, Community Led Ebola Management and Eradication (CLEME)).

Linking Development and Relief – Development contexts with weak WASH infrastructure, overcrowding and poor hygiene practices have high potential for disease transmission and often have on-going WASH programming. Linking development programs to emergency response activities was found to be successful for chlorine projects in Haiti and Madagascar and a CLTS project in Liberia.

Objective 5: What is the cost-effectiveness of interventions?

Cost-effectiveness of WASH interventions in emergencies was not able to be assessed. There were minimal economic outcomes or cost related data and information was inconsistent and too heterogenous for analysis.

Implications for policy and practice

From the review, three implications for policy and practice should be considered: field evidence, expectations of reporting and evaluation; and enabling conditions.

Field Evidence – The strength and utility of practical field evidence came from collecting consistent data across multiple contexts, as opposed to because it had strong evaluation design. As such, low quality evaluations and grey literature contributed significantly to the review and are a valuable resource in establishing field evidence.

Expectations of Reporting and Evaluation – The indicators measured across interventions were inconsistent and varied, and most evaluations did not attempt to measure impacts of disease reduction and cost-effectiveness. This is likely due to lack of resources, time or evaluation expertise in emergency response. It is recommended to continue to collect outcome indicators, but to collect consistent indicators to facilitate comparison. It is also recommended to dedicate specific resources and funding to collect impact indicators in an ethical manner in order to broaden the evidence base available.

Enabling Conditions – Previously implemented development projects, beneficiary knowledge and preparedness are important considerations in emergencies. Improved understanding of previous development projects and social influences could improve emergency interventions.

Research implications

There is ample opportunity to fill research gaps identified and advance the knowledge base of WASH in emergencies. Suggestions for future research include:

Consistent Field Non-experimental Design Evaluations – Non-experimental design studies (such as case studies) provided valuable evidence for this review, as long as they had consistent indicators and were conducted with similar methodology across differing contexts. Methods that use similar evaluations in different contexts highlight both differences in use and barriers and facilitators for a specific intervention. It is recommended additional consistent field research be conducted on the under-researched interventions identified in this review.

Research Methods with Control Groups in Emergencies – Research methodology that requires significant time and resources (e.g. randomized control trials) are generally not appropriate for emergency WASH interventions. Several practical research methods, with control groups, for emergency contexts include: stepped-wedge, retrospective control groups and identifying natural experiments.

WASH Package Evaluations – WASH Package interventions are complex and pose difficult considerations for research. However, the lack of any published WASH Package evaluation is representative of a disconnect between academic research and field evaluations, and research on WASH Package interventions is needed.

Behavior Change Research – The technical efficacy of most interventions is well established from the laboratory or development settings; the ‘human factor’ remains a primary hurdle to many interventions. Evaluating how the beneficiaries use the WASH intervention, what they like and don’t like and other barriers or facilitators is necessary to understand the strengths and weaknesses of interventions.

Best Practice Comparisons – There are numerous best practice and guidance documents available (from United Nations (UN) agencies, donors and individual Non-governmental organizations (NGOs)) on how to conduct WASH in emergency activities. An analysis to identify inconsistencies between what is considered ‘best practice’ and what is ‘evidence-based’ is needed to align actives across the sector.

Conclusion

We found that some WASH interventions are successful at increasing access to water and sanitation services and reducing the risk of disease; however, program design, implementation characteristics and community aspects are critical to program success. While we need more research on specific WASH interventions that are under-researched, it is anticipated that the implementation and social aspects would remain critical, especially for more complex WASH interventions. Improved understanding of previous development projects and social influences could also improve emergency interventions. Overall, in emergency contexts, there is low quality but consistent evidence that WASH interventions reduce disease risk through improved access to services. However, improving the field evidence for emergency WASH interventions remains imperative to improve strategies as humanitarian needs continue to increase.

Contents

List of figures and tables

Abbreviations and acronyms

ACF	Action Contre La Faim (Action Against Hunger)
CDC	Centers for Disease Control and Prevention
CATS	Community Approach to Total Sanitation
CFR	Case Fatality Rate
CHW	Community Health Worker
CLTS	Community Led Total Sanitation
CLEME	Community Led Ebola Management and Eradication
DALY	Disability Adjusted Life-Year
D.R.C.	Democratic Republic of Congo
FCR	Free Chlorine Residual
FGD	Focus Group Discussion
HH	Household
HTH	High Test Hypochlorite
HWT	Household Water Treatment
IRC	International Rescue Committee
IEC	Information, Education and Communication
KII	Key Informant Interview
LMIC	Low and Middle-Income Country
MSF	Médecins sans Frontières
NFI	Non-Food Item
NGOs	Non-governmental Organization
OR	Odds Ratio
PHAST	Participatory Hygiene and Sanitation Transformation
PICOS	Populations, Interventions, Comparisons, Outcomes and Study Types
RCT	Randomized Control Trial
RR	Risk Ratio
SODIS	Solar Disinfection
UV	Ultra-violet
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
UN	United Nations
UNHCR	United Nations High Commissioner for Refugees
Unicef	United Nations Children’s Emergency Fund

1. Background

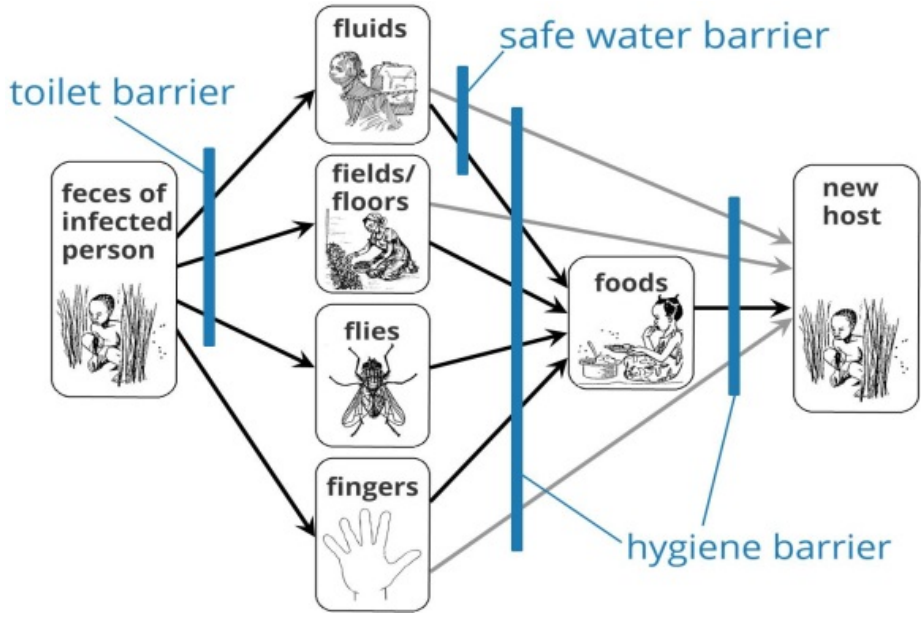
1.1 Description of the problem

In almost all emergency contexts, such as natural disasters, conflicts and disease outbreaks, there is a basic need to establish access to water, sanitation and hygiene (WASH) (Connolly et al. 2004, Toole 1995, 1996). According to the *Humanitarian Charter and Minimum Standards in Humanitarian Response (Sphere Project 2011):*

> "Water and sanitation are critical determinants for survival in the initial stages of a disaster. People affected by disasters are generally much more susceptible to illness and death from disease, which to a large extent are related to inadequate sanitation, inadequate water supplies and inability to maintain good hygiene."

Emergency WASH interventions should provide access to safe water and sanitation and promote good hygiene practices with dignity, comfort and security (Sphere Project 2011). The overall aim of all emergency WASH interventions is to promote safe practices that reduce preventable waterborne and communicable diseases (Sphere Project 2011). A visual depiction of how WASH interventions can interrupt primary disease transmission routes is provided by the F-Diagram (Figure 2).

Figure 2: F-Diagram (Water 1st International 2015)



1.1.1 Increasing needs

Emergency events where WASH interventions are needed – including natural disasters, conflict and disease outbreaks – are occurring at increasing rates and affecting an increasing number of people.

> *Natural Disasters* – Natural disasters (i.e. earthquakes, hurricanes, flooding events, disease outbreaks or droughts) affect more than 200 million people annually (EM-DAT 2014). Climate change is expected to increase the scale and frequency of natural disasters, and the rapidly increasing urban and slum

populations in disaster prone regions are expected to increase the number of people impacted by natural disasters (Walker, Glasser, and Kambli 2012).

Conflict – Currently, 1.5 billion people are potentially threatened by conflict and violence (Institute for Economics and Peace 2014, IISS 2015). As a result, in 2015 there were more than 60 million displaced persons (refugees and internally displaced persons (IDPs)) worldwide, the highest number ever recorded (UNHCR 2015). This large number causes enormous strain on limited funds and resources.

Disease Outbreaks – An outbreak is declared when the number of disease cases increases above what would normally be expected in a defined community, geographical area or season (GIDEON 2016). Between 1980 and 2013, 12,102 outbreaks of 215 human infectious diseases, including greater than 44 million cases, were reported into the Global Infectious Disease and Epidemiology Online Network from 219 nations (Smith et al. 2014). The total number of outbreaks and the diversity of causal diseases (the number of diseases causing outbreaks) have both increased over time ($p<0.0001$).

As there is a growing number of people at risk and in need, evidence-based emergency WASH strategies are needed to support decision makers (Darcy et al. 2013, Parkinson 2009). This review is a systematic review of WASH interventions in emergencies.

The scope of this review was to investigate the outcomes and impacts of WASH interventions in emergencies in low- and middle-income countries (LMIC). In the following sub-sections, WASH interventions are generally described. Additionally, theories of change for, and actors involved in, emergency WASH response are described.

1.2 Description of the intervention

Emergency WASH interventions differ from development interventions because of the speed, scale and approach that are taken in emergency response activities. The needs of emergency affected populations are often immediate, requiring rapidly increasing access to water and sanitation services while promoting activities that may be unfamiliar to the population (e.g. treating water with chlorine for the first time). The scale of emergencies can be in the millions of people, such as with the current Syrian refugee crisis. In terms of approach, emergency WASH interventions are also typically short-term and often unsustainable without significant external funding. The main components of emergency WASH interventions include water, sanitation and hygiene interventions. Within the spectrum of WASH, 13 more specific interventions common in emergencies are described:

Well or spring repair – Access to potable water is critical for disaster-affected populations. Existing water sources can be damaged or rendered no long potable because of a disaster, or overwhelmed by a sudden influx of displaced persons. In the acute emergency, there is rarely time for new construction of water points. Thus, the most common water access interventions are to repair or clean existing

wells or springs. Water sources cleaning or repair are often one-time interventions that restore water points familiar to the local populations.

- **Pumping Saltwater Intrusion** – Saltwater flooding can occur because of a hurricane, storm surge or tsunami. Agencies pump wells to remove saltwater and debris, followed by chlorination to disinfect the well.
- **Well Disinfection –** Chlorine is used to disinfected contaminated wells. Liquid and powdered chlorine are both used; simple devices that help to release the chlorine more slowly can also used to provide a protective free chlorine residual (FCR) over an extended time.

Source-based water treatment – The aim of source-based water treatment is to improve water quality at the point of collection. Most source-based treatments use chlorine solution or chlorine tablets to treat water; they may also include processes that help to reduce the 'cloudiness' or turbidity of the water.

- **Large-scale Source-based Water Treatment –** 'Bulk water treatment' is a general term that includes systems that are operated by agencies without beneficiary involvement, often able to treat between 1,000 and 15,000 L/hour of water. Treatment and storage could be in semi-permanent tanks, water trucking, or temporary bladders.
- **Small-scale Source-based Water Treatment –** On an individual beneficiary level, interventions include: bucket chlorination and chlorine Dispensers. Bucket chlorination is when a dedicated staff member is stationed by the water source and adds a dose of chlorine directly into the recipient's water collection container. Chlorine Dispensers are hardware installed next to a water source so recipients can collect water and then turn the Dispenser valve to dose their own container.

Household water treatment – Household water treatment (HWT) interventions are used in contexts with access to water, but where water quality is not adequate. HWT interventions are dependent on beneficiary understanding and use of distributed materials. Often jerricans or buckets are distributed concurrently to encourage safe storage of treated water.

- **Chlorine-based HWT –** The most common HWT products distributed in emergencies are chlorine products, such as liquid solutions or tablets (i.e. Aquatabs®) and flocculent/disinfectant sachets, such as P&G® Purifier of Water also known as 'PuR.' Effective treatment dose depends on the initial water quality and container size.
- **Filters –** Water filters, including ceramic or hollow fiber filters, are usually easy to use and remove harmful microbes per their effective pore size. Biosand and pot filters are less common in emergency response due to challenges with distribution due to size and fragility.
- **Other HWT –** Solar disinfection (SODIS), boiling, flocculation and safe storage are HWT options also used to improve household drinking water.

Sanitation **–** Sanitation interventions in outbreak response aim to isolate feces from the environment. Minimizing open defecation and ensuring proper management of feces in a latrine or latrine alternative reduces exposure to infectious waste and can reduce ongoing disease transmission.

- ***Latrines*** – Latrines are temporary or semi-permanent structures made from cement, plastic, bricks or local materials intended to isolate feces from the environment. Latrines are constructed for individual households or in clusters to serve large communities or camps.
- ***Latrine Alternatives*** – Latrine alternatives are used as a temporary solution in the initial days after an emergency or where latrines cannot be built. Beneficiaries defecate into bags and dispose of them through a collection system established by an emergency agency.

Hygiene – Hygiene interventions aim to educate the population, promote safe practices and reduce the risk of disease from the environment.

- **Hygiene Promotion** – Hygiene messages educate affected populations on disease risks and transmission routes. Often in emergencies, hygiene promotion is condensed to key messages, such as hand-washing at critical times. Promotion can be at schools, in large community groups or at the household level.

    Social mobilization is a sub-set of activities within hygiene promotion that describes strategies for engaging communities and responders *facilitating* communities to address identified risks with local solutions. The most notable example is Community Led Total Sanitation (CLTS) programming, CLTS is widely used in development settings to motivate communities to build their own latrines; specifically, no materials are given to the population. In CLTS activities, an outside facilitator aims to influence the population to be open defecation free (ODF) and find their own local solutions to address open defecation.
- ***Distribution of Soap and/or Hygiene Kits*** – Hygiene kits equip affected populations to act on hygiene promotion. Hygiene kit distributions often provide populations with HWT products, soap, buckets, feminine hygiene materials, toothbrushes and other materials depending on the context. Hygiene kits can be distributed as standalone packages, or a component of a large distribution of non-food items (NFIs) that includes materials such as blankets, cooking pots or other materials. Cash, material subsidies and vouchers are an alternative to providing hygiene kits and offer flexibility to the disaster-affected households.
- **Environmental Hygiene** – Environmental hygiene efforts aim to protect populations from existing or new risks by reducing environmental pathways of disease. Environmental hygiene interventions can include rubbish collection and disinfection of household objects or even improving land drainage.

WASH Package – Responders commonly conduct interventions concurrently, consisting of multiple individual WASH interventions

- **WASH Package –** Interventions carried out in combination with several interventions with components of water, sanitation, and hygiene. The specific WASH interventions identified in the review are described in more detail in Section 5, Results.

1.2.1 Primary actors in emergency response

Effectively responding to an emergency requires collaboration between many different actors. Major actors include:

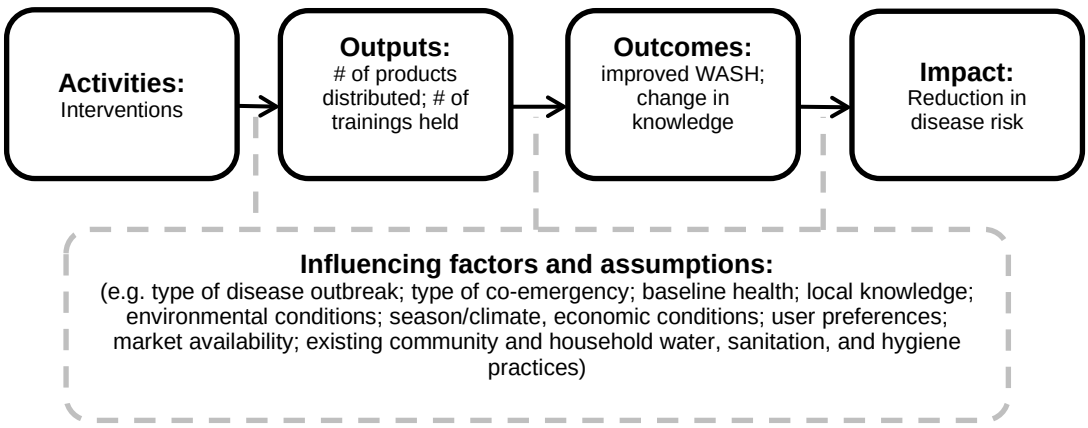
- United Nations (UN) agencies lead emergency 'clusters' that cover the range of humanitarian needs in an emergency (e.g. WASH, shelter, health). United Nations Children's Fund (Unicef) typically leads and coordinates the WASH response, with substantial coordination with other sectors and respective UN agencies. For example, the health sector is led by the World Health Organization (WHO) and refugee management is led by United Nations High Commissioner for Refugees (UNHCR).
- Local governments, who are involved all on-the-ground aspects of emergency response, from agency coordination to municipal services; and
- Non-governmental organizations (NGOs) play a key role working directly with the communities to implement interventions, in coordination with other actors. Some NGOs specialize in emergency response (e.g. Action Contre la Faim (ACF), Oxfam or International Rescue Committee (IRC)).

Collectively, these collaborators are referred to as "responders" throughout this review.

1.3 Theory of change for the intervention

The goal of all WASH interventions is to reduce the risk of disease transmission. For this review, a theory of change model was developed for the WASH interventions to describe the theoretical route from intervention activities to outputs, outcomes and impacts (disease reduction); and identify influencing factors and assumptions (Yates, Vujcic, et al. 2015). The theory of change template is presented in Figure 3.

Figure 3: Theory of change template

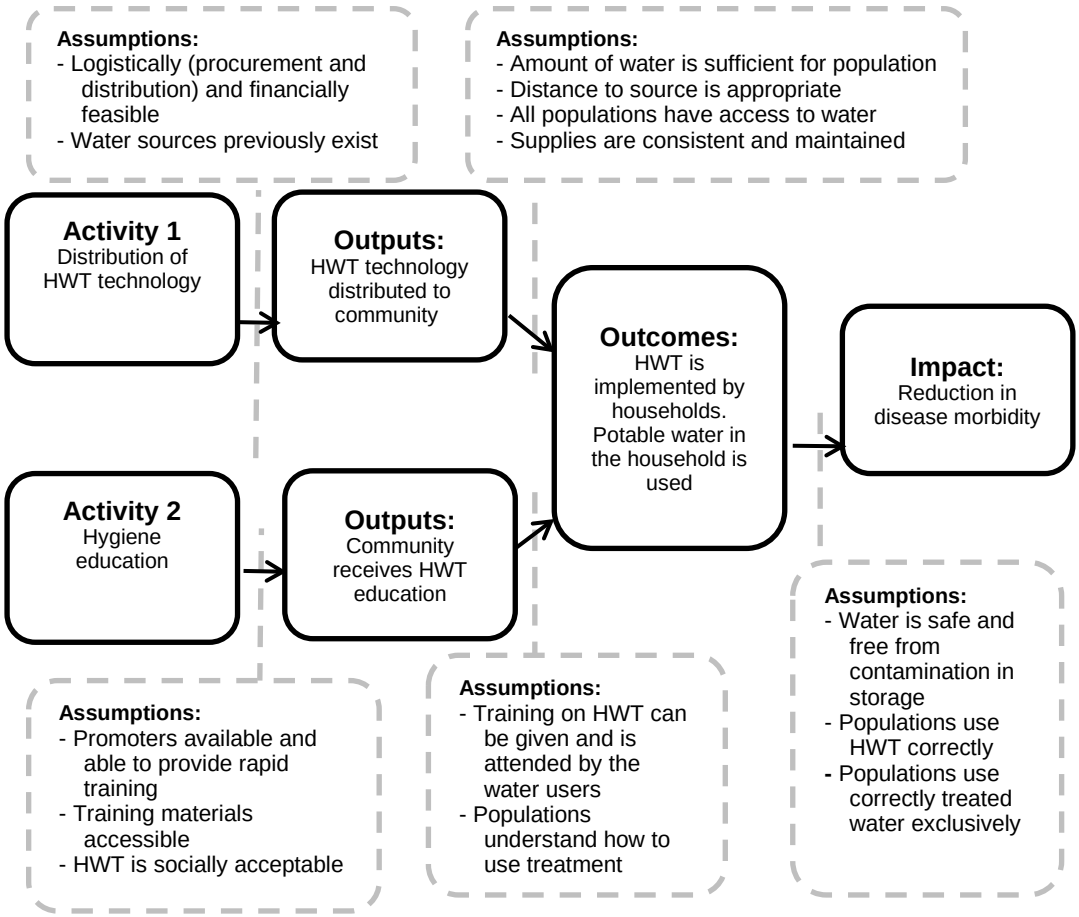


The extent to which WASH interventions are successful in interrupting transmission is dependent on their efficacy and effectiveness. *Efficacy* is the theoretical potential for breaking transmission routes, and answers the question "Could the intervention work?" *Effectiveness* includes contextual factors of the intervention such as implementation quality, the natural environment, culture and social preferences, and answers the questions "Was the intervention implemented correctly?" and "Did the

intervention have the outcomes and impacts that are possible and were intended in the target population?"

To illustrate the difference between efficacy and effectiveness, the theory of change for a combined household water treatment intervention and hygiene education intervention is depicted below (Figure 4). In this example, a water filter and hygiene education are distributed to households; both are known to be efficacious from previous laboratory and field studies. The assumptions detailed at each stage of the model show the steps necessary to achieve correct and consistent use in the target population, i.e. effectiveness. Additional specific models for other interventions are included in the protocol in Appendix B.

Figure 4: Theory of change example - HWT



As a part of a larger WASH review, a systematic review of cholera case-control studies was conducted, and is described below in Box 1. The risk and protective factors identified in the case-control studies quantified the influence of assumptions in the causal chain and validated our theory of change models.

Box 1: Cholera Case-Control Study Review Example

A systematic review of cholera case-control studies identified 77 studies and nine exposure pathways; the exposure pathways included those in the F-Diagram (Figure 2), socio-economic status and local customs (e.g. actions at a funeral) (Kaur 2016). Each exposure pathway consisted of a protective factor and the opposing risk factor. For instance, access to treated water was protective, and the lack of treated water was a risk. In total, 12 protective factors and 23 risk factors were identified in the nine exposure pathways. The most notable conclusions were that 50% (6/12) of the protective factors were significant ($p>0.05$), yet all (23) risk factors were significant ($p<0.05$). This indicates that the *absence of* treated water or a latrine, for example, clearly increases the risk of disease. However, the opposite, *access to* treated water or a latrine, is not always clearly protective. The WASH intervention Theory of Change was validated by noting that the influencing factors and assumptions play an important role in the impact of a WASH intervention. Improved WASH access or increased knowledge does not always translate to a reduction of disease, thus an appreciation of local customs, ease of use and other factors must be considered to achieve impact.

1.4 Why is it important to do this review

This review is timely and important as the number of people affected by emergencies is increasing (Smith et al. 2014, Walker, Glasser, and Kambli 2012, UNHCR 2015, EM-DAT 2014) and is anticipated to continue to increase with climate change and a rapidly growing population (Walker, Glasser, and Kambli 2012). Better understanding of the efficacy and effectiveness of WASH interventions in emergencies can shape how WASH interventions are implemented to better serve their target communities (Cairncross et al. 2013). Additionally, there is a gap in documented evidence for WASH in emergencies that could lead to responders making unjustified assumptions.

Recently, two reviews of published literature on WASH interventions for cholera response (Taylor et al. 2015) and the health impact of WASH interventions in emergencies (Ramesh et al. 2015) concluded there was a lack of evidence to support implementing WASH interventions in outbreaks and emergencies. The reviews found that the quality of evidence is low and limited to only a small portion of interventions, primarily focused on household water treatment. However, neither review had inclusion criteria that enabled a full appreciation for the scope of information in emergencies, ultimately leading to few included studies and a narrow scope of interventions. Specifically, Taylor et al. did not include grey ‘unpublished’ literature and Ramesh et al. only investigated health impacts. The work presented herein includes both published and grey literature, broader inclusion criteria and additional outcomes compared to the reviews described above. Additionally, previous manuscripts have highlighted the need to informing global policy by identify which WASH interventions are evidence-based and which need further research (Parkinson 2009, Darcy et al. 2013). Ideally, the evidence base would draw from published literature, as well as grey literature and qualitative information through a clearly defined review (Brown et al. 2012). This review addresses these previously identified needs.

In the absence of evidence, WASH interventions currently used in emergency response are often ones shown to be efficacious and effective in development

contexts, not emergencies (Darcy et al., 2013; Parkinson, 2009). Additionally, responders often default to familiar interventions using “intuition” and “if it worked before it will work again” (Darcy et al. 2013, Loo et al. 2012, Steele and Clarke 2008). As the effectiveness of WASH interventions depends on contextual factors unique to each emergency (Bastable & Russell, 2013; Loo et al., 2012; Parkinson, 2009), these unjustified assumptions has led to use of interventions in inappropriate situations (Dorea, 2012; Loo et al., 2012). Contextually appropriate information on WASH intervention effectiveness may provide more relevant and effective guidance for responders and lead to better WASH interventions in emergencies. For example, in northern Uganda there were cultural beliefs that a disease outbreak was caused by “bad spirits”, not water, and responders need to understand the local beliefs and the potential impact on use of WASH interventions while responding (de Vries et al. 2016).

2. Objectives

The objective of this review was to assess the outcomes and impacts of short-term emergency WASH interventions in LMIC through a systematic review process that incorporates published and grey literature. Specific goals were to address five knowledge gaps in emergency WASH interventions:

- What are the effects of short-term WASH interventions on use of service in emergency response situations?
- What are the effects of short-term WASH interventions on health-related outcomes (i.e. morbidity and mortality) in emergency response situations?
- What are the non-health related outcomes (i.e. psycho-social, quality of life, behaviour change) from WASH interventions in emergency WASH interventions?
- What contextual factors act as barriers or facilitators to implementation and uptake and the effectiveness of short-term WASH interventions in emergency response situations?
- What is the cost-effectiveness of WASH interventions in emergency situations?

Results are presented by intervention in Section 5, and discussions are structured by objective in Section 6.

How to read this review

This review is intended to provide policy makers and responders a comprehensive understanding of the available information on the effectiveness of WASH interventions in emergencies. It is a systematic synthesis of relevant information intended for a reader with a basic understanding of WASH interventions. The reader is referred to the WASH Gap Analysis (2013), the Humanitarian Innovation Fund Problem Explanation Reports (2016) and NGO technical guidance documents for information outside the scope of this review.

3. Methods

A detailed systematic review protocol was developed to identify published and grey literature documents with quantitative and qualitative outcomes from a wide network of sources. The full protocol is available as Appendix B and at the 3ie website (http://www.3ieimpact.org). Herein, a brief summary of the methods for identification of studies, inclusion criteria, selection process and quality appraisal is presented.

3.1 Criteria for considering studies for this review

Inclusion criteria were established to define: Populations, Interventions, Comparisons, Outcomes and Study Types (PICOS) (Yates, Vujcic, et al. 2015). The definitions were developed to guarantee transparency in selection of included evaluations and were approved through a peer review process. General inclusion criteria are summarized below, with detailed criteria available in Appendix B.

3.1.1 Types of participants

All age, gender and socio-economic populations were eligible for inclusion, provided they were affected by an emergency and lived in LMIC, as defined by the World Bank. For this analysis, an 'emergency' is defined as an event affecting a specific population that requires national or international assistance because local capacity is overwhelmed (UNISDR 2007). For natural disasters, conflict or outbreaks, factors used to help define an emergency included: a UNDAC (United Nations Disaster and Coordination) response, international funding appeal, population displacement or acute events in chronic emergencies. Outbreaks were limited to communicable diseases for which WASH interventions can break known transmission routes, including: cholera, Ebola, Hepatitis E, Hepatitis A, typhoid fever, acute watery diarrhea and bacillary dysentery (shigellosis).

3.1.2 Types of interventions

A WASH intervention was eligible for review if it was in response to an acute emergency. Beneficiary needs and intervention goals change with time in an emergency; however, there is no clearly defined transition from the acute emergency phase to recovery or development (Figure 5). We defined emergency WASH interventions as a project length of less than 12 months AND occurring within 12 months of the disaster or emergency. This timeframe restriction excludes interventions in chronic emergencies (e.g. South Sudan) and long established camps (e.g. Da'daab refugee camp in Kenya) unless an acute emergency also occurred in those contexts (e.g. outbreak of cholera, or sudden population spike). 'Less' acute emergencies were beyond the scope of review with a brief explanation in Box 2.

Figure 5: Phases of an Emergency

Source: www.emilms.fema.gov

Box 2: Beyond Review Scope – Less Acute Emergencies

The scope of this review centered on an "acute emergency," but this was difficult to differentiate at times. Group discussions and guidance from the Advisory Board of this review assisted in maintaining the scope of acute emergencies. The rationale for excluding protracted, repeated and slow onset emergencies was:

Protracted Emergencies – Protracted emergencies have enormous humanitarian needs (e.g. years of conflict in Afghanistan or long-running refugee camps in Kenya), but in most circumstances chronic needs are more aligned with development interventions than acute emergencies. There are exceptions with spikes in displaced populations and sudden disease outbreaks.

Repeated or Cyclical Emergencies – Populations that are affected by reoccurring disasters (e.g. seasonally or annually) have established response activities and coping mechanisms. For instance, annual floods in Bangladesh or endemic cholera in the Democratic Republic of Congo (D.R.C.) are often locally managed with ongoing WASH interventions.

Slow Onset Emergencies – Drought and some complex conflicts are slow onset that may take several years to develop into an emergency. This long duration often precludes having acute need for immediate response.

3.1.3 Types of comparisons

No specific comparisons were required for inclusion.

3.1.4 Types of outcomes

Evaluations were included if at least one intermediate outcome (use of service or economic analysis) or final impact (disease reduction or non-health outcomes) was reported.

Use of service: Use of services is a general term that includes three specific indicators: self-reported use, confirmed use and effective use. Most notably this is with HWT interventions, but also apply to other interventions like the use of latrines or hygiene kits. Self-reported use is when a beneficiary reports the use

of a product or event without additional verification; this indicator is often biased. Confirmed use is when the evaluation tests, observes or confirms a product or service was used in some way (i.e. FCR in household drinking water confirms the use of a chlorine water treatment method or observation of a reported activity such as handwashing). Effective use is specific to water supply and water treatment interventions and combines confirmed use with microbiological testing to determine the improvement in water quality from contaminated to uncontaminated.

Cost-effectiveness: Economic analyses types that were included in this review were: cost-benefit analysis, cost-utility analysis, cost per beneficiary, cost of products or cost per Disability Adjusted Life-Year (DALY) averted.

Disease reduction: Health impact data was included if beneficiary morbidity and mortality impact was expressed as an odds ratio (OR), risk ratio (RR) or disease prevalence or incidence rate. Odds and risk ratios less than one reflect the intervention is protective; ratios greater than one reflect an increase in risk from the intervention. The intervention statistically significantly increases or decreases risk if the confidence interval around the point estimate does not include one.

Non-health outcomes: Non-health related outcomes of preferences from the population on use of interventions (e.g. ease of use, taste or smell of water), quality of life improvement (e.g. feeling safer, time savings) or agency preferences for interventions were included. Changes in behavior and attitude due to interventions were also included.

3.1.5 Types of studies

Experimental, quasi-experimental, non-experimental, mixed-methods and qualitative methodological designs were eligible for review but were specific to the research objective (Table 2).

Table 2: Study type inclusion by research objective

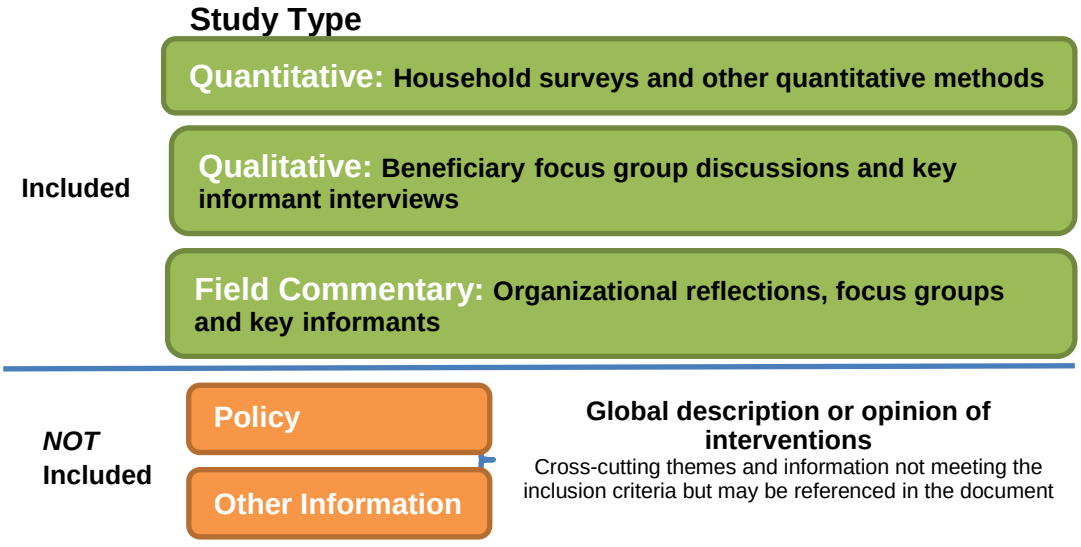
Research Question	Includable Study Types
1) Use of service (quantitative analysis)	Experimental (Randomized Control Trial (RCT); Quasi-RCT, quasi-experimental (cohort, regression discontinuity, difference-in-difference and propensity score matching) and non-experimental (cross-sectional, case reports, correlations, uncontrolled before-after) designs that allow for causal inference.
2) Health-related outcomes (quantitative analysis)	Experimental (RCT; Quasi-RCT), quasi-experimental (cohort, regression discontinuity, difference-in-difference and propensity score matching) and non-experimental (cross-sectional, case reports, correlations, uncontrolled before-after) designs that allow for causal inference.
3) Non-health related outcomes (quantitative analysis)	Experimental (RCT; Quasi-RCT), quasi-experimental (cohort, regression discontinuity, difference-in-difference and propensity score matching) and non-experimental (cross-sectional, case reports, correlations, uncontrolled before-after) designs that allow for causal inference.

Research Question	Includable Study Types
4) Barriers or facilitators to implementation and uptake (qualitative analysis)	Any study (whether quantitative, qualitative or mixed-methods) will be eligible for inclusion regarding this question provided it contains relevant contextual data. However, blogs, diaries, newspaper articles, web postings, magazine articles and legal proceedings/court documents were excluded.
5) Cost-effectiveness (quantitative analysis)	Studies containing cost benefit, cost-effectiveness, cost per beneficiary or cost per DALY averted analysis.

There were no language restrictions for inclusion; however, only English and French language search terms were used. Documents were eligible with reporting dates between 1995 and 2016. Both peer-reviewed and grey literature documents were eligible for review. Grey literature could include responder documents and reports; however, personal blogs, diaries, newspapers articles, magazine articles, website postings, poster abstracts, and legal proceedings/court documents were not included (these were collectively termed 'policy documents and other information'). Systematic review documents were not included, but individual references were screened for inclusion.

As the scope of this review is wide, for ease in comparing and presenting data, all included documents were categorized as quantitative, qualitative and/or field commentary (Figure 6). For the purpose of this review, quantitative documents included quantitative and mixed-method evaluations, typically including household surveys. Qualitative documents relied exclusively on beneficiary focus group discussions and key informant interviews. Field commentary documents are organizational or personal reflection on a particular intervention, and sometimes also included focus groups or key informant interviews from NGO, UN or government staff (non-beneficiary).

Figure 6: Document type classification



3.2 Search methods for identification of studies

A comprehensive and systematic search strategy was developed to identify published and grey literature through databases, agency websites and solicitation.

3.2.1 Database and website searching

All search strings for the WASH interventions included terms related to emergencies, disasters and outbreaks as well as LMICs. Individualized search terms were developed for each WASH intervention from their associated theory of change, including keywords, outcomes and impact measures specific to that intervention (Appendix C). The eight search strings were used in a total of nine peer-reviewed databases, in English (7), French (2) and English/Spanish (1) including: Cochrane Library, Google Scholar, IDEAS, LILACs, Ovid Medline (Pubmed), Scopus, Web of Science, Academic Search Premier (English and French) and ArticleFirst. Searching took place between November and December 2015 and then again in September 2016. An example search string for household water treatment is presented in Box 2.

Box 2: Search String Example - Household Water Treatment

("household water treatment" OR "house hold water treatment" OR "HWT" OR "hwts" OR "safe storage" OR "SWS" OR "safe water system" OR "point of use" OR point-of-use OR "PUR" OR aquatab OR "bottled water" OR "chlorine solution" OR "HTH" OR "sodis" OR boiling OR "water treatment" OR filter OR chlorine OR alum… *more key words…*)

AND

(outbreak OR emergenc* OR disaster* OR crisis OR "emergency response" OR "complex emergency" OR "natural disaster" OR flood OR tsunami OR outbreak OR earthquake OR drought OR disease OR endemic OR pandemic OR hurricane OR …*more key words*…)

AND

("LMIC" OR "low and middle income" OR "low-and-middle-income" OR Afghanistan OR Libya OR Albania OR Macedonia OR Algeria OR Madagascar OR "American Samoa" OR Malawi OR Angola OR Malaysia OR Armenia OR Maldives OR Azerbaijan OR Mali OR Bangladesh OR … *more countries…*)

Journals most likely to have relevant research were also searched by hand. NGO, UN and other relevant emergency responder websites were searched with simplified keyword strings, as many sites were not equipped for complex word searches or did not have data repositories. For example, an NGO website without a data repository might be examined through the search bar with key words like: "water emergency" or "disease outbreak." The references list of all review documents found in the search and all included evaluations were also reviewed to identify additional documents.

3.2.2 Open requests for information

Email requests for reports, data and general information (termed ‘documents’ henceforth in the report) on WASH interventions in emergencies were sent out to the Global WASH Cluster email list in September 2015 and February 2016, and to the global household water treatment network and personal contacts lists in September 2015. Overall, more than 75 organizations were contacted through email. Additionally, Evidence Aid posted requests for information on their Facebook page and sent email messages to specific individuals. Organizations and individuals were also approached at the Emergency Environmental Health Forum in Nairobi in October 2015 (where an oral presentation on this work was presented) and the University of North Carolina Water and Health: Where Science Meets Policy conference in October 2015 (where a poster on this work was presented).

3.2.3 Screening procedures and reference management

All identified documents were screened according to the standards of Cochrane Intervention Reviews (Higgins and Green 2011) by title, abstract and full text review.

Title screening – A single reviewer removed documents that were not: WASH related, from LMIC, published between 1995 and 2016 or field-based interventions. Any document that was questionable was included for review in abstract screening. There were no restrictions on languages includable in the review.

Abstract screening – Included documents from the title screening were independently assessed by two reviewers based on the abstract or executive summary. In addition to the first filter criteria, development and protracted contexts and long-term projects of more than 12 months were eliminated. If a document was approved by either reviewer, the document was approved for full text screening.

Full text screening – Included documents from the abstract screening were independently assessed by two reviewers to determine if the documents adhered to all the previous criteria and included at least one of the four intermediate outcomes or final impacts. Both reviewers needed to be in agreement for the study to be included in the review. Any discrepancies were discussed by a third member of the review team for a final decision.

Throughout the screening process, references were managed with Endnote X7 (New York, NY) and Microsoft Excel 2010 (Redmond, WA, USA).

3.3 Data collection and management

For included studies, data collection was done with a detailed coding sheet using Microsoft Excel 2010. Data collection included: author and publication details, type of intervention, context of the intervention, study design, study quality, effect estimation, intermediate outcomes and final outcome. The data collection template is included as Appendix D. Data collection was completed by four research assistants and independently double screened to ensure accuracy.

3.4 Dependency

The unit of observation was on the intervention level, thus one effect size for each outcome within an intervention was constructed. Multiple evaluations within a study were independently assessed. When a NGO report was followed by a journal article, only the published version was included. Similarly, when dissertations and journal articles overlapped in content, only one study was included.

When multiple outcomes were reported in a study, all relevant outcomes of interest were recorded and reported. In situations where the same outcome was reported with multiple modes of data collection (e.g. self-reported diarrhea and scientific assessment) both measures were reported.

3.5 Critical appraisal and risk of bias assessment

3.5.1 Critical appraisal and risk of bias assessment of studies

The quality appraisal included two parts, an assessment on the quality of each individual included evaluation and an assessment of the total quality of evidence for each WASH intervention.

Each included evaluation was assessed for the potential risk of bias, with different tools used for quantitative and qualitative/field commentary evaluations, as described below and included in Appendix B. As part of the data extraction, risk of bias assessment was completed by four research assistants and independently double screened to ensure accuracy. Discrepancies were discussed and agreed upon.

Quantitative evaluations – To assess the risk of bias in quantitative studies, an assessment tool was developed based on the Cochrane Handbook Risk of Bias Tool and Baird et al (2013) (Higgins and Green 2008, Baird et al. 2013). The risk of bias was assessed through five categories: 1) selection and confounding; 2) spillover and contamination; 3) incomplete outcome; 4) selective reporting; and 5) other bias. Economic quality assessment was adapted from the CASP Economic Checklist (*Economic Evaluation Checklist*, 2013) assessing: 1) appropriate inclusion analysis; 2) sensitivity; and 3) wider applicability.

Each study was scored across the five categories as ‘Low Risk,’ ‘High Risk’ or ‘Unclear.’ The summary risk of bias for an individual study was based on the number of ‘Low Risk’ assessments across the five categories. If there were four or more Low Risk assessments the study was considered ‘Low Risk’, if there were three it was Medium Risk and if there were 2 or fewer it was High Risk.

Qualitative/field commentary evaluations – The qualitative assessment was adapted from Spencer et al. 2003 “Quality in Qualitative Evaluation: A framework for assessing research evidence” (Spencer et al. 2003). The quality assessment is evaluated on four appraisal categories: 1) design, 2) bias, 3) data collection; and 4) clarity of finding.

Each criteria were scored as ‘Low Risk,’ ‘High Risk’ or ‘Unclear,’ and an overall determination for the risk of bias for each evaluation was summarized as ‘Low Risk,’ ‘Medium Risk’ or ‘High Risk.’

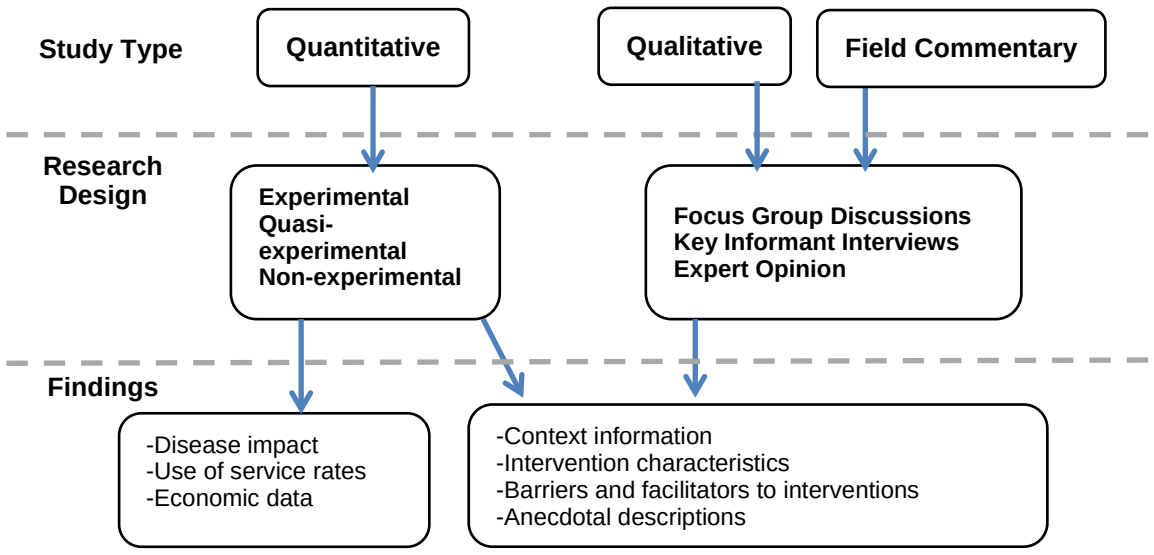
Each study was scored across the four categories as ‘Low Risk,’ ‘High Risk’ or ‘Unclear.’ The summary risk of bias for a qualitative/field commentary study was based on the number of ‘Low Risk’ assessments across the four categories. If there were three or more Low Risk assessments, the study was considered Low Risk, if there were two it was Medium Risk and if there were one or zero it was High Risk.

3.6 Integrated synthesis

Quantitative and qualitative research was used together to provide a comprehensive understanding of emergency WASH interventions. Contextual factors were also collected and combined with research designs to provide information from the effectiveness an intervention, to barriers and facilitators of the intervention as described by the beneficiary and responding organization. Results were grouped by intervention and summarized based on reported outcomes originating from different data sources. Themes common to each intervention were assessed and summarized within the scope of use, health and non-health factors from all three data sources. By assessing all three data sources, the complete causal chain was evaluated.

Due to the included study designs, narrative synthesis was use to summarize the information in the review. Quantitative studies evaluated health, use and economic outcomes, as well as barriers and facilitators. Programmatic factors and beneficiary preferences were coded and summarized by theme for all study types (Figure 7) in accordance with the coding sheet. Comparison tables and figures were used to show differences and similarities within interventions. The quality of evidence for each outcome of an intervention followed the quality of evidence described in Section 2.4 and Appendix B.

Figure 7: Source of data retrieval flow diagram



3.7 Summarizing the evidence

To establish the summary of evidence from multiple studies of varying qualities and study designs, a protocol was developed to establish transparency in communicating the overall evidence for outcomes and interventions. The summary of evidence protocol is based on GRADE assessment of evidence outlined in Cochrane Review; however, some modifications were made so there would be a less emphasis on randomized control trials (RCT), which were rarely carried out in humanitarian research. An evaluation process was used to determine the level of evidence with transparency. The baseline of evidence was determined by the study designs in the intervention. Then, evidence was downgraded or upgraded considering biases, effect size, consistency and generalizability. See Appendix F for further description. The summary of evidence is described through four categories to give the reader levels of confidence in the quality for the outcomes and interventions. The four hierarchal categories mimic the GRADE conclusion definitions (Oxman and GRADE Working Group 2004):

- *High* **–** Further research is very unlikely to change our confidence in the estimate of effect or accuracy.
- *Moderate* – Further research is likely to have an important impact on our confidence in the estimate of effect or accuracy and may change the estimate.
- *Low* – Further research is very likely to have an important impact on our confidence in the estimate of effect or accuracy and is likely to change the estimate.
- *Very low* – Any estimate of effect or accuracy is very uncertain.

3.8 Changes from the protocol

Considerations for missing data and meta-analysis techniques were described in the protocol; however, the low quality research designs identified and included in the review undermined the relevance of meta-analysis and therefore most contingency measures. Procedures to address unit of analysis issues, independent findings, economic synthesis, use of weighted average, pooled effect, forest plots and funnel plots are found in Appendix B but not further described herein because they were not utilized in the review. Formal heterogeneity analysis with I^2 could not be completed as reported outcomes remained too different for direct comparison. The summary of evidence protocol was modified as described above.

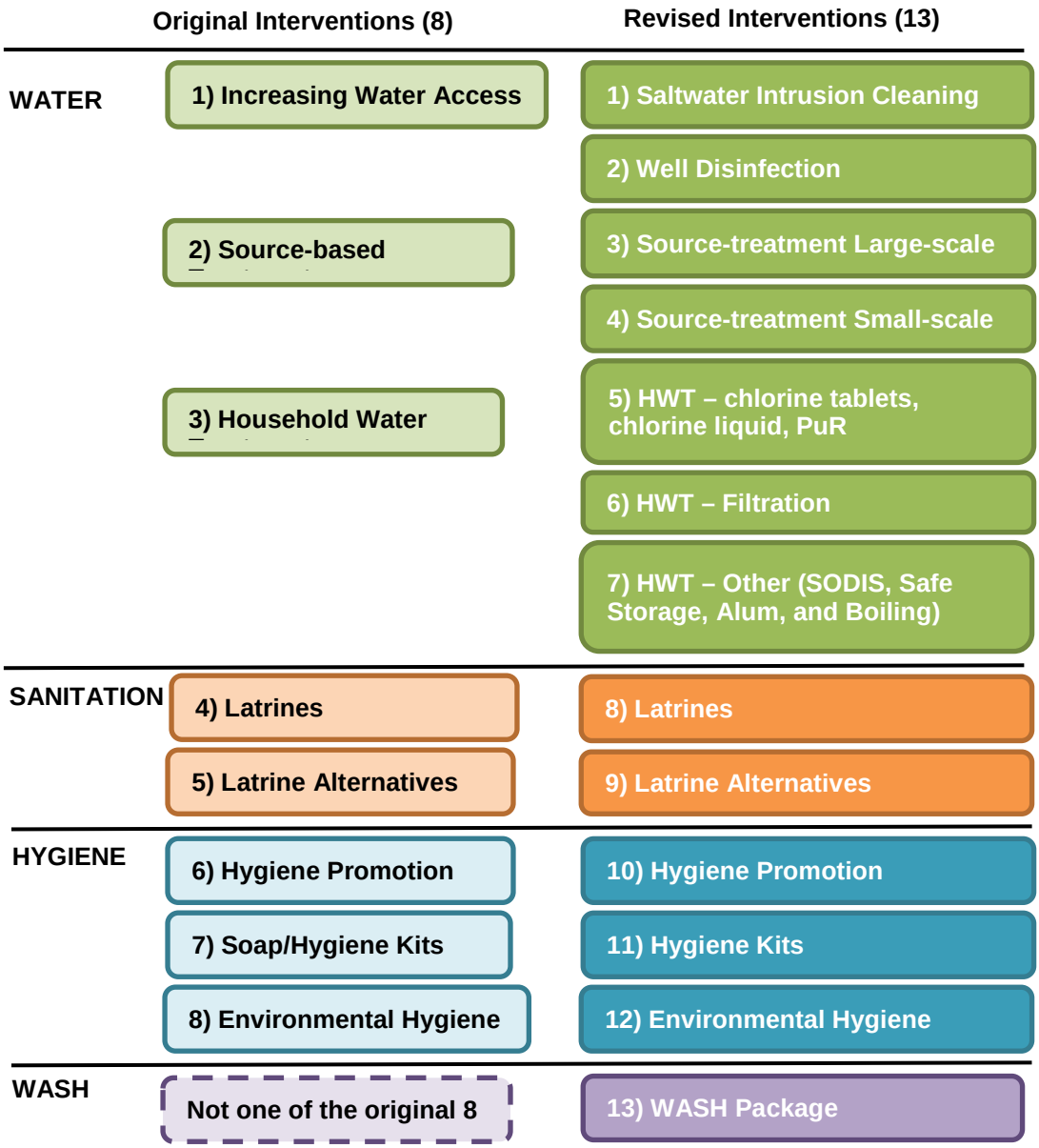
Case-control studies focusing on disease risk factors were not included in the main review, as cholera or other diseases were the outcome (and as such well described) and the WASH interventions identified as significant (or not) were input variables that were self-reported and poorly described in the studies. A separate systematic review was conducted, summarizing cholera risk factors (See Box 1).

The anticipated comparisons described in the protocol were also undermined by the lack of data quality and could not be carried out. The WASH interventions were not targeted to a specific gender, age range or other demographic along the PROGRESS-Plus subgroups. Additionally, the intervention setting (urban, rural, per-urban) was not regularly reported, and with some interventions covering a wide

geographic area to large populations it was not possible to compare across intervention setting. Timing of the intervention or evaluation was also regularly not documented which limited intended analysis.

The search strategy was tailored for eight different emergency WASH interventions; however, upon review of the included studies, more specific intervention categories were found to be necessary to improve intervention comparisons. Ultimately, 13 intervention categories were determined by the review team to better describe the interventions and were subsets of the original categories (Figure 8).

Figure 8: Intervention categories



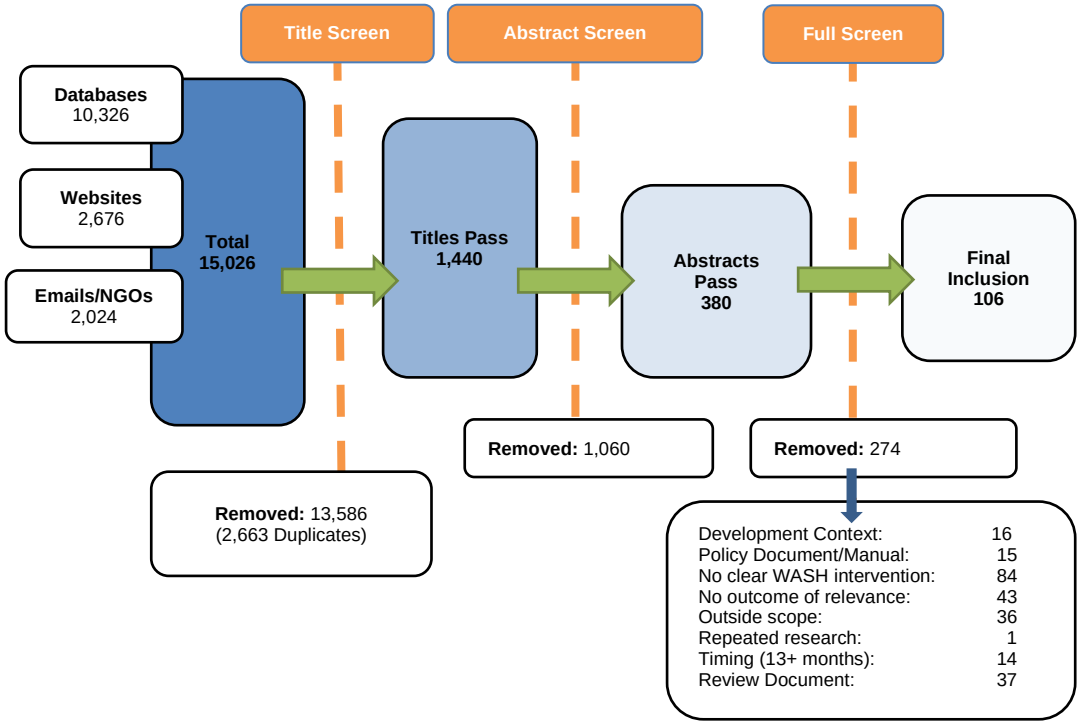
4. Results

The results are separated by a general description of the included studies (Section 5.1), then individual interventions (Sections 5.2-5.7), interventions beyond the scope of review (Section 5.8), economic analysis (Section 5.9), quality assessment of included studies (Section 5.10) and a summary of interventions (Section 5.11).

4.1 Summary of included studies

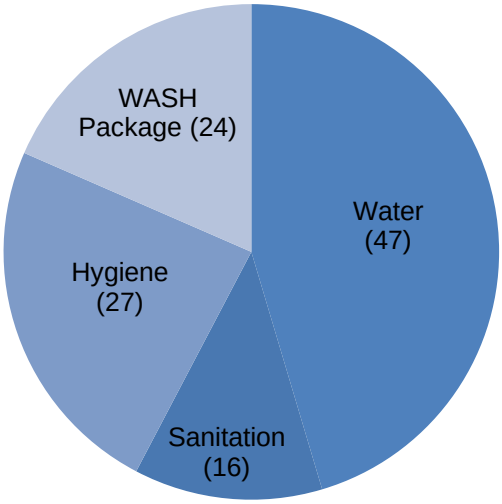
Overall, 15,026 documents were identified in the systematic review process; including 79 review documents (Figure 9). After applying the three selection filters, 106 documents with 114 interventions met inclusion criteria. Please note several documents reported multiple separate evaluations from different countries or emergencies. In September 2016, database searches were re-run for recent publications; but no additional studies were identified for inclusion. The included evaluations are summarized for comparison in tabular format in Appendix A; studies excluded during the full screening are listed in Appendix G.

Figure 9: Screening process



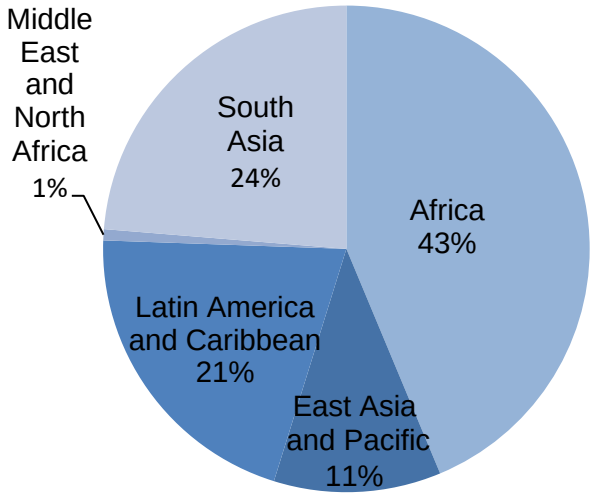
Water interventions represented the most included evaluations (n=47, 41%), followed by hygiene (n=27, 24%) and WASH Package (n=24, 21%) (Figure 10). Sanitation interventions were represented in 16 evaluations (14%). The included evaluations described WASH interventions in 39 countries, with the highest frequency of evaluations from Haiti and Zimbabwe. Africa was the most common World Bank Region, while South Asia and Latin America and the Caribbean were also strongly represented (Figure 11).

Figure 10: Primary WASH component category



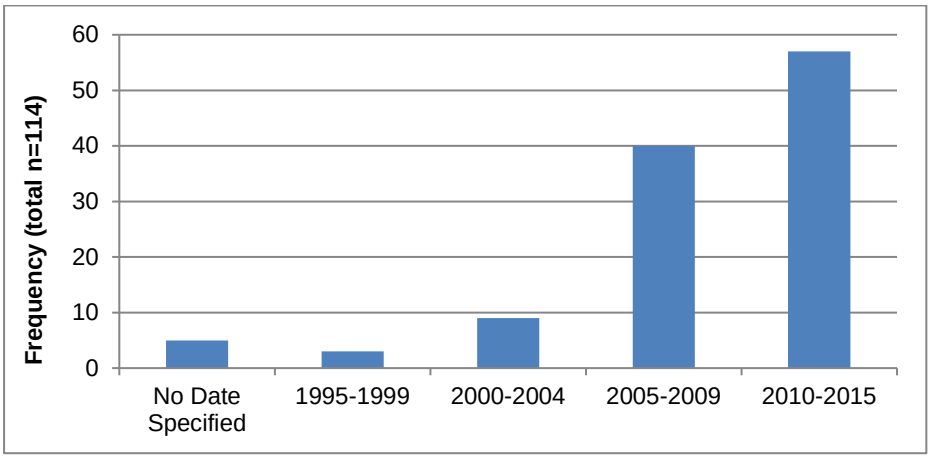
n=114

Figure 11: Included studies by World Bank region



Half of the evaluations (57/114) were published or documented between 2010 and 2015, and 85% (97/114) were within the last 10 years (Figure 12). The high proportion of documents in the last decade coincides with several major emergencies, including the Southeast Asian Tsunami in 2004; cholera outbreaks in Zimbabwe and Haiti in 2008 and 2010; the earthquake in Haiti in 2010; flooding in Pakistan in 2010; and typhoons in the Philippines and Bangladesh in 2013 and 2008. The WASH cluster system was established during this time and NGO reporting requirements increased, creating the recent knowledge base. However, there is a lack of interventions relating to the Ebola outbreak and Syrian conflict.

Figure 12: Intervention contexts by date



An equal number of evaluations were identified from the peer-reviewed (n=57, 50%) and grey literature (n=57, 50%) (Table 3). Although the overall number of evaluations was balanced between published and grey literature, differences were seen by intervention, with water having more published evaluations and hygiene and WASH Package having more grey literature evaluations.

Table 3: Included studies by intervention, evaluation and publication

Intervention	Quantitative	Qualitative	Field Commentary	Published or Grey Literature (P:G)
Water	**54**	**3**	**1**	**44:14**
Saltwater Intrusion Well Cleaning	5	1	0	6:0
Well Disinfection	4	2	0	6:0
Source Treatment – Large Scale	3	0	1	3:1
Source Treatment – Small Scale	3	0	0	3:0
HWT – Chlorine and Disinfectant/ Flocculent	28	0	0	17:11
HWT – Filters	6	0	0	4:2
HWT – Other	5	0	0	5:0
Sanitation	**3**	**1**	**12**	**12:4**
Latrines	2	1	10	9:4
Latrine Alternatives	1	0	2	3:0

Intervention	Quantitative	Qualitative	Field Commentary	Published or Grey Literature (P:G)
Hygiene	**9**	**6**	**16**	**11:20**
Hygiene Promotion	5	4	11	7:13
Hygiene Kit Distribution	2	0	5	0:7
Environmental Hygiene	2	2	0	4:0
WASH Package	**0**	**9**	**15**	**0:24**
WASH	0	9	15	0:24
Totals	**66**	**19**	**44**	**67:62**

Note: The evaluations could include more than one intervention.

The majority of the evaluations (77%, 82/106) had a high risk of bias (Figure 13). The quantitative studies were mostly completed on water interventions, were more likely to be published and had less risk of bias. For example, published water evaluations were 23% low risk of bias (7/30), while only 3% of the other WASH intervention evaluations had a low risk (2/76) (Figure 15). Conversely, the WASH Package evaluations were field commentary, unpublished, high risk of bias evaluations (Figure 14). The risk of bias for each evaluation is documented in Appendix E.

Figure 13: Risk of bias summary

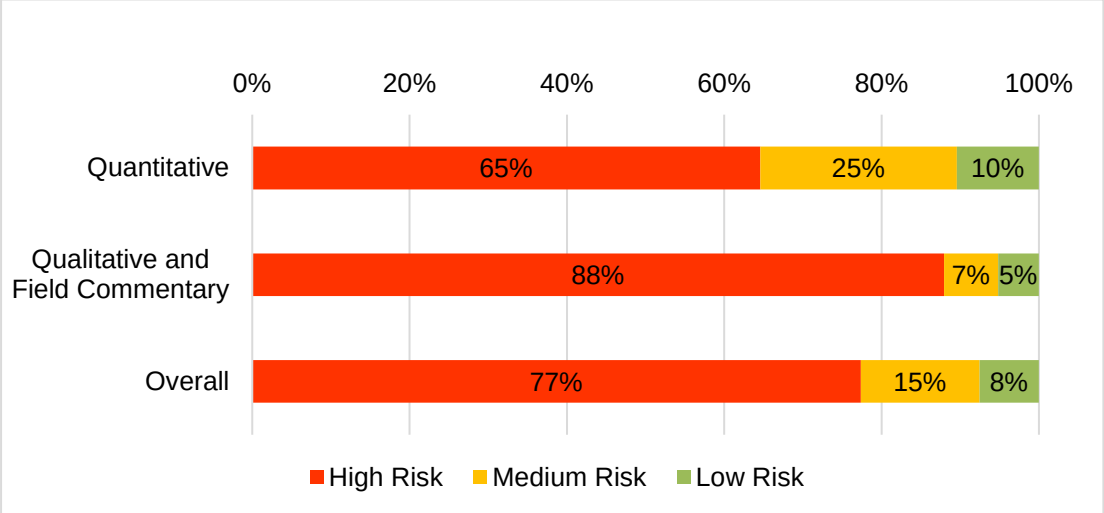


Figure 14: Risk of bias by WASH category

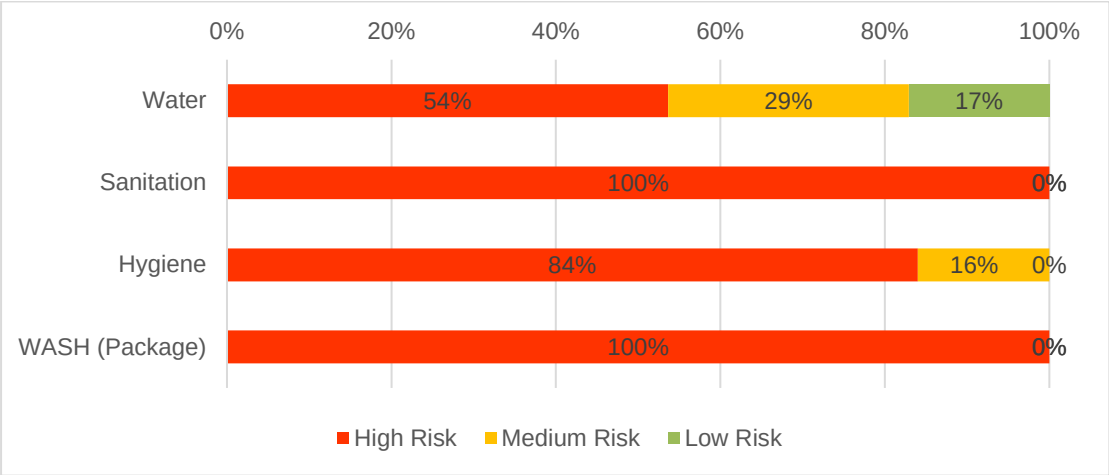
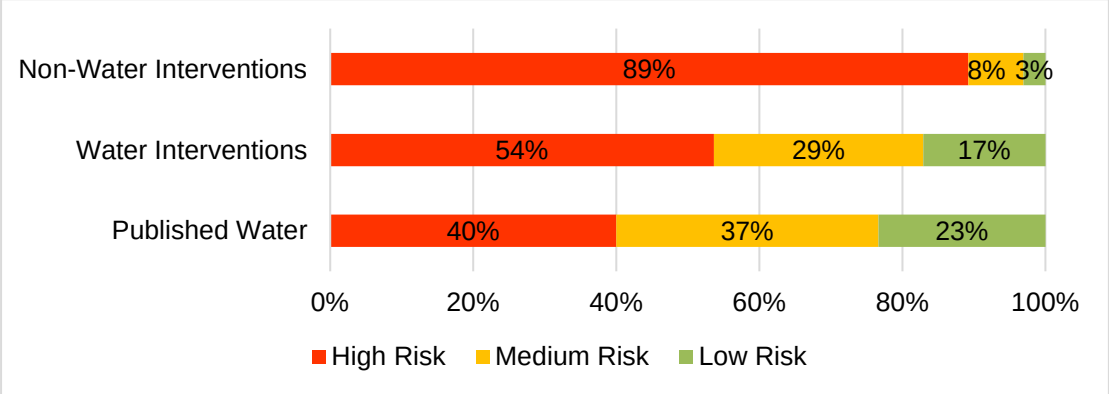


Figure 15: Risk of bias - water highlight



The weakness of study design was also made clear, as only 9% (10/106) of studies had any type of control group and less than 4% (4/106) were randomized control trials. Diversity of outcomes were also weak, with measured health impacts in only 8% (9/106) of the interventions.

Sensitivity

The body of included evidence was sensitive to evaluation design, implementing organization and grey literature. The review was sensitive to the inclusion of low quality research designs; if they were not included the review would be limited to HWT studies, leaving the other 10 interventions identified with no evidence. While studies were conducted by organizations varying from local governments to university (academics), most were from NGOs (74%, 79/106). Overall, at least 35 different agencies had documents that were reviewed in the identification process; however, ACF and Oxfam contributed the largest amount of studies in the identification process. This was represented in the included studies, as documents submitted from these two organizations accounted for a substantial portion of the evidence base (33%, 35/106). Lastly, grey literature contributed to nearly half (49%, 52/106) of the included studies. These factors are fundamental to the review, and as such, sensitivity was not investigated by individual intervention.

Organization of Results

Each of the 13 WASH intervention categories are presented in the following subsections as a synthesis of information, including (if available) quantitative research, qualitative research and field commentary. The results are separated by intervention category presented in Table 4. Each section is structured to describe basic activities of the intervention, comparative information and outcomes relevant to the review and summary of evidence.

Table 4: Results by section

Intervention	Section
Saltwater Intrusion Well Cleaning	5.2.1
Well Disinfection	5.2.2
Source Treatment – Large Scale	5.3.1
Source Treatment – Small Scale	5.3.2
HWT – Chlorine and Disinfectant/Flocculent	5.4.1
HWT – Filters	5.4.2
HWT – Other	5.4.3
Latrines	5.5.1
Latrine Alternatives	5.5.2
Hygiene Promotion	5.6.1
Hygiene Kit Distribution	5.6.2
Environmental Hygiene	5.6.3
WASH Package	5.7

4.2 Water: Source rehabilitation

The source rehabilitation interventions were separated into cleaning wells affected by saltwater flooding (salt water intrusion) (6 documents) and well disinfection (6 documents).

4.2.1 Saltwater intrusion well cleaning

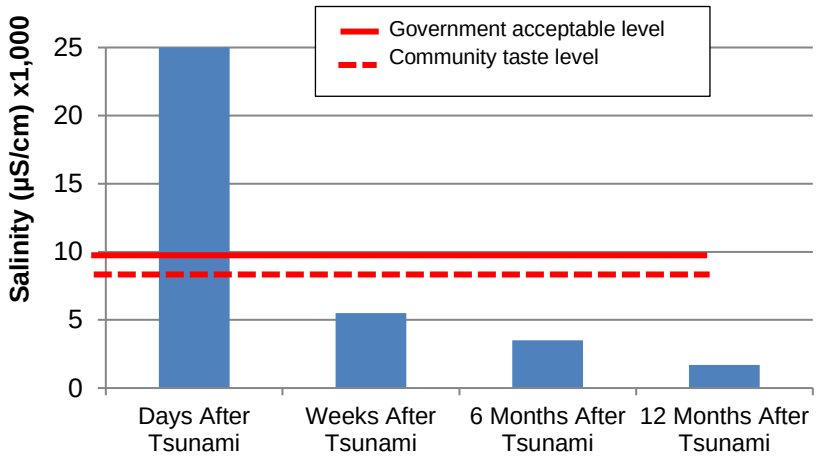
Pumping and cleaning (physically removing silt, sand and debris) a well is a common activity after a flood or tsunami. Pumping wells flooded with seawater is expected to reduce the impact of saltwater intrusion (as measured by salinity or conductivity) and increase the recovery time of the well (the time it takes for water to refill the well). Six evaluations of well cleaning were identified, all after the Southeast Asian tsunami in late 2004 (Table 5).

Table 5: Saltwater intrusion well cleaning comparison

Author (Year) *Country* *Bias*	Activity Description	Evaluation	Findings
Lytton (2008) *Sri Lanka* Low Risk of Bias	Clearing and pumping wells to reduce salinity and make functional wells.	Cross-sectional: 5 wells – salinity (TDS) monitored during pumping	Pumping stopped after 5 wells (64 planned), no improvement of salinity. At best no difference but possible well damage with high permeability and rapid recirculation of contaminated water back into well. Recommendation: abandon until end of dry season.
Villholth (2007) *Sri Lanka* High Risk of Bias	Well pumping and chlorination carried out.	Mixed-methods – cross-sectional: 150 well monitored in 3 villages; 120 household (HH) surveyed.	Well cleaning did not affect salinity, had to wait for replenishment of rainwater. Psychological effects from well cleaning were positive for community. Poor communication of salinity risks made people wary about drinking the well water and worried about the transition from water trucking back to wells. More emphasis on information sharing rather than cleaning activities itself.
Vithanage (2009) *Sri Lanka* Low Risk of Bias	Well monitoring; pumping and cleaning.	2 transects observed: Disturbed transect (15 hand dug wells with piezometers, 4 wells were abandoned). Undisturbed transect (20 piezometer wells).	Well pumping/cleaning delayed the restoration process compared to undisturbed wells. Salinity decreased by a factor of ~5 12 -20 months after tsunami. Disturbed transect 1,000-1,500 µS/cm, abandon wells 750-1,000 µS/cm.
Saltori (2006) *Sri Lanka* Low Risk of Bias	Well pumping and cleaning.	Cross-sectional: 122 wells by ACF for microbiological contamination. Sets of 50 and 30 wells monitored by ICRC for salinity.	78% of wells had >10 *E. coli*/100 mL. Repeated over pumping a primary concern, public perception was that it would help recover faster. Pumping did not achieve any meaningful effect on salinity. Full recovery only after one or more rainy seasons, confirmed with ICRC monitoring of 50 wells.
Fesselet (2006) *Indonesia* Low Risk of Bias	Well pumping and cleaning.	Cross-sectional: 289 wells monitored after cleaning.	14% had salinity levels <2,500 µS/cm; 1.7% below the taste threshold of 900 µS/cm (repeated cleanings had no effect). Cleaning improved the turbidity, but did not reduce salinity levels suitable for drinking, heavy rains reduced salinity.
Lipscombe (2007) *Sri Lanka* High Risk of Bias	Well pumping and cleaning.	9 wells – salinity measured before and after pumping. 20 wells – measured salinity over time.	Pumping had no effect and possibly increased salinity. Repeated pumping not useful – only to remove silt and debris. Community expectations were not met.

The salinity (saltiness) of water is measured as conductivity (µS/cm). The Sri Lankan government maximum salinity threshold is set at 3,500 µS/cm, and NGOs used 2,000 µS/cm as a cut off to stop water trucking, yet the taste threshold was reported to be much lower at 900-1,000 µS/cm (Saltori and Giusti 2006, Fesselet and Mulders 2006). Days after the tsunami, the water was above 25,000 µS/cm in most wells – more than 7 times the Sri Lankan acceptable drinking water limit (Figure 16). After a few months, salinity dropped to 3-8,000 µS/cm. Only after the monsoon season, approximately one year after the tsunami, did salinity levels return to acceptable levels below 3,000 µS/cm. Among all six evaluations it was universally concluded that well pumping had no effect on salinity and likely delayed the date which the communities could use the well.

Figure 16: Well salinity monitoring



Adapted from Saltori et al. 2006

Taste and community perception were major hurdles in well cleaning and transitioning away from water trucking. Well pumping had no effect on water quality, worsened salinity and endangering well structure; however, the community perception was that well pumping was needed to safely rehabilitate the well (Saltori and Giusti , Villholth 2007, Lipscombe 2007). This perception, combined with the general community taste threshold being lower than government or NGO levels, meant that communities were reluctant to move away from water trucking – despite irregular supply and low quantity of trucked water (Villholth 2007, Lipscombe 2007). Improved communication, especially around the safety and transition from water trucking to well use, was needed to address community concerns about well safety.

Saltwater Intrusion Well Cleaning Summary

Almost all of studies (5/6) were from the east coast of Sri Lanka. While a limited geographic area, conclusions would be applicable for similar porous and sandy soil types. Despite a mixture of high and low bias evaluations, all studies conclude that pumping wells had *at best* no effect and alternative water sources should be used until salinity levels naturally decrease (Table 6).

Table 6: Saltwater intrusion well cleaning summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	-	No Evidence	-
Use	-	No Evidence	-
Non-health	6	High	Evidence suggests that well pumping after a saltwater intrusion was **NOT** effective. Seasonal rains to reduce salinity naturally and faster than pumping. Users taste threshold were below government and NGO thresholds for water safety, hindering use of the wells in the recovery phase and causing a user desire for increased water trucking.

4.2.2 Well disinfection

Disinfecting a contaminated well with chlorine is a common intervention in emergency response and is achieved through shock or pot chlorination.

> *Shock chlorination* – A single dose of chlorine is added directly into the well, intended to quickly clean the well. The well can be, but is not always, closed for several hours to one day to allow the chlorine to dissipate.
>
> *Pot chlorination* – A porous container filled with sand and powdered chlorine is inserted in a well, intended to slowly disperse chlorine and treat water over an extended time.

Six evaluations were identified that describe four slightly different approaches to well disinfection with chlorine (note that two studies evaluated multiple methods) (Table 7):

- A shock dose of liquid chlorine (bleach);
- Pot chlorination with powdered chlorine, sand and gravel in a pierced jerry can;
- Pot chlorination with locally pressed chlorine tablets in a perforated container; and
- Floating pot chlorinator (commercial plastic mushroom-shaped device used with swimming pools).

All of the approaches require an understanding of chlorine dose with respect to chlorine concentration and water volume. The amount of organic content and withdrawn water also impact the amount of chlorine needed for treatment. Ideally, the FCR for water treatment would be greater than or equal to 0.2 mg/L and less than or equal to 2.0 mg/L – which is the range ensuring water treatment but not exceeding taste or guideline thresholds (Lantagne 2008). Six documents were identified in the review evaluating well disinfection.

Table 7: Well disinfection comparison

Author (Year) *Country Bias*	Approach	Evaluation	Findings
Rowe (1998) *Guinea-Bissau* High risk of bias	1) Liquid chlorine: Bleach added to achieve 30 mg/L in well	Cross-sectional 10 shallow (hand dug) wells monitored every 24 hours until FCR ceased	1) 40% of wells had FCR >0 mg/L after 24 hours (median 24 hours; range 0-6 days)
Libessart (2000) *Somalia* High risk of bias	1) Liquid chlorine: 1% chlorine solution 2) Pot chlorination: 5L jerry can with gravel, sand and chlorine layers (chlorine not described) 3) Pressed chlorine tablets: 125g of high test hypochlorite (HTH) (75% chlorine) pressed into a tablet, inserted into a pierced pipe	Cross-sectional FCR measured at different times over several programming cycles: 1) 1% Liquid Chlorine: 173 wells over 1 year; 2) Jerry can pot chlorination: 919 tests over 3 month; 3) Pressed tablet pot chlorination: 98 tests (duration not reported)	1) 69% of sample had FCR >0 mg/L; n=178 samples. FCR lasted about an hour. 2) 87% of sample had FCR >0 mg/L; n=919 samples 3) 94% of sample had FCR >0 mg/L; n=98 samples
Garandeau (2006) *Liberia* High risk of bias	1) Liquid chlorine: 5% chlorine bleach, twice per day 2) Pot chlorination: 4L jerry can with gravel, sand and powdered chlorine layers (0.5 litre calcium hypochlorite granules, 65% chlorine) 3) Pot chlorination with pressed chlorine tablets: 70 g calcium hypochlorite (65% chlorine) pressed into a tablet, 1-2 tablets suspended in a pierced plastic bag with 2L of sand 4) Floating pot chlorinator: Floating pool chlorinator, 200g trichloroisocyanuric acid tablets	Cross-sectional 12 hand dug wells (3 protected and 9 unprotected) used over 9 weeks with different chlorination techniques, FCR measured	1) FCR was >0.2 mg/L for less than 1 day 2) Chlorine granules dissolved too quickly, spiking the well up fast (FCR up to 10 mg/L) 3) FCR stable between 0.2-1.0 mg/L in all wells for 3-6 days 4) FCR could be stable with close monitoring but pots not locally available and interfered with drawing water

Author (Year) *Country* *Bias*	Approach	Evaluation	Findings
Guevart (2008) *Cameroon* Low risk of bias	1) Pot chlorination (with perforated bag), including powdered chlorine (calcium hypochlorite, 70% chlorine) and ~1 kg sand	Cross-sectional 18 wells (2 villages – 9 wells each) 36 chlorinations – FCR measured daily	1) FCR remained >0.2 mg/L for 3 days, after 4 days half of the wells were <0.2 mg/L
Cavallaro (2011) *Guinea-Bissau* Low risk of bias	1) Pot chlorination in 1.5L plastic bottle with gravel, sand and powdered calcium hypochlorite (HTH), 15g per 1000 L of well water (70% chlorine)	Cross-sectional 30 wells – FCR and TCR measured daily for 1-3 days after inserting chlorinator	1) FCR was >0 mg/L FCR in 73% of wells (19/26) after 24 hours; 42% (11) >0 mg/L after 48 hours; 31% (8) after 72 hours
Luby (2006) *Bangladesh* *Low risk of bias*	1) Shock chlorination to tube well, 35 g calcium hypochlorite bleaching powder per 100 ft (30.5 m) well depth; mixed in 10 L of water and supernatant decanted into well	n=13 in treatment group, 13 in control group (total n=26)	1) FCR detectable in 46% (6/13) of wells after about 1.5 hours. Shock treatment had no effect on microbiological contamination

Results were separated by three variations of pot chlorination (traditional, floating pot and pressed tablet) and shock chlorination:

Traditional Pot Chlorination – Pot chlorination with pierced jerricans had mixed results, but did have the negative effect of spiking wells in Liberia to levels approaching 10 mg/L. Pot chlorination in Mogadishu and Cameroon did not report spikes, but also did not detail the timeframe for FCR levels. A small 1.5L pot chlorinator had limited success in Guinea-Bissau with 73% of wells maintaining FCR for 24 hours and 31% for three days or more (Cavallaro et al. 2011). Pot chlorination was successful in providing consistent FCR for three days in Cameroon (Guevart et al. 2008). In a non-emergency context in Angola (evaluation not included in the review) pot chlorination also reduced microbiological contamination in hand dug wells (Godfrey et al. 2003).

Floating Pot Chlorinator – Evaluated once, floating pot chlorinators could be effective, but required regular adjustments and were not locally available.

Pressed Tablet Pot Chlorination – Calcium hypochlorite pressed into tablets was deemed the best well treatment option in both comparative evaluations (Garandeau, Trevett, and Bastable 2006, Libessart and Hammache 2000). Pressed tablets were locally made and maintained appropriate levels of FCR for 3-4 days.

Shock Chlorination – Single and regular repeated doses of liquid chlorine solution were consistently determined to be ineffective at maintaining a FCR for more than a few hours. In the only tube well evaluation, shock treatment did not have an effect on microbiological contamination (Luby, Islam, and Johnston 2006). This protection lasted only a short time, yet the community perceived (when asked) that a single dose of chlorine would protect the well for up to six months (Rowe et al. 1998).

All six evaluations used different variations of dosing techniques and amounts of chlorine. An adequate chlorine dose necessary to achieve measurable FCR levels will vary by location and season and may be difficult to determine without empirical testing.

Well Disinfection Summary

Through a mixture of high and low bias evaluations, shock chlorination did not provide residual protection for more than a few hours and did not impact microbiological contamination. Traditional pot chlorination inconsistently maintained measurable FCR for 1-4 days. In comparative evaluations with inconsistent methods, pressed HTH tablets in pot chlorination maintained FCR for 3-4 days and were the preferred mode of well disinfection by implementing agencies (Table 8). It is noted that community perception of the time the treated water is safe may be much longer than the actual time FCR is maintained.

Table 8: Well disinfection summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	-	-	-
Use	-	-	-
Non-health	6	Moderate	Pot chlorination with pressed chlorine tablets can maintain FCR for 3-4 days in a well; pot chlorination with powdered chlorine also had some success. (Inconsistent evaluation methods)

4.3 Water: Source treatment

Source treatment interventions were separated by scale. Large-scale interventions included: bulk water treatment, decentralized bulk water treatment and water trucking and municipal systems. Small-scale interventions included chlorine Dispensers and bucket chlorination.

4.3.1 Large-scale source water treatment

For this review, large-scale water treatment was considered the treatment of more than 1,000L (1 m^3) of water with systems operated and managed by responders (as opposed to beneficiaries), including: bulk water treatment, decentralized bulk water treatment and water trucking. Municipal systems were not included, as town, camp or city water supplies are implemented and used in long-term development and protracted contexts (non-acute), which are beyond the scope of this review. Recent

publications on established water networks not included in this review include documents on: urban water utilities (Pinera and Reed 2007, Boot 2015); maintaining appropriate chlorine levels in established refugee camp settings (Ali, Ali, and Fesselet 2015); and the impact of consistent municipal water supply on endemic cholera (Jeandron et al. 2015).

Bulk water treatment (BWT) mimics well-known municipal water treatment processes, typically with chemical treatments to reduce turbidity and chlorine disinfection using large storage vessels (e.g. 45 m^3 or 5-20 m^3 mobile bladders). Well-trained staff is needed to operate and maintain the systems. Some BWT systems are intended to be mobile, while others are more often used in contexts that are likely to be long-term (i.e. refugee or IDP camps) (Luff and Dorea 2012).

Although BWT is a common emergency WASH strategy, only one document was identified in the review. The up-flow clarifier is used to reduce turbidity, often necessary when treating surface water from a lake or river (Dorea et al. 2009). The clarifier uses a chemical coagulant and non-woven mat in an 11 m^3 tank to improve water quality. The system was evaluated in field trials in Haiti and Indonesia. The relatively inexpensive system (~$7,500 USD) was effective at reducing turbidity to less than 5 NTU with a high flow rate (10 m^3/h). Other positive aspects of the up-flow clarifier were that it had a 2-log (90%) reduction in thermotolerant coliforms, reduced chlorine demand and required little training. In a policy document not included in this review, widespread use of BWT was described after a major flood in Pakistan but many were likely not appropriate for deployment (Luff and Dorea 2012). Moreover, the authors state that while BWT is an effective response tool, alternative water treatment options (i.e. HWT) are better suited for short-term displacements, as BWT units are expensive and complex to operate.

Decentralized Bulk Water Treatment – Between bulk water treatment (often 5-15,000 L/hour) and household water treatment (5-30L), there is a middle ground of semi-decentralized bulk water treatment of 200-1000L. Decentralized bulk water treatment is more mobile, faster to set up and better suited for smaller, more sparely populated regions.

Only one field trial on decentralized bulk water treatment was identified in the review, this was an evaluation in Bangladesh to respond to regional flooding (ACF 2014b). Working with an international NGO, local partners carried out batch treatment with flocculent/disinfectant of 1,000 L a total of 538 times over three months. Treating flooded river water, the semi-decentralized bulk treatment reduced turbidity to less than 5 NTU and left >0.2 mg/L FCR in 98% of batches. The FCR was between 0.5-1.0 mg/L in most circumstances, with populations complaining of the unfamiliar taste and smell. The organization was supportive of the treatment unit as it was easy to store, transport and operate (15 minutes to set up). Not included in this review, laboratory based trials of semi-decentralized bulk water treatment were promising and consistent with the field trial above (Dorea and Jalaber 2014); water quality improved through reduced turbidity (>90 NTU reduced to <1 NTU) and FCR (0.08-0.10 mg/L) was found in waters with a pH range 5-9.

Water Trucking – In water trucking (or water tankering), water is transported from a distant source to the disaster-affected population using a large truck or lorry. Water trucking usually has high costs with limited capacity, thus it is often a temporary solution used in acute situations until other water sources are available.

Water trucking is a regular emergency activity, reported in 11 included documents in six different countries. Most documents simply report that a certain volume of water was delivered each day for several weeks or months (Simpson, Bazezew Legesse, and Mubayiwa 2009, Pinera and Reed 2006, Beau De Rochars et al. 2011, El-Mahmid and Roussy 2009, Saltori and Giusti 2006, Neseni and Guzha 2009, Baker and Mbogha 2009, Patinet 2010, Martin 2011), with only two documents evaluating water quality of tanker trucks (Gupta and Quick 2006, Lantagne and Clasen 2013) (Table 9).

Table 9: Water trucking comparison

Author (Year) *Country* *Bias*	Approach	Evaluation	Findings
Gupta (2006) *Indonesia* High risk of bias	Monitoring water trucking quality	Cross-sectional: 40 different trucks from 12 organizations 54 microbiological samples 75 FCR samples	17% (n=54) had microbiological contamination >0 CFU/100 mL of E. coli 44% (n=75) had no measurable FCR
Lantagne (2013) *Haiti* Low risk of bias	Monitoring water trucking quality	Cross-sectional: 25 microbiological samples 22 FCR samples	56% (n=25) had microbiological contamination 77% (n=22) had no measurable FCR

Monitoring of 40 different water tanker trucks associated with 12 organizations was carried out over two days in the Indonesian tsunami response. Despite measured FCR 0.2-0.6 mg/L from the water source, 44% (n=75) of water trucking samples had no measurable FCR; 17% (n=54) were contaminated with faecal coliforms. Gupta et al. (2006) also noted long wait times (median wait 2 hours and 45 minutes) that likely prompted unmonitored trucks to use alternative (unsafe) sources. The inconsistent presence of FCR and contamination was likely underestimated and put the community at risk when water trucking was communicated as a *safe source.* Unmonitored water trucking was also a concern in the Haiti earthquake response (Lantagne and Clasen 2013). In a review document not included in this review, high variation of FCR in water trucks was also noted in the 2004 Asian tsunami response; with under-dosing (0 mg/L) and severe over-dosing (6 mg/L) noted without further description (Clasen et al. 2006).

Of note is that emergency water trucking for a displaced population in the Democratic Republic of Congo (D.R.C.) led to a disruption of a functioning water market, with the number of households paying reduced by ~25%, forcing water committees to reduce

the price by 50% (Baker and Mbogha 2009). Not included in the review, a technical guidance document on water trucking had two brief examples of NGO water trucking impact on local markets (Wildman). In Ethiopia, NGO water trucking also disrupted local water markets as communities were no longer able to use traditional coping mechanisms (pooling community resources to hire water trucks) because all the commercial trucks were hired by NGOs and no longer available. On the other hand, in Somalia, vouchers for water trucking increased community management through an existing water market with private trucking vendors.

Large-Scale Source Treatment Summary

BWT is not well documented in the acute emergency setting. While the technology is well understood, BWT may be overly promoted in inappropriate settings. Water trucking is widely used as an emergency activity to provide potable water; however, it is not commonly evaluated and when evaluations occur evaluations are generally low quality. Water trucking should only be carried out when necessary, with consideration for current water markets and close supervision to minimize risk of disease (Table 10).

Table 10: Large-Scale Source Treatment Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	-	No Evidence	-
Use	-	No Evidence	-
Non-health	4	Low	*BWT* – Well established treatment methods (not evaluated) requires well trained staff and regular monitoring. *Decentralized BWT* – Effective at improving water quality with consistent FCR in one context. Quick and relatively easy to operate. *Water Trucking* – A common activity in acute emergencies. FCR and microbiological contamination were found to be low in limited evaluations. Local water trucking markets could also be impacted by external involvement.

4.3.2 Small-scale source water treatment

Small-scale source treatment is water treatment that occurs at the source, one container at a time, including: Chlorine Dispensers and bucket chlorination.

> *Chlorine dispensers* – A Chlorine Dispensers program ‘Dispensers’ includes hardware installed next to a water source that dispenses chlorine solution, a local Promoter who refills the Dispenser and conducts community education and a supply chain of chlorine refills. Users treat water by turning a valve that dispenses a controlled amount of chlorine solution.

Bucket chlorination – A common emergency response activity where a person is stationed near a water source and adds a known dose of chlorine directly into the recipients' water collection container.

Evaluations were identified in the review only for Dispensers. Bucket chlorination, a known intervention, was not evaluated, but mentioned twice as an activity in the included evaluations (Grayel 2011, Neseni and Guzha 2009).

Dispensers were used in three different cholera contexts: Haiti, Sierra Leone and D.R.C., with three different NGOs (Yates, Armitage, et al. 2015). Results varied over two acute (2-8 weeks after installation) and three sustained (4-7 months after installation) evaluations focused on reported use, confirmed use and effective use (Table 11). Spillover effects from other water treatment options were present and assist in explaining results, as the municipal water system in D.R.C. was functional in the sustained evaluation and 32% of households in Haiti reported using chlorine tablets, an alternative household water treatment method. Speaking to the Promoter within the last month and collecting water from a source with a Dispenser were factors consistently associated with higher use.

Table 11: Small-scale source water treatment comparison

Author (Year) Country Bias	Context Approach	Evaluation	Use Outcomes		
			Reported Use	Confirmed Use	Effective Use
Yates (2015) Haiti Low risk of bias	Cholera outbreak – Rural 60 Dispenser sites 20L and 5L dose per site 1 Promoter/site	Cross-sectional (cluster) 298 HH	Sustained		
			55%	9%	4%
Yates (2015) Sierra Leone Low risk of bias	Cholera outbreak – Peri-urban 50 Dispenser sites 20L dose per site 32 Promoters/50 sites	Cross-sectional (cluster) 300 HH (initial and sustained)	Initial		
			26%	11%	10%
			Sustained		
			31%	18%	10%
Yates (2015) DRC Low risk of bias	Endemic cholera – Rural and peri-urban 100 Dispenser sites 2 – 20L doses per site 1 Promoter/site	Cross-sectional (cluster) 300 HH (initial and sustained)	Initial		
			76%	34%	28%
			Sustained		
			75%	5%	0%

A fourth case study in the same evaluation was conducted in a non-acute food crisis emergency situation and had much higher results (>79% reported, confirmed and effective use in initial and sustained evaluations). The three implementing organizations and evaluators gathered at project end and reflected on factors that led

to success. These included: 1) appropriate source selection; 2) chlorine solution quality and supply chain; 3) Dispenser hardware installation and maintenance; 4) integration into a larger WASH program; 5) promoter recruitment and remuneration; 6) experienced program staff; 7) partnering with local organizations; 8) conducting on-going monitoring; and 9) having a sustainability plan.

Source Treatment Summary

Use rates varied, but Dispensers were deemed to be an appropriate option if the certain contextual conditions, discussed above, were met (Table 12). Through low risk studies, promotion and access were consistently significant factors in use of the Dispensers. Bucket chlorination was not evaluated.

Table 12: Small-Scale Source-Based Treatment Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	-	No Evidence	-
Use	3	Moderate	Variation in reported, confirmed and effective use – context specific based on established criteria.
Non-health	3	Moderate	Speaking with Promoter and easy access to Dispenser associated with increased use.

4.4 Water: Household water treatment and safe storage

HWT products (also called point-of-use water treatment products) are interventions used in the home to improve microbiological quality of household drinking water. These may be distributed as a sole intervention or included as one of several items in a hygiene kit. Distributions also sometimes include hygiene promotion.

> *Household Water Treatment (HWT)* – HWT products (chlorine products, filters, solar disinfection or boiling) disinfect, remove or inactivate harmful pathogens. HWT products are used at home, relying on the beneficiary to understand instructions and use materials correctly.
>
> *Hygiene Kit Distributions* – Hygiene kits, a type of Non-Food Items (NFI) distribution, provide disaster-affected populations with materials necessary to reduce the risks of disease transmission. HWT products, soap, water storage containers and household disinfection materials are commonly included items in hygiene kits.
>
> *Hygiene Promotion* – Hygiene promotion related to HWT products typically include printed instructions on how to use a product or a community health worker (CHW) giving a lesson on correct use. CHWs may also share emergency-related information.

HWT was the most studied intervention with 39 evaluations, some with multiple products. Overall, 21 used chlorine-based products (12 with chlorine tablets, nine

with liquid chlorine), seven used flocculant/disinfectants, six used filters and five other less common methods.

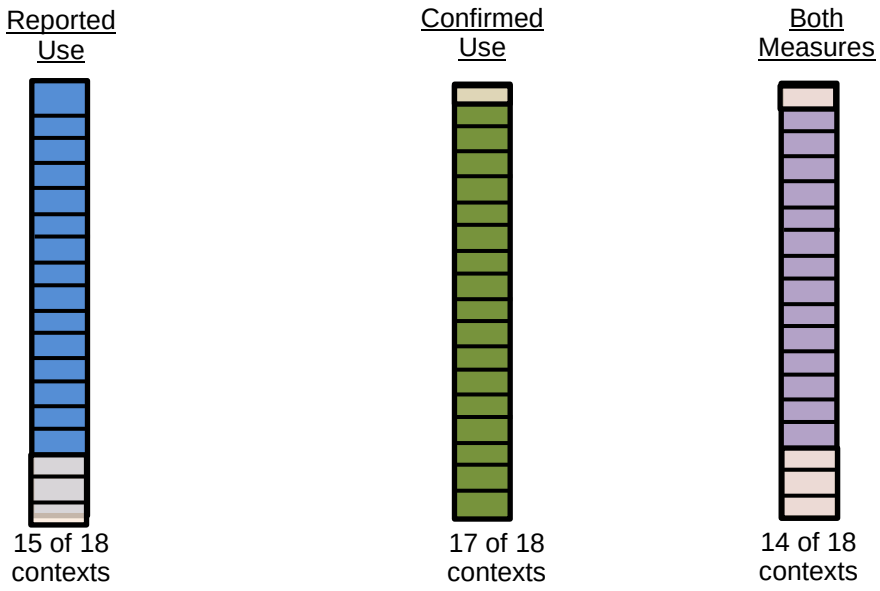
4.4.1 Chlorine-based HWT Products

Chlorine is often distributed in emergency response because chlorine effectively inactivates most bacterial and viral pathogens, leads to residual protection, is low cost and is easy to use and transport. Users add one tablet or measured amount of liquid (usually 1 capful) to low-turbidity water, wait 30 minutes and drink. Higher turbidity water can be treated by doubling the dose. There are two chlorine-based HWT options used in emergencies: tablets and liquids.

> *Chlorine tablets* – Small tablets of 7-167 mg sodium dichloroisocyanurate used to treat 1-20L of water (e.g. Aquatabs®).
>
> *Liquid chlorine* - Either a small bottle of 1-1.25% sodium hypochlorite, sized so one cap is used to treat 20L of water (e.g. WaterGuard) or commercial bleach, where the dosage is generally in drops.

Reported, confirmed and effective use are all outcome metrics reported for chlorine-based HWT options. Among the 21 chorine-based evaluations, 18 contexts measured reported or confirmed use, 15 measured reported use, 17 measured confirmed use and 14 reported both (Figure 17). Effective use was measured in four evaluations.

Figure 17: Chlorine HWT evaluations with reported or confirmed use



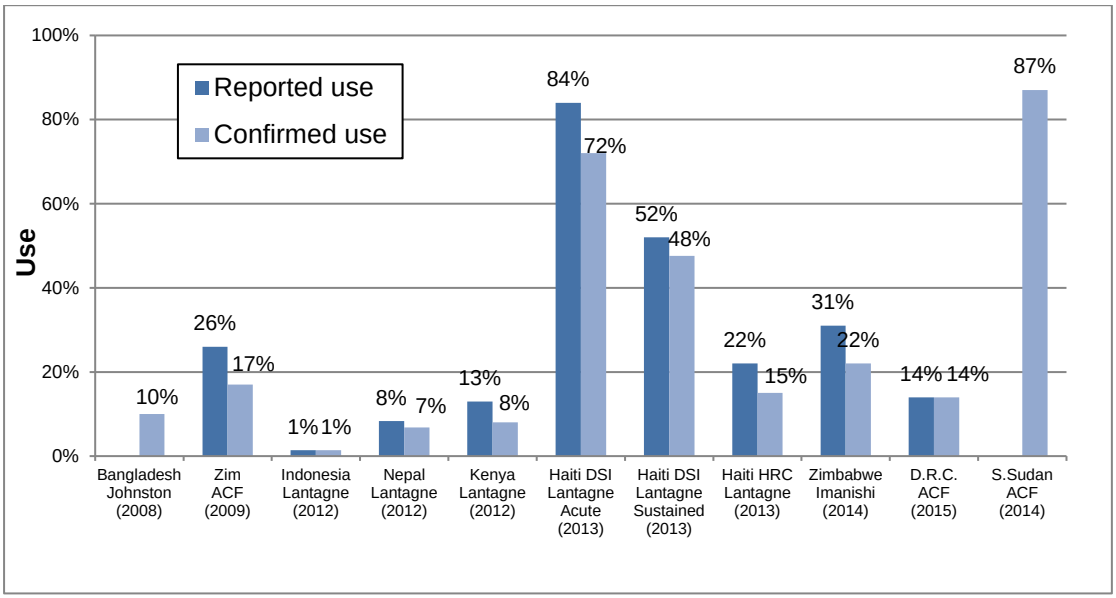
Each box represents a HTW chlorine evaluation. Shaded boxes indicate the outcome was reported.

Individual assessments of chlorine tablets and liquid chlorine are separated for further analysis below. While HWT are the most reported intervention, the heterogeneity of context, intervention and evaluation was still too high to calculate summary statistics or conduct meta-analysis.

Chlorine Tablets

Chlorine tablets were used in 12 evaluated contexts (Table 13). Distribution of chlorine tablets was typically through a hygiene kit. The distributed tablets (33-167 mg) were intended to treat 5-20L of water. Evaluations included both reported and confirmed use in nine out of 12 contexts (Figure 18). The reported use ranged between 1-84% and confirmed use ranged between 1-87%.

Figure 18: Chlorine Tablet Evaluations with Reported and Confirmed Use



The highest rates were reported in South Sudan and Haiti. In South Sudan more than 92% of households reported receiving a household visit before the distribution and 82% reported that treating drinking water prevents cholera (ACF 2014c). In Haiti, treated water campaign had been operating in the area for several years with 75-82% of HH knowing the correct use of Aquatabs (Lantagne and Clasen 2013).

Table 13: Chlorine Tablet Comparison

Author (Year) Country Bias	Approach	Evaluation	Use Outcomes	
			Reported Use	Confirmed Use (FCR)
Johnston (2008) *Bangladesh* High risk of bias	Chlorine tablets distributed by various stakeholders with limited instructions, compared to PuR distribution and control groups.	Cross-sectional: 126 HH	Not reported	10% of HH confirmed use (FCR >0.0 mg/L)
ACF (2009) *Zimbabwe* High risk of bias	Aquatabs® distributed HH as part of an NFI kit with bucket and lid (~33,000 kits, other contents not described).	Cross-sectional: 218 HH	26% of HH reported use	17% of HH confirmed use (FCR >0.5 mg/L)

Author (Year) Country Bias	Approach	Evaluation	Use Outcomes	
			Reported Use	Confirmed Use (FCR)
Lantagne (2012) *Nepal* Low risk of bias	Local NGOs using pre-positioned hygiene kits. 1,565 HH received Aquatabs® and also liquid chlorine (WaterGuard, Piyush) with hygiene promotion.	Cross-sectional: 400 HH	8.3% of HH reported use	6.8% of HH confirmed use (FCR ≥0.2 mg/L)
Lantagne (2012) *Kenya* Low risk of bias	Pre-positioned hygiene kits. Aquatabs® and PuR® Purifier of Water included to 5,592 HH.	Cross-sectional: 400 HH	12.7% of HH reported use	7.9% of HH confirmed use (FCR ≥0.2 mg/L) (Effective use: 5.3% of HH)
Lantagne (2012) *Indonesia* Low risk of bias	HWTS to 1,578 HH who received chlorine tablets (Rotary).	Cross-sectional: 270 HH	1.4% of HH reported use; boiling reported in 88% of HH	1.4% of HH confirmed use
Lantagne (2013) DSI Program Acute *Haiti* Low risk of bias	Aquatabs distributed to 2,880 HH, pre-existing project before the earthquake, expanded after earthquake.	Cross-sectional: 182 HH	84% of HH report Aquatabs use	72% of HH confirmed use (FCR ≥0.2 mg/L) 63% effective use
Lantagne (2013) DSI Program Recovery *Haiti* Low risk of bias	Aquatabs distributed to 2,880 HH, pre-existing project before the earthquake, expanded after earthquake.	Cross-sectional: 143 HH	52% (74) HH report Aquatabs use	47.6% (68) of HH confirmed use (FCR ≥0.2 mg/L) 46% effective use
Lantagne (2013) HRC Program *Haiti* Low risk of bias	Aquatabs distributed in an NFI kit to 87 HH in an IDP camp, without promotion.	Cross-sectional: 87 HH	22% (19) of HH reported use	15% (13) HH confirmed use (FCR ≥0.2 mg/L) 13% effective use
ACF (2014) Hygiene Kits PDM Report* *South Sudan* High risk of bias	Aquatabs, filter cloth, PuR packets and bucket in hygiene kits with promotion.	Cross-sectional: 351 HH	Reported use not measured.	87% of HH confirmed use with Aquatabs (FCR >0.1 mg/L)
Imanishi (2014) *Zimbabwe* Medium risk of bias	Three chlorine tablets distributed by different organizations: Oasis 67 mg, Aquatabs 67 mg, Aquatabs 167 mg in hygiene kits with door-to-door promotion and information, education, and communication (IEC) materials.	Cross-sectional: 458 HH	31% of HH reported use	22% of HH confirmed use (FCR >0.0 mg/L)

Author (Year) Country Bias	Approach	Evaluation	Use Outcomes	
			Reported Use	Confirmed Use (FCR)
ACF - Topklo (2015) *D.R.C.* Low risk of bias	Distribution of chloramine tablets in hygiene kits with promotion.	Cross-sectional: 384 HH	14% of HH reported use	14% of HH confirmed use (FCR 0.3-0.6 mg/L)
Sirajul Islam (2007)* *Bangladesh* Low risk of bias	Field trial of HWT disinfectants: Halotab (15 mg chlorine tablet) from 20 drinking water sources; no beneficiary involvement.	300 samples – total coliforms (TC), faecal coliforms (FC), faecal streptococci (FS) tested	Not reported	Efficacy in flood waters: Total and faecal coliforms eliminated in 81.5% and 77.1% of samples

*Reported or confirmed use not measured and not shown on the Figure 17

Health impact was measured in one document after the typhoon/flooding in Bangladesh; a 55% diarrhea reduction was measured in children under five but was not significant (RR 0.45, 95% CI 0.19-1.03) (Johnston 2008). Similar, but less strong disease impact for adults were noted but not detailed.

One evaluation measured the effectiveness of several HWT products in a field trial of water sources during a flood in Bangladesh (Sirajul Islam et al. 2007). Chlorine tablets and bleaching powder eliminated total coliforms in 84% and 65% and samples, respectively. Similarly, faecal coliforms were eliminated in 77% (tablet) and 72% (bleaching powder) of samples.

The taste and smell of chlorine tablets was reported as a barrier to use in nearly half of the contexts (5/11) from three countries (ACF 2009, Lantagne and Clasen 2012, Imanishi et al. 2014, Ruiz-Roman 2009, Johnston 2008). Part of the reason for the taste and smell objections may have been confusion between the appropriate tablet dose and water storage container size, as some respondents did not have the appropriate water storage container and this may have led to high doses and unfavorable taste (Imanishi et al. 2014, ACF 2009, Johnston 2008, Varampath 2008). Knowing a HWT method before the emergency was an indicator of use in Zimbabwe (Imanishi et al. 2014) and Nepal (Lantagne and Clasen 2012); in both contexts, familiarity of the products and ease-of-use was described by the beneficiaries.

Chlorine Tablet Summary

Reported and confirmed use varied widely and the quality of evidence was mixed. Use was low when products were distributed in hygiene kits with minimal hygiene education or alternative treatment methods were present (Table 14). Although the simplicity and ease-of-use of tablets was appreciated, strong knowledge of water treatment practices was associated with higher use. A storage container sized appropriately for the distributed tablet was helpful and having multiple tablets for varying volumes of water distributed in the same emergency was noted as confusing.

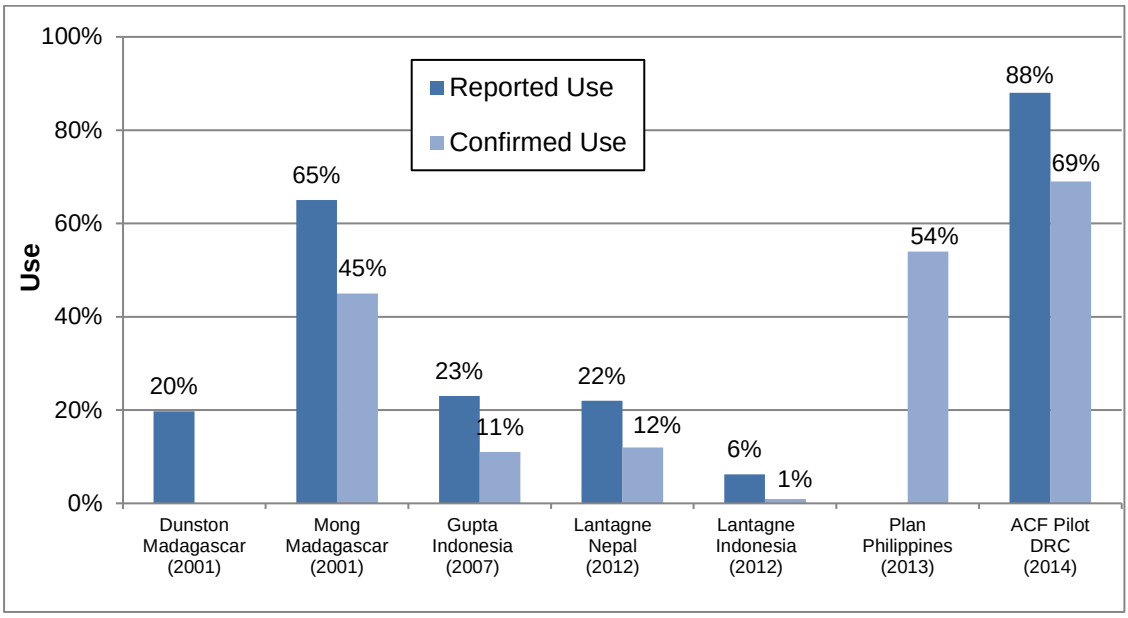
Table 14: Chlorine Tablet Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	1	Very Low	Diarrhea reduction from one evaluation. Strong effect but insignificant.
Use	11	Moderate	Reported use range: 1-84%, n=9 Confirmed use range: 1-87%; n=11
Non-health	5	Moderate	Chlorine taste/smell, ease-of-use and familiarity influence use and acceptance.

Liquid Chlorine

Liquid chlorine was evaluated in nine contexts in six countries (Table 15). Considering all liquid chlorine evaluations, reported use ranged between 6-88%, and confirmed use ranged between 1-69% (Figure 19).

Figure 19: Liquid Chlorine Evaluations with Reported and Confirmed Use



Some of the heterogeneity could be explained by the active promotion of liquid chlorine before the outbreaks in the two studies with higher usage rates in the D.R.C. (Tokplo 2015) and Madagascar (Mong et al. 2001). Cost may explain the low use in Madagascar (Dunston et al. 2001) as the free distribution of the same product had much higher rates in the same area (Mong et al. 2001). Excessive dosing was observed in Madagascar (FCR >3.5 mg/L) (Mong et al. 2001) and taste was noted as a hindrance to use in Nepal and Philippines (Lantagne and Clasen 2012, Plan 2013).

Table 15: Liquid Chlorine Comparison

Author (Year) Country Bias	Approach	Evaluation	Use Outcomes	
			Reported Use	Confirmed Use
Mong (2001) Madagascar High risk of bias	Liquid chlorine and 5 gallon flexible jerry can distributed to 11,700 HH with some education about use. Distribution in area with program before emergency.	Cross-sectional 123 HH	65% of HH reported use	45% of HH confirmed use (FCR ≥0.2 mg/L)
Lantagne (2012) Nepal Low risk of bias	Local NGOs using pre-positioned hygiene kits. 1565 HH received liquid chlorine (WaterGuard®, Piyush®) but also Aquatabs® with hygiene promotion.	Cross-sectional 400 HH	22.2% reported use (2 products: WaterGuard®: 6.3% Piyush®: 15.8%)	11.8% of HH confirmed use (2 products: WaterGuard®: 3.5%; Piyush®: 8.3%) (FCR ≥0.2 mg/L)
Dunston (2001) Madagascar High risk of bias	Liquid chlorine marketed to community. Jerry cans available but not distributed.	Cross-sectional 375 HH	19.7% of HH reported use	No confirmed use measured
ACF (2014) D.R.C. High risk of bias	Distribution and promotion of liquid chlorine with vouchers to 834 HH.	Cross-sectional 32 HH	88% of HH redeemed voucher (proxy for use)	69% of HH confirmed use
Plan (2014) Typhoon Usagi *Philippines* High risk of bias	Hyposol (sodium hypochlorite) and hygiene kit to 4,000 HH.	Cross-sectional 105 HH	Not reported.	54% of HH confirmed use (FCR: 'trace')
Sirajul (2007)* *Bangladesh* Low risk of bias	Field trial of Zeoline-200 (commercial liquid chlorine);	300 water samples from 20 drinking water sources.	Not reported.	Efficacy in flood waters: Total and faecal coliforms eliminated in 83.8% and 72.6% of samples
Macgregor-Skinner (2005)** *Indonesia* High risk of bias	SWS project including liquid chlorine and training – emergency-affected population (# of HH not mentioned).	2 stage random; 320 people in Betun and Panite – HH visited 2x/week for 7 weeks	Not reported.	70-94% of HH confirmed use (FCR >0.0 mg/L)

* Reported or confirmed use not measured and not shown in Figure 18

** 'Peak rates' mentioned but suitable for comparison in Figure 18

As noted in the chlorine tablet section above, the effectiveness of liquid chlorine on total and faecal coliforms was measured during a flood in Bangladesh in one document (Sirajul Islam et al. 2007). Liquid chlorine was effective eliminating 82% of total coliforms and 77% of faecal coliforms.

Liquid chlorine was more often linked to longer-term development approaches; including promotion (compared to distribution), cost-recovery, social marketing (Dunston et al. 2001, Lantagne and Clasen 2012), local production (Date et al. 2013) and vouchers (ACF 2014d). All these program types were used in liquid chlorine programming and not generally described in other interventions. Liquid chlorine was also more regularly used in endemic disease situations, where repeated outbreaks are responded to like a development project, occasionally scaling-up on-going interventions.

Liquid Chlorine Summary

Liquid chlorine interventions included programs that promoted, distributed, marketed and redeemed vouchers for chlorine solutions. Some communities had previous exposure to liquid chlorine products and exposure to development and sustainable activities. This is believed to have contributed to relatively higher use of liquid chlorine than chlorine tablets, which were predominantly distributed in NFI kits (Table 16). With the differences in evaluation and mostly high bias studies, direct comparisons could not be made.

Table 16: Liquid Chlorine Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	-	No Evidence	-
Use	7	Moderate	Reported use ranged: 6-88%; n=6 Confirmed use ranged: 1-69%; n=6
Non-health	4	Moderate	Familiarity of liquid chlorine was beneficial; flexibility to be scaled-up from development projects

Combination Flocculant/Disinfectants

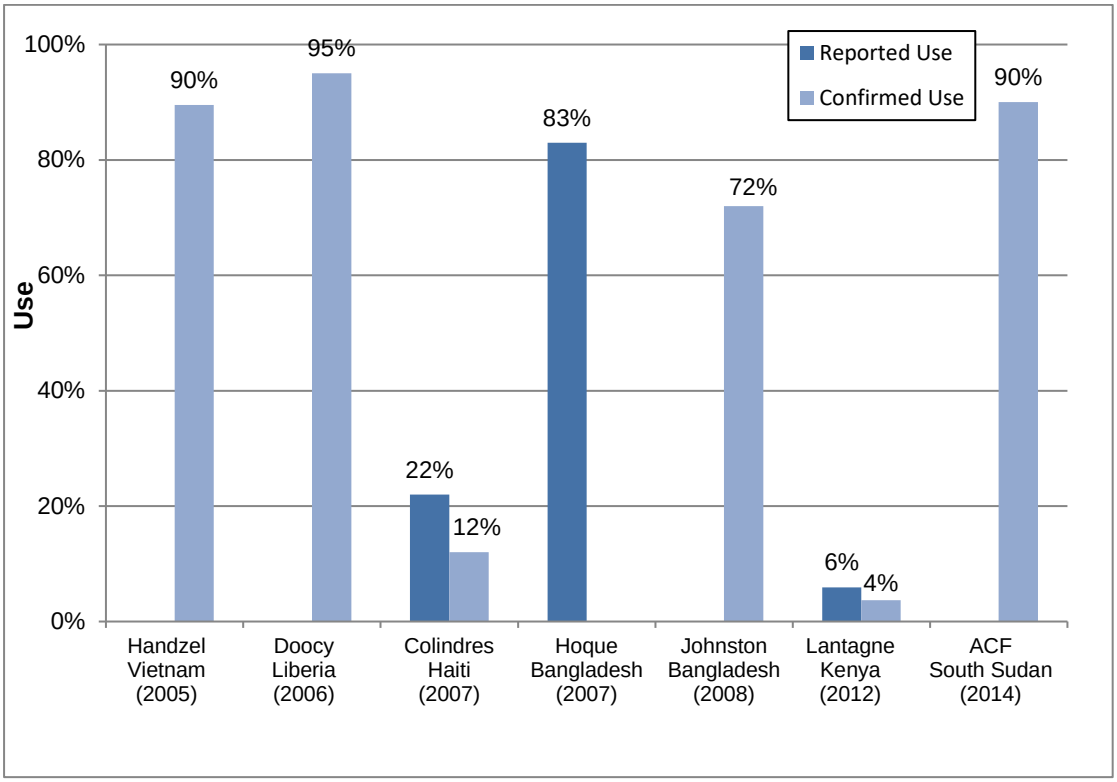
Combination flocculant/disinfectants, such as P&G Purifier of Water (formally PuR® and referred to as ‘PuR’ for this report), are well suited to treat turbid water. To use the sachet, users add the contents to 10L of water, stir for five minutes, wait five minutes for the solids to settle, filter the water through a cloth into a second bucket and wait 20 minutes before drinking.

PuR was evaluated in seven evaluations, with use and health impact evaluated. Only two evaluations measured both reported and confirmed use (Lantagne and Clasen 2012, Colindres et al. 2007) (Table 17). Documents with both measures, reported use ranged between 6-22% and confirmed use ranged 4-12% (Figure 20). Ranges

with all seven documents jump considerably with reported use ranging between 6-83% (n=3) and confirmed use ranging between 4-95% (n=6).

High use (reported or confirmed) was reported with strong promotion and knowledge of how to use PuR (Doocy and Burnham 2006, ACF 2014c, Colindres et al. 2007). In a study in Kenya, PuR was distributed through an NFI distribution with minimal promotion, only 2.3% of households could describe the five steps necessary for PuR translating to similarly low reported use of 5.9% and confirmed use of 3.7% (Lantagne and Clasen 2012). Access to materials was also a factor in Kenya, with many families reporting the supply had run out. Plans to make PuR available in local Kenyan markets were intended, but ultimately did not provide access to the affected population.

Figure 20: PuR Evaluations with Reported and Confirmed Use



Health impact was reported in two evaluations, a randomized control trial in Liberia and typhoon response in Bangladesh. In Liberia, PuR reduced diarrhea incidence by 67% (adjusted RR 0.33; 95% CI 0.30-0.37) (Doocy and Burnham 2006), with similar results of 77% reduction in Bangladesh (RR 0.23; 95% CI 0.07-0.72) (Johnston 2008).

Table 17: PuR Comparison

Author (Year) Country	Approach	Evaluation	Outcomes	
			Reported Use	Confirmed Use (FCR)
Handzel (2005) *Vietnam* High risk of bias	3 month supply of PuR (90 sachets) to 2,500 HH.	Cross-sectional: 30 HH	Not measured	89.5% of HH confirmed use (FCR >0.0mg/L)
Doocy (2006) *Liberia* Low risk of bias	Randomized control trial of PuR sachets with all necessary equipment compared to distribution of 10L buckets only.	RCT: 200 HH in intervention and 200 HH in control	Not measured	95% of HH confirmed use (FCR >0 mg/L)
Colindres (2007) Haiti High risk of bias	PuR (410,000 sachets) and PuR-related education provided to 9,000 HH.	Cross-sectional cluster randomization: 100 HH	22% of HH reported use	12% of HH confirmed use
Hoque (2007) *Bangladesh* High risk of bias	20 sachets of PuR and 20 Aquatabs (33 mg) in hygiene kits to 4,800 HH (food, two 20L buckets, one plastic water container 3L and other items).	Cross-sectional: 200 HH	83% of HH reported use of either PuR or Aquatabs	Not measured
Johnston (2008) *Bangladesh* High risk of bias	Chlorine tablets distributed by various stakeholders, compared to PuR distribution and control groups.	Cross-sectional: 131 HH	Not measured	72% of HH confirmed use (FCR >0.0 mg/L)
Lantagne (2012) *Kenya* Low risk of bias	Distribution of PuR and Aquatabs in prepositioned hygiene kit.	Cross-sectional: 409 HH	5.9% of HH reported use	3.7% of HH confirmed use (FCR ≥0.2 mg/L) (Effective use: 2.3%)
ACF (2014) Hygiene Kits Post Distribution Monitoring Report *South Sudan* High risk of bias	Aquatabs, filter cloth, PuR and bucket in NFI kits with some promotion.	Cross-sectional: 351 HH	78% of HH could demonstrate correct use of PuR	Aquatabs and/or PuR, >90% of HH had FCR (range 83-100%)

Community preference to taste and smell of PuR ranged widely, with two populations (Haiti and Liberia) reporting liking the taste (Doocy and Burnham 2006, Colindres et al. 2007) and two populations reporting not liking the taste or smell (Bangladesh and Vietnam) (Hoque and Khanam 2007, Handzel and Bamrah 2006). Similarly, PuR was described as easy to use in one evaluation (Colindres et al. 2007), but also ‘too time consuming’ (Hoque and Khanam 2007). When distributed together, PuR was preferred over Aquatabs (Johnston 2008, Hoque and Khanam 2007).

Flocculant/Disinfectant Summary

Most the studies were high risk of bias evaluations; however, with sufficient training and access, high rates of use were consistently observed, leading to significant diarrheal disease reduction. Community preferences varied but PuR was consistently preferred over other treatment options (Table 18).

Table 18: PuR Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	2	Low	With high confirmed use, strong and significant diarrhea rates are possible.
Use	6	Moderate	Reported use ranged: 6-83%, n=3 Confirmed use range: 4-95%, n=6
Non-health	4	Moderate	Taste and ease-of-use varied, consistently preferred over other HWT options but training needed.

4.4.2 Filtration

HWT filter types include simple screens, ceramic, sand and hollow-fiber filters. These filters are generally effective at removing protozoa and bacteria, and some hollow-fiber filters can also remove viruses.

Six evaluations in five countries (Sri Lanka, Dominican Republic, Haiti, South Sudan and Pakistan) were identified in the review (Table 19).

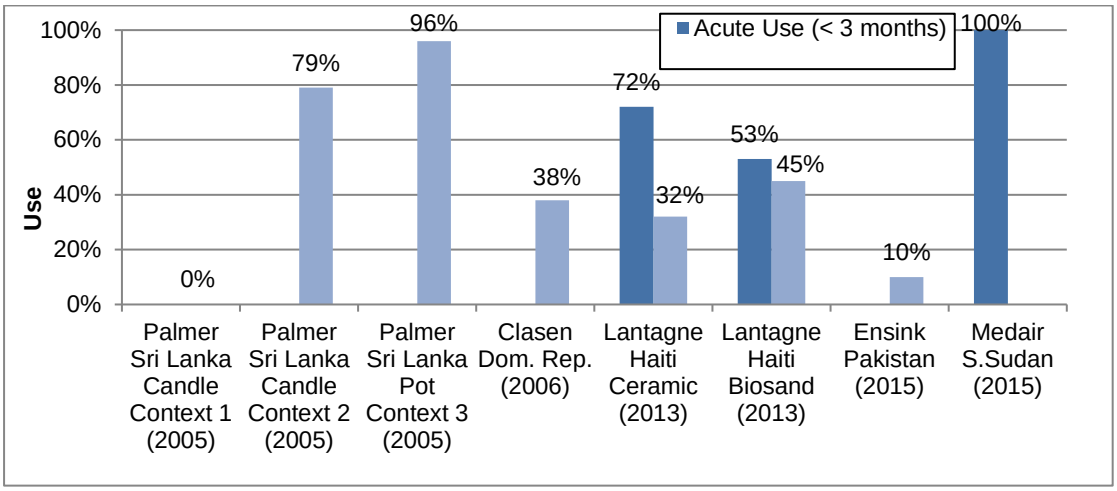
Table 19: Filter Comparison

Author (Year) *Country*	Filter Description	Evaluation	Findings
Palmer (2005) *Sri Lanka* High risk of bias	3 filter distributions: 1) Candle filter in emergency shelter 3 months after tsunami; 2) Candle filters in transitional shelter 6 months after tsunami; and 3) Pot filter in permanent housing 6 months after tsunami	Cross-sectional: 79 HH and focus group discussion (FGD)	1) 0% of HH reported use (n=13), only 23% have water in the home. 2) 82% of HH reported use (n=33), 79% have water in the home. 3) 100% of HH reported use (n=26), 96% have water in the home.
Clasen (2006) *Dominican Republic* High risk of bias	Ceramic candle filter (ceramic element and granulated activated carbon in a 20L bucket) distributed to 40 HH.	RCT followed by a cross-sectional study 16 months later; 80 HH (40 control, 40 intervention)	Self-reported use: 38% using filter after 16 months. 51% of those were still drinking from other sources. Breakage and lack of access to replacement filters were reported as reasons for disuse.

Author (Year) *Country*	Filter Description	Evaluation	Findings
			70.6% of water samples met WHO guidelines for <1 fecal coliforms per 100 mL compared to 31.8% of samples from control HH's.
Lantagne (2013) *Haiti – Biosand* Low risk of bias	Distribution of Biosand filter to 238 HH.	Cross-sectional; 51 HH surveyed within 8 weeks of emergency onset (acute) and 47 HH 10 months after onset (recovery)	53% (27) of HH report filter treatment in acute evaluation; 8% effective use. 45% (21) HH report filter use after 10 months. 28% effective use.
Lantagne (2013) *Haiti – Ceramic* Low risk of bias	Distribution of FilterPure Ceramic filter to 350 HH.	Cross-sectional; 43 HH surveyed within 8 weeks of emergency onset (acute) and 28 HH 10 months after onset (recovery)	72% (31) of HH report filter use in acute evaluation; 20% effective use. 32% (9) HH report filter use after 10 months; 0% effective use.
Ensink (2015) *Pakistan* High risk of bias	Nerox microfiltration system intervention group compared to Stefani porous ceramic (candle) filter control group.	Cross-sectional: 210 HH with Nerox and 20 HH with ceramic candle filter	10% of HH reported use 6 months after distribution. No filter removed all faecal coliforms.
Medair (2015) *South Sudan* High risk of bias	Distribution of Sawyer PointONE filter and one pre-drilled bucket (12L or 14L) to 206 HH.	Mixed methods: 85 HH	100% reported use (after 8 weeks). 86% of HH could demonstrate correct use.

Filters provide immediate water treatment that can also last into the recovery phase (3-9 months after the disaster) without additional distributions from NGOs. This is in contrast to supply driven water treatment (i.e. chlorine, flocculent/disinfectants) where households are often dependent for NGOs to deliver treatment products every few weeks or months. In the acute emergency phase, filter use was higher (range: 53-100%, n=3) than sustained use (range: 0-96%, n=7) (Figure 21). *Note that filter distributions did note always occur in the acute phase; for example, in the Palmer document, filters were distributed in month three and six to different populations – one had limited access to water resulting in 0% use. Also, sustained use was measured between 6-16 months after distribution.*

Figure 21: Filter Use by Time



The quality of the source water is an important consideration in filter distributions. Muddy, turbid waters can quickly clog filters which reduce the flow rate and limit the microbiological effectiveness (Clasen and Boisson 2006). The time needed to treat enough water for a household may not match beneficiary needs or expectations (Cressey 2015), but beneficiaries often report improved taste (Clasen and Boisson 2006, Ensink, Bastable, and Cairncross 2015, Palmer 2005).

Not included in this review, in a non-emergency context with endemic cholera, two simple filters (a small nylon screen of 150 µm mesh size and a folded piece of sari cloth) were used in intervention groups and compared to a control group (Colwell et al. 2003). Cholera morbidity was significantly reduced by approximately 40% in both the nylon and sari cloth filter groups (nylon filter OR: 0.59, 95% CI 0.37 – 0.92, $p<0.02$; sari cloth OR: 0.52, 95% CI 0.35 – 0.77, $p<0.001$). After five years, participants were revisited and households in the sari cloth group were more likely to report use of some method of water treatment (35% compared to control at 23% and nylon group at 26%), and filter use was identified to have a protective reduction in morbidity that extended to neighbors of filter users neighbors (Huq et al. 2010).

Filter Summary

With more high than low risk of bias evaluations, water filters consistently had high use and beneficiaries appreciated the taste improvement from the filters (Table 20). Use declined over time and functionality diminishes with turbid water. Also, note that distributions were comparatively smaller than chlorine distributions.

Table 20: Filter Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	-	No Evidence	-
Use	6	Moderate	Acute use (<3 months since emergency) ranged: 53-100%, n=3 Sustained use (≥3 months since emergency) ranged: 0-96%, n=7
Non-health	4	Moderate	Improved taste is consistent among populations

5.4.3 Other HWT and safe storage interventions

Less common than chlorine, flocculent-disinfectants and filters, several other HWT interventions were used in emergencies. Solar disinfection (1), safe storage (2), alum (1) and boiling (1) are described in the following sections.

SODIS

Solar Disinfection (SODIS) uses heat and ultra-violet (UV) radiation from the sun to inactivate bacteria, viruses and protozoa in drinking water. Users place a clear container (e.g. 1.5L plastic bottle) on their roof in the sun for 6-48 hours depending on direct sunlight.

SODIS was evaluated in one evaluation that started off as a development context in Kenya, but led into an outbreak evaluation when cholera spread to the project area (Conroy et al. 2001). SODIS was effective at reducing self-reported diarrhea rates by 88% in children under 6 (RR 0.12; 95%CI 0.02-0.65; p=0.014). Older children (7-15 years old) and adults (16 years and above) had a statistically insignificant increased risk of diarrhea; although it was unclear if the family members used SODIS or other drinking water sources (6-15 yr: RR 1.09; 95% CI 0.58-2.05; Adults: RR 1.2; 95% CI 0.59-2.5).

Chemical coagulants

Chemicals coagulants (e.g. alum, ferric salts, lime) are added to water to help suspended solids clump together, flocculate and settle to the bottom. Bacteria also settle to the bottom, improving the water quality.

One evaluation measured the effectiveness of alum in a field trial of water sources during a flood in Bangladesh (Sirajul Islam et al. 2007). Alum was effective at treating total coliforms in 73% of samples, but was less effective with fecal coliforms (30%). Alum was not as effective in microbiological contamination compared to chlorine options; however, alum was considered ‘most appropriate’ when considering the cost, ease of use, familiarity and availability compared to other HWT options.

Safe water storage

Safe water storage is storing water in a way that reduces the risk of contaminants in the water (i.e. a bucket with a lid and spigot or a narrow-mouthed jerrican as compared to an open container where water is accessed with a ladle).

Two evaluations isolating safe water storage were identified in the review. The control group in the PuR evaluation in Liberia received jerricans, and this alone reduced diarrhea rates by 16% compared to the preceding week (OR 0.84, 95%CI 0.82-0.86) (Doocy and Burnham 2006). And in a Malawi refugee camp, buckets with a spout and a permanent partial lid were provided as the intervention in a randomized control trial (RCT), compared to regular open buckets as the control (Roberts et al. 2001). Diarrhea rates were reduced by 31% (95% CI -63.4 - 1.4%) in children under 5 years and 8% (95% CI -5.8 – 21.8%) overall for the intervention group, however neither were statistically significant (p=0.06 and p=0.26). The community preferred the improved buckets over chlorination, as chlorine was associated with a bad taste and smell.

Boiling

Boiling water is not widely promoted as the primary emergency response HWT strategy because it is energy intensive and does not provide residual protection. However, the materials for boiling are often available and beneficiaries are often already aware of boiling as a treatment strategy. The 2005 tsunami response in Indonesia is a notable exception where boiling was widely promoted after a multitude of HWT products overwhelmed the local population with unfamiliar options (Blake, Walker, and Walker 2011, WHO 2005). Previous knowledge and ease were drivers for boiling promotion over the actual effectiveness of treatment (Clasen et al. 2006). Boiling was also promoted as part of a hygiene campaign for cholera in Guinea-Bissau (Einarsdbttir, Passa, and Gunnlaugsson 2001). After the campaign, 40% of households reported boiling water; although, 66% reported using lemon to treat water and no household reported consistent use of either method.

Summary of other HWT interventions

SODIS, safe storage, alum and boiling are not typical HWT strategies in an emergency, with limited number of evaluations. Overall the quality of evidence is very low; some but not all diarrhea reductions were significant (Table 21). These HWT interventions were reported to be simple, sustainable and accepted by the communities.

Table 21: SODIS, Safe Storage, Alum and Boiling Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	1	Low	*SODIS* – Reduced diarrhea in children under 6 years, but risk factor for other family members. *Safe Storage* – Consistent diarrhea reduction with simple bucket provision and minimal promotion
Use	1	Very Low	*Boiling* – Self-reported at 40%
Non-health	5	Moderate	Ease of use and community acceptance reported

4.5 Sanitation

The goal of sanitation programs in emergency response is to break disease transmission by isolating feces from the environment, either using output driven approaches (e.g. latrine construction) or community driven approaches (e.g. stop open defecation).

> *Output Driven* – Latrines are designed and built by responders according to a pre-planned number to meet guidelines or based on budget (Sphere Project 2011). Community involvement in these programs generally varies from none to volunteering labor or materials to a cash-for-work project. Removing the feces from a latrine, desludging and managing the waste disposal are important intervention components, along with accessibility and cleanliness.
>
> *Community Driven* – Community driven approaches focus on specific promotion to 'trigger' the community to address their sanitation needs with local materials. Community Led Total Sanitation (CLTS), Community Approach to Total Sanitation (CATS) and Participatory Hygiene and Sanitation Transformation (PHAST) are all community driven approaches. CLTS is a sanitation strategy that focuses on hygiene education and community mobilization to stop open defecation. Communities are engaged through a facilitator with a specific process and encouraged to build their own latrines from locally available materials. Similarly, CATS and PHAST also use community mobilization, but provide some material assistance to help build latrines.

Emergency sanitation was assessed in 16 output-driven evaluations: latrines (13) and latrine alternatives (3). Community-driven sanitation interventions are described below in 'social mobilization' (Section 5.6.1.2).

4.5.1 Output Driven Sanitation

Providing access to sanitation through output driven latrine construction is common, with numerous different guidelines and options from NGOs, the UN and academics (de Lange et al. 2014). Latrine construction is often carried out with water and/or hygiene interventions described in other sections of this document; 12 evaluations were focused on provision of latrines and three on latrine alternatives. Latrine use or impact was rarely evaluated, and the heterogeneity of reporting precluded direct comparison; however, details on sanitation interventions are in Appendix A. Key themes from documents included in this review are summarized herein around: use in the acute emergency (less than 1 week from disaster); eco-sanitation; rehabilitation of damaged latrines; vulnerability targeting; and reduced disease burden.

> *Acute Disaster Latrines* – In dense urban areas or places where digging is not feasible, portable toilets (e.g. porta-johns, porta-loos) were successful at providing safe dignified sanitation immediately after the Haiti earthquake (Eyrard 2011). Costs were comparable to semi-permanent latrines ($5.4/user/month compared to $5.2/user/month), although desludging and final sludge disposal requires careful consideration before implementation. Raised latrines were also temporary solutions where digging was not feasible. Used in Haiti and Bolivia, raised latrine

including a cubicle structure were placed over a barrel or tank operating similar to port-a-johns, but required less frequent desludging (Bastable and Lamb 2012, Kinstedt 2012). Where digging was possible, a simple 'shallow trench latrine' was trailed in the Pakistan flood response in 2010 (Singh 2012, Bastable and Lamb 2012). Constructed with tarpaulin and timber/bamboo poles, there was community support for the trench latrine as a temporary solution. Ultimately more than 6,000 trench latrines were built in two months. Acute refugee response from the 1980's (published in 1996) focused on flexibility and creativity of sanitation solutions (Howard 1996). While each context is unique, it was consistently found that beneficiaries will use latrines provided they are safe, clean and offer privacy.

Eco-sanitation – Ecological sanitation (Ecosan) includes many latrine designs (e.g. urine diversion or composting toilets) but all focus on decomposition of waste, rather than desludging. Ecosan latrines were informally evaluated in nine countries after earthquakes, floods and camp settings (Bastable and Lamb 2012, Mwase 2006, Kinstedt 2012). Ecosan is a viable option in many contexts, but considering the time and resources, it was considered best suited for recovery or development phases.

Rehabilitation of Existing Latrines – Rehabilitating latrines was a viable option after an earthquake in Iran and flood in China. Rehabilitating latrines was better suited than temporary latrines because materials were locally and immediately available, longer lasting and more culturally appropriate with similar costs to other options (Pinera, Reed, and Njiru 2005).

Vulnerability Targeting – Specific consideration for women and vulnerable populations (i.e. handicapped, elderly, pregnant and children) were documented in South Sudan, India and Liberia (de Lange et al. 2014, Moyenga and Rudge 2011, Visser 2012, Singh 2009). Engaging with specific populations was not burdensome but led to more appropriate latrine designs (e.g. locking doors, handrails) with marginal additional costs. In South Sudan, female use of latrines was significantly higher ($p<0.001$) where this gender targeting was done compared to another camp in the area (de Lange et al. 2014).

Disease Reduction – Latrine repair, with other flood response measures, led to a drop in diarrhea cases immediately following the intervention (11.2 cases/1,000 persons dropped to 3.6 cases/1,000 nine days after the intervention) (Lin, Zhang, and Yan 2008). As a refugee camp formed in Nepal, latrine coverage rapidly increased to meet demand, helping to reduce diarrhoea cases from 6.6 case/100 people to 3.5 cases/100 people (Puddifoot 1995); the refugee camp did stabilize and 80% of households report washing their hands. In this refugee camp, the provision of latrines helped to change behaviour, with 98% of beneficiaries reporting they stopped their traditional practice of open defecation. In contrast, latrine provision in the Andaman Islands after the tsunami in 2004 was unaccepted by the IDP population, who did not stop open defecation (Pinera and Reed 2006). In this context, latrines were 'too far,' poorly lit, and offered little privacy.

5.5.2 Latrine Alternatives

Latrine alternatives are also an output driven intervention necessary when latrine construction is not possible because of timing or location. Latrine alternatives (e.g. Peepoo® bags) are a short-term solution aimed to fill a temporary gap in sanitation services. Latrine alternative interventions include a supply of bags (often biodegradable), a safe private location (in the home or a community cubical) and a waste collection procedure. Temporary IDP or refugee camps or areas with high water tables are contexts well suited for latrine alternatives. Three documents were included in the review, from the Haiti earthquake and Typhoon Haiyan in the Philippines (Table 22).

Table 22: Latrine Alternatives Comparison

Author (Year) Country	Approach	Evaluation	Findings
Patel (2011) Haiti High risk of bias	Trial in 2 IDP camps of 54 and 391 HH. Camp 1: 2 week trial of Peepoo® bags, then 2 weeks or normal plastic bags. Camp 2: 4 week trial of plastic bags. Communal latrines were set up, with a 'desludge' operation Community cubical and use in home. Collection of deposit drums 6 days a week to composting site.	151 HH pre-emergency, 146 HH post-emergency 19 FGD; key informant interviews (KII) (not described)	91% reported use. Significant difference in reported diarrhea rates: 36% (n=146) pre-intervention compared to 42% (n=151) post intervention of HH experienced diarrhea; (95% CI 5.7-11.4% difference, p<0.03) High acceptance from community. Built off pre-emergency common practice to use plastic bags to defecate. Peepoo® sanitize and reduce smell.
Coloni (2012) Haiti High risk of bias	15 IDP camps with 22,765 people; 197 cubicles, 192,200 bags distributed. 2 different biofragmentable bags used and 1 biodegradable bag (at different stages of emergency). Toilet cubicles in camps. 60L bin/5 cubicles for collection. Removed daily to landfill.	Field commentary – case study	13% bag use (range: 8-18%) reported – base on supply data. High acceptance, previous community previous use of bags to defecate. Modular, quick. Biodegradable bags minimize environmental burden but have short shelf life.
Parsa (2013) Philippines High risk of bias	3 locations with different NGOs: 300 HH urban settlement, 2,000 HH and 700 students in an urban settlement and 280 HH in a different urban settlement Paying local workers for collection of waste every other day, with paid workers and buried.	Field Commentary – case study	74% of beneficiaries 'observed' use by organization 280 HH. Community involvement in waste management stream.

All three contexts were in IDP camp or 'urban settlements,' and intended to be used for 4-8 weeks. In a beneficiary survey in Haiti, self-reported use was 91%, whereas, use based on distribution records was much lower at 13% (range: 8-18%). It was noted that distribution records and estimated camp population may underestimate the use, although a full scale operational project 10 times larger than the trial may also explain the differences.

Pre-emergency cultural acceptance of using plastic bags for sanitation, termed 'flying toilets,' was documented in both Haitian evaluations. Another organizational

evaluation included in this review explored Peepoo® bags as an option but "…did not promote the use of plastic bags due to a judgment that their use was undignified and inappropriate" (Fortune and Rasal 2010). In hindsight, it was determined latrine alternatives would have been a suitable option. In the Philippines, the need for a sanitation option outweighed the fact that flying toilets were not a pre-emergency practice. Key informant interviews and focus group discussions suggested that Peepoo® bags would be acceptable, with ACF monitoring reports suggesting 74% use. Provision of household bags in the Philippines and Haiti had high (>70% use), compared to community cubicles (<20% use).

Management and disposal of the bags was different in each context and was generally not problematic, but 100% of beneficiaries reported disposing of bags in 'indiscriminate locations' (Coloni et al. 2012). There was consideration for community involvement in all evaluations and ranged from community volunteers to CFW. Hauling the waste away was considered easier than desludging a latrine that often requires specialized equipment with excessive costs.

Output-Driven Latrine Summary

Sanitation evaluations were primarily high risk of bias qualitative studies. Different latrines designs were better suited for acute and recovery phases of emergencies, while also able to target vulnerable populations and reduce disease transmission. In two contexts, latrine alternatives were successful as a temporary intervention in the acute emergency. Use was higher with promotion of use in the household compared to community cubicles only (Table 23).

Table 23: Output-Driven Latrine Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	2	Low	Reduced diarrhea rates with reported use, also likely spillover effects from concurrent interventions.
Use	3	Low	Latrines: Vulnerable population targeting increased use. Latrine alternatives: Reported use ranged: 8-91%; interventions promoting use in the home had higher rates of use.
Non-health	12	High	Ease of access, cleanliness and privacy are important non-health considerations.

4.6 Hygiene

In the following sections, hygiene interventions are sub-categorized as hygiene promotion (including hygiene education and social mobilization), distribution of hygiene kits and environmental hygiene (jerrican disinfection, household disinfection and environmental clean-up).

4.6.1 Hygiene promotion

Hygiene promotion is the sharing of personal and environmental hygiene related information to educate emergency-affected populations with the goal of reinforcing or changing behavior. In an emergency context, hygiene promotion must provide accurate information, adapt to changing conditions and appropriately address concerns and fears of the community. Hygiene promotion is separated into two approaches: *giving* hygiene education messages and *facilitating* social mobilization.

Hygiene Education

Hygiene education is the delivery of hygiene messages by responders to emergency affected populations to improve knowledge and encourage practices (i.e. instructions on using HWT products; messages about handwashing with soap). Nine studies were identified in the review that evaluated hygiene education with preferred message delivery and health impacts (Table 24).

Table 24: Hygiene education comparison

Author (Year) Country	Approach	Evaluation	Findings
Einarsdbttir (2001) *Guinea-Bissau* High risk of bias	Hygiene promotion to support treating water (and other hygiene practices). Radio, TV, health staff, poster, word-of-mouth, song, theatre group	Cross-sectional: 53 HH	94% report hearing at least 1 message; 1) Radio (45%); 2) Word of mouth 41% (despite no door-to-door messaging); 3) poster (24%). Language issue with radio messages (some people didn't understand the message); many people were illiterate - so posters were not well understood. Transmission routes not well described - Many thought transmission was through the air, also spirit sacrifices done frequently.
Khan (2008) *Pakistan* Medium risk of bias	Evaluation of communication after earthquake (not specific to 1 intervention); 'non-significant HH surveys,' observations and informal discussions.	FGD, KII, HH surveys (quantity not described)	Radio, face to face communication and 'entertainment events' best mode of communication because that was accessible. First radio messages (acute phase) - were taken from previous disasters. TV programming was not as relevant because most TVs were destroyed in earthquake.
Date (2013) *Kenya* High risk of bias	Evaluation of promotional activities with distribution of HWT and hygiene kits (not described); 723 HH surveyed.	Cross-sectional: 358 intervention HH and 365 control HH	Social contacts (friends, family and neighbors), which suggests that social networks can be a valuable resource. 'Reported any water treatment' Intervention: Control 56%: 37%; 95% CI 7.8-30.3% difference, p<0.001.
WHO (no date) Guidance on Communication – Case Study *South Africa* High risk of bias	Hygiene campaign, messages: Water storage, personal hygiene, safe refuse disposal, food handling, use of HWT.	Field commentary: case study	Red Cross (working in specific areas) observed a sharp decline in mortality rates following education program. Hygiene messages were known beforehand.

Author (Year) Country	Approach	Evaluation	Findings
	Mode: health workers, schools, religious leaders; some religious services use to recruit volunteers.		
WHO (no date) Guidance on Communication – Case Study *Zimbabwe* High risk of bias	Messages: Cholera prevention, control, food prep, hand washing, use of HWT (tablets/sachets). Mode: T-shirts and dramas used, 310,000 flyers, 14,000 posters in three languages distributed to 250,000 people.	Field commentary: case study	Change in behavior - not attending funerals, reducing physical contact (hugs, shaking hands). Response built on existing programming. Unwillingness to drink chlorinated water. Lack of resources and worthless currency.
Wall (2011) *Haiti* Medium risk of bias	Evaluation of communication after cholera and earthquake (not specific to 1 intervention)	15 focus groups	Multiple channels of communication to share and listen, reinforcing and listening in complementary ways. Cholera treatment centers were initially rejected due to fears about the origin and response to the disease. The assessments of overall effect on communication efforts on cholera, as "too many organizations were involved and too many techniques used."
Contzen-Mosler (2013) *Haiti* Medium risk of bias	Evaluation of communication strategies after cholera intervention (not specific to 1 intervention)	Cross-sectional: 811 HH survey	For both feces and food related handwashing, the most effective were material distributions with demonstrations and radio spots. Spontaneous/unplanned promotions by friends and neighbors also influential. Focus groups, hygiene days and stickers/posters/paintings were rated at less likeable, less convincing and less trustworthy than other methods.
ACF – Matemo (2014) *Kenya* High risk of bias	H_2S used as part of hygiene promotion a visual aid to assist hygiene messaging as well as test water samples.	Field commentary: 2820 HH tests	Feedback to communities with tangible explanations that ‘clear doesn’t mean safe’.
Williams (2015) *Haiti* Medium risk of bias	Evaluation of communication strategies after cholera interventions (not specific to 1 intervention)	18 focus groups assess regional preferences	Community Health Worker (CHW); Megaphone and CHW going house to house were the best ways to reach the communities. Most ‘trusted’ vender of HWT products were pharmacies. Increase in handwashing as a result from messaging. Perceived reduction in diarrhea reported from community in focus groups.

Hygiene message delivery was assessed in nine evaluations. Common factors that were evaluated were: person sharing the message (i.e. community health worker

(CHW), NGO, friend, neighbor, family member, local leader), how it was shared (i.e. radio, TV, posters/pamphlets, theatrical skits, face-to-face) and location (e.g. home, school, place of worship, community). Face-to-face communication was preferred by beneficiaries in seven evaluations (Williams et al. 2015, Matemo 2014, Contzen and Mosler 2013, Date et al. 2013, Einarsdbttir, Passa, and Gunnlaugsson 2001, Wall and Chéry , Khan and Syed 2008). Additionally, material demonstrations (i.e. instruction on HWT), visits by CHWs and conversations with friends and family were consistently positive across all documents. Short radio ‘spots’ or radio communication was the other consistently preferred and trusted source for hygiene messages. These two modes of communication offer a personal approach to ask questions and justify fears to a knowledgeable person (i.e. CHW) and receive repeated authoritative messages from a trusted source like the radio.

Multiple modes of communication compliment and reinforce hygiene messages; however, different or conflicting messages undermine the response, as seen in Haiti where Wall notes, "too many organizations were involved and too many techniques used." There are also doubts if hearing a message on the radio translates to an realistic understanding of the local situation (Wall and Chéry) and language/dialect differences (Einarsdbttir, Passa, and Gunnlaugsson 2001). Additionally, two documents included in this review, but focused on other WASH interventions, also noted inconsistent messages being an issue; in the West Africa Ebola response (Meyer Capps and Njiru 2015) and technical errors in printed IEC materials in Zimbabwe (Neseni and Guzha 2009).

Health impact was qualitatively described as an observed sharp decline in morbidity following the education program in South Africa and a community perceived reduction in diarrhea rate (WHO , Williams et al. 2015). Differences in behavior were also noted with an increase in HWT use in Kenya (Date et al. 2013) and reducing physical contact (i.e. hugs, shaking hands) in Zimbabwe during a cholera outbreak (WHO).

Handwashing is a primary component of ‘key hygiene messages’ used in emergency response. Handwashing promotion was described in 17 evaluations included in this review, with six reporting building handwashing stations (ACF 2015a, Plan 2013, Visser 2012, Varampath 2008, Singh 2009, Fortune and Rasal 2010). While handwashing is widely promoted, it is rarely the only intervention carried out or evaluated. Only two documents report specific outcomes or impacts of handwashing interventions in emergencies. In an acute refugee camp setting, distribution of a handwashing bag was observed to have a high use of >65% after three months, with 99% of households liking the bag (Husain et al. 2015). However, reported use was lower at 36-46% and soap access was limited. The only other handwashing evaluation was an alcohol based hand sanitizer used in IDP camp kitchen staff after an earthquake in Peru (Cabezas et al. 2008). The hand sanitizer significantly reduced bacterial loading (1.7 log reduction, 95% CI 0.6-2.4 log reduction, $p<0.001$) and was deemed effective for areas without access to potable water. The absence of relevant handwashing studies is aligned with recent research attempted to review handwashing in emergencies (Vujcic, Ram, and Blum 2015). The scope of work of

that research was adjusted when virtually no impact evaluations or information on promotional strategies were found.

Social Mobilization

Social mobilization is a term to describe strategies for engaging communities and responders *facilitating* communities to address identified risks with local solutions. Originating from stable development settings, social mobilization is the foundation of 'community driven sanitation' described above, often as CLTS or CATS. The ideals of social mobilization are for communities to identify and address problems locally with no or minimal outside assistance, which is different than many emergency relief strategies which directly provide assistance. Social mobilization approaches define a process, often at a community level, and outputs are determined by the community (e.g. 23 communities are 'triggered' through a CLTS facilitator which could result in any number of latrines determined by the community). Community mobilization, in particular CLTS, has consistent success stories in many development contexts (Pickering et al. 2015). In emergency contexts and displaced populations, concerns of a weak sense of community, lack of timing and scarce resources may limit broader application.

Social mobilization strategies were identified in nine evaluations in seven countries; five interventions were aimed specifically at sanitation but described here because of the mobilization approach (Table 25).

Table 25: Social Mobilization Comparison

Author (Date) Country Bias	Approach	Evaluation	Outcome
Waterkeyn (2005) *Uganda* High risk of bias	Community mobilization through Community Health Club and PHAST approaches.	Field commentary - case study	Group cohesion and peer pressure adjusted hygiene behaviour and improve hygiene practices. Motivation of > 15,000 beneficiaries built 8,500 latrines, 6,000 bath shelters, 3,400 drying racks and 1,550 handwashing stations in a 4 month timeframe. Rapid, scalable and cost-effective.
IWSD -Neseni (2009) *Zimbabwe* High risk of bias	Social mobilization.	Field commentary - case study	Social mobilization considered most impactful to reduce disease transmission.
Polo (2010) CATS: Community Approaches to Total Sanitation Pilot in *Haiti* High risk of bias	Pilot CATS in 5 IDP camps– existing latrines in IDP camps, tried to reduce open defecation in camps.	Field commentary - case study	1 camp had strong positive reaction, 2 promising. Quality of facilitation more important than the site; previous concern if camps would not have the same cohesion as an established village. Land availability in camps/urban and availability of materials were strained.

Author (Date) Country Bias	Approach	Evaluation	Outcome
	Transect walk ('taboo walk') and education about food/water contamination from flies; introducing community-ownership of latrines.		Culture of waiting for latrines to be built by NGOs; individuals not shocked by talking about 'shit'.
Wall (2011) Haiti Medium risk of bias	Social mobilization.	15 FGD, KII (not described)	Maintaining relationships and sharing difficult information, open channels of communication.
WV – Khan (2012) *Pakistan* High risk of bias	CLTS in 10 pilot communities (~10,000 people). Clean up campaigns following flood – repairing piping, drainage.	Field commentary - case study	525 latrines built within 4 months. 10/10 communities were ODF in 1 year from start of CLTS. Women and children helped encourage men to use latrines.
IFRC - Rees-Gildea (2013) *Sierra Leone* High risk of bias	Social mobilization.	Field commentary - case study	Decrease in case fatality rate (CFR) assessed to be more influenced by social mobilization than case management.
Miziniak (2014?) *Zambia* High risk of bias	Community-driven approach: Voluntary Water Sanitation Hygiene and Education (VWASHE).	Field commentary - case study	761 latrines built in 3 months. Use of local materials and flexibility of design. Latrines could be built at no cost to household.
Meyer Capps (2015) *Liberia* Medium risk of bias	CLTS project (running for 5 years – carried on through Ebola outbreak) in 6,865 HH.	Mixed-methods; Matched controls: 239 Project HH: 312 non-Project HH, 16 FGD, KII	HH in CLTS communities 17 times less likely to have cases of Ebola than non-CLTS communities (OR=0.06, 95% CI 0.01-0.32, p<0.001). Beneficiaries trusted: 1) health workers, 2) radio, then 3) NGOs for sources of information. Natural leaders were 'trusted sources of information due to the relationships built from the ODF verification process'.
ACF (2015) Trigger Behavioural Change Sierra Leone High risk of bias	Community Led Ebola Management and Eradication (CLEME)	Field commentary - case study	Social mobilization better than case management. Community ownership and trust. 80% of communities planned isolation rooms; tippy tap handwashing widely promoted.

In contrast to hygiene promoters that give messages, community mobilizers are engaged with the community to have conversations with beneficiaries and ask questions. Compared to a purely education campaign that is 'top-down,' designed to deliver or extract information (Contzen and Mosler 2013), community mobilization (engagement) approaches were conducive to NGOs: listening to communities, dispelling fears and stigmas and learning how to adapt to the context. A 'dialog-based' approach by NGOs led to an improved understanding of the community, leading to a better response (Wall and Chéry 2011).

Overall, social mobilization was effective at reducing disease risk, output of structures and building stronger community relationships.

Reducing Disease Risk – Communities that were ODF during the West Africa Ebola outbreak were 17 times less likely to have cases of Ebola than non-CLTS communities (OR=0.06, 95% CI 0.01-0.32, p<0.001) (Meyer Capps and Njiru 2015); note that the CLTS intervention was running for five years and continued on through the Ebola response. Social mobilization was also qualitatively assessed to reduce disease transmission better than disease case management in outbreaks (2015a, Rees-Gildea 2013, Neseni and Guzha 2009).

Output of Structures – Community driven sanitation resulted in more than 8,000 latrines in Uganda, 525 latrines in Pakistan and 761 latrines in Zambia – all in less than four month interventions with low material input from responders (Waterkeyn, Okot, and Kwame 2005, Miziniak , Khan 2012). ACF piloted a community mobilization project based on CLTS methodology tailored to Ebola management, and 80% of villages planned to build community isolation rooms for Ebola patients and handwashing stations (ACF CLEME).

Stronger Relationships – Stronger community relationships were also described in three of the social mobilization evaluations (trust, group cohesion and ownership) (Wall and Chéry 2011, Waterkeyn, Okot, and Kwame 2005, ACF 2015a, Miziniak). A pilot CLTS project in five IDP camps after the Haiti earthquake had limited success, with 'positive reactions' in three out of five triggered camps, and needing to overcome a culture conditioned for free distributions and scarce local resources (Pollo 2010).

Policy documents (not included in the review) also describe strong support for community mobilization and community engagement. A learning document from outbreaks notes that, "community engagement and social mobilization are key aspects of reducing transmission rates…" (Oxfam 2014); and the most common lessons learned from a survey of 20 organizations was described as "encouraging local participation and ownership during the relief stage" (Accord WASH Alliance 2016). Additional examples of CLTS in chronic and protracted emergencies, not included in this review, can be found at: 'Learning and recommendations on the use of CLTS in emergency and post-conflict/post-emergency situations' (Greaves 2012).

Hygiene Promotion Summary

Hygiene education and social mobilization are not mutually exclusive. Multiple channels of hygiene education are preferred to address a wide audience and reinforce key messages. Consistently, radio messages and face-to-face communication were the most liked, preferred or trusted by beneficiaries. Face-to-

face communication is necessary, preferred by the communities and cannot be substituted. Community mobilization approaches were consistently positively evaluated in seven countries, but may not be well suited for acute response; however, nearly all evaluations were organizational evaluations with high bias. Interventions had a high output of structures (mostly latrines) with local materials and were associated with 'trust' and 'cohesion' developed by the engaging communities (Table 26).

Table 26: Hygiene Promotion Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	5	Low	*Education* – Anecdotal descriptions of disease or disease risk reductions. *Social Mobilization* – Evaluated and perceived health impact in the community.
Use	1	Low	*Education* – Reported use of HWT increased.
Non-health	12	Moderate	*Education* – Face-to-face communication and radio are preferred and trusted by the community. *Social Mobilization* – High numbers of latrine construction in short timeframes with limited external material input. Community led interventions can engage and empower with surprising effects (rapid coverage of outputs with community resources). Trust and ownership commonly documented.

4.6.2 Hygiene kit distribution

The primary goal of most hygiene kit distributions (e.g. non-food items or NFIs) was to deliver HWT products and support hygiene activities with soap and personal hygiene items (e.g. toothbrush).

A major component of emergency WASH interventions, hygiene kit distributions were mentioned in 21 evaluations described throughout this report that were not specifically HWT interventions. The heterogeneity of reporting precluded direct comparison of NFI kits; however, details on hygiene kit interventions are in Appendix A, and key themes from documents included in this review are summarized around: kit contents, timing (logistics) and preferences.

> *Kit Contents* – The most commonly included items were: HWT products, soap and water storage containers (e.g. jerrican or buckets with lids). Differences in kits (Ruiz-Roman 2009), including different types of doses of HWT products (e.g. several different Aquatabs doses), caused confusion (Varampath 2008, Imanishi et al. 2014). Standard sized kits may not address the needs of larger families or those with different preferences or needs (Gauthier 2014, Simpson, Bazezew Legesse, and Mubayiwa 2009, Ruiz-Roman 2009).

Timing – There is a distinct gap between sudden emergency events and delivering hygiene kits to beneficiaries. Pre-positioning hygiene kits was noted as a key aspect of the response, even if more kits were needed later (Simpson, Bazezew Legesse, and Mubayiwa 2009, DeGabriele and Musa 2009, Neseni and Guzha 2009, Ruiz-Roman 2009, Lantagne and Clasen 2012, Varampath 2008). In an emergency, normal markets may not be functioning, or not functioning at the needed capacity, for a large-scale response leading to delayed procurement and distribution (Neseni and Guzha 2009) (ACF 2007). Delays undermine response and reduce the overall impact of interventions, especially with rapidly changing needs of beneficiaries in acute emergencies (Khan and Syed 2008, Varampath 2008, Mountfield 2013, Wango 2011).

Preferences – Items within the kits were described as 'liked' or 'valued' and generally 'appreciated' by the beneficiaries. Valuing items differed by gender, but also with time since the emergency (Mountfield 2013, Hayden 2012, ACF 2015b). Vouchers were used in a specially organized market to offer flexibility and choice to beneficiaries in the D.R.C. (Pennacchia, Poidatz, and Hearne 2011), and cash based assistance in Philippines was also preferred. Cash and vouchers are increasingly used in humanitarian and development settings but often require access to functioning markets with consideration for beneficiary transportation to and from the market. Not included in this review, a policy document describes options for cash and vouchers in emergency WASH and Shelter interventions (Juillard and Opu 2014). Options and preferences for specific items unique to women's needs are considered with Menstrual Hygiene Management (Box 3).

Box 3: Menstrual Hygiene Management

The specific education of feminine health and distribution of feminine hygiene items (e.g. dignity kits) is encompassed in Menstrual Hygiene Management (MHM). MHM interventions and specific hygiene kits for women are regularly distributed with an increase in gender mainstreaming. Dignity kits were distributed in four interventions included in this review (Khan and Syed 2008, ACF 2014a, Singh 2009, Baker and Mbogha 2009), with two from Pakistan describing sanitary pads and women's underwear as not culturally appropriate (Khan and Syed 2008, ACF 2014a). No intervention evaluated an MHM intervention; however, three documents not included in the review describe the call for targeted MHM interventions. Together, the three needs assessments included 69 focus group discussions, with key informant interviews and observations from five countries (Haiti, the Philippines, Uganda, Sri Lanka and Somalia) and mostly with IDP populations. The women identified needs for: access to water and a safe space, increased education, influence of local beliefs and local MHM materials.

Access to safe water and safe space – Women and girls described the need for improved access to safe and private areas to wash and dry reusable cloths (Hayden 2012, Parker et al. 2014).

Increased education – Sanitary pads were sometimes distributed in kits without instructions or education on their use (Parker et al. 2014, Hayden 2012, Wickramasinghe 2012). Particularly in settings where traditional MHM cannot be carried out, increased and specific education is needed.

Local beliefs – The subject of menstruation is 'taboo' with cultural and spiritual beliefs influencing practices (Hayden 2012).

Materials – Sanitary cloths or commercial pads were preferred by different groups with concerns for cost (commercial pads) and needed private space to wash and dry (cloths). Additional soap, tight underwear, washing basin and drying line were also standard requests.

MHM has been a secondary priority in most emergency responses; however, there is an identified gap and requests to have improved gender appropriate response.

Hygiene Kit Summary

Hygiene kits are a mode to equip emergency affected populations with materials necessary to improve hygiene practices. Contents, quantity and timely distribution are important factors (Table 27).

Table 27: Hygiene Kit Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	-	No Evidence	-
Use	2	Low	Reported use of hygiene kit contents is high.
Non-health	10	Moderate	Size of hygiene kits (quantity of materials); timeliness of delivery are important factors – especially to enable HWT and hygiene messages.

4.6.3 Environmental hygiene

Environmental hygiene efforts aim to protect populations by reducing disease transmission risks in the local environment. In emergency response, environmental hygiene interventions include:

Jerrican Disinfection – Cleaning jerricans with chlorine solution.

Household Disinfection – Sanitizing a home or building that is potentially contaminated with chlorine solution (i.e. an Ebola patient's home).

Environment Clean-up – Rubbish collection, drainage or landscape improvements that aim to remove contaminated solid and liquid wastes.

Environmental hygiene interventions were evaluated in four evaluations included in the review, including jerrican disinfection and household disinfection hygiene kits.

Jerrican Disinfection

Jerrican disinfection was investigated in three evaluations, all in camp settings, and all assessed with no beneficiary input (Table 28).

Table 28: Jerrican Disinfection Comparison

Author (Year) Country	Approach	Evaluation	Findings
Steele (2008) *Uganda* High risk of bias	Disinfecting jerry cans with 3% sodium hypochlorite solution using two different cleaning methods: 1) Fill halfway with disinfectant solution, seal, shake for 1min, decant back into stock solution; n=9. 2) Fill with stock solution, let sit for 1min – 5min, decant back into stock solution; n=4.	Jerry cans from 13 HH barrowed then revisited 3-5 days after cleaning.	Data indicates that both methods are equally effective (low sample size), Method 1 had more consistently lower coliform counts than Method 2. Overall: 92% (11/12) had *reduced E.coli* after cleaning; 75% (9/12) had <5 *E.coli*/100 mL after cleaning; 42% (5/12) had <1 *E.coli*/100mL after cleaning. One-time disinfection did not affect recontamination 3-5 days later.
Walden (2005) *Sudan* High risk of bias	Disinfecting jerry cans with 5% chlorine solution: 100-150mL added to each bucket with stones (as abrasives), sealed, shaken vigorously, dumped, refilled with 1% chlorine solution; 15-20 min/container.	Field commentary: case study with cross-sectional evaluation of 172 containers.	On average, the FCR remaining in the containers was 0.2 mg/L, n=172. Number of watery and bloody cases of diarrhea continued to decline after the disinfection. 1 week later, observations were that people were keeping containers clean.

Author (Year) Country	Approach	Evaluation	Findings
Roberts (2001) *Malawi* Low risk of bias	Buckets were chlorinated with 2.5 mg/L solution 8 times over 2 months.	Cross-sectional: 24 containers sampled.	Fecal coliform virtually eliminated for 4 hours, but increased after 6 hours. Stock solution concentrations were considerably lower than intended on several occasions, leading to inadequate chlorination.

All three jerrican cleaning methods were found to reduce disease risk, although with very weak evaluation methods. Chlorine concentration depletion was noted in all three documents (Steele, Clarke, and Watkins 2008, Walden, Lamond, and Field 2005, Roberts et al. 2001), although the chlorine residual reported in Roberts et al. (2001) is not a suitable chlorine concentration for cleaning inanimate objects; however, the evaluation focused on HWT, not a cleaning evaluation. One time disinfection did not have a long-term impact on re-contamination as jerricans had microbiological contamination measured after six hours and 3-5 days after disinfection (Roberts et al. 2001, Steele, Clarke, and Watkins 2008).

Household Disinfection

Primarily used in outbreak emergencies, household spraying was described as an activity in five documents (Neseni and Guzha 2009, Gauthier 2014, Grayel 2014, 2011, 2012), but the effectiveness was not assessed. Household or community spraying has several drawbacks (Box 4).

Documents not included in the review also describe the limitations of household spraying. In Ebola response in West Africa, household spraying did not include bedding and other possible routes of transmission, thus spraying was 'incomplete' and likely ineffective (Nielsen et al. 2015). The Unicef Cholera Toolkit also suggests that one-time household spraying is often carried out too late, is resource intensive, has no evidence of effectiveness and can stigmatize the household (Unicef 2013); however, it is recommended that families should thoroughly clean the house with soap and chlorine solution.

Box 4: Household Spraying with Chlorine Solution

During the Haiti cholera outbreak, an NGO had initially set as an objective to disinfect 80% of contamination sources in households within 48 hours (Grayel 2011). Spraying was ultimately abandoned due to: 1) concern of patients being stigmatized; 2) logistical, financial, and staffing resources required; 3) false sense of protection to households, which counters prevention messages; and 4) likely limited impact as only 15-20% of people shed cholera in the environment develop symptoms, the benefits of spraying the households of sick people are limited.

As an alternative to sending disinfection teams to patients' households, MSF provided cholera patients a self-disinfection kit for the household in the cholera outbreak in Haiti. After a 30-40 minute group hygiene session, kits were given to the patient or caretaker, including: 0.5-1 kg of soap, a 14L bucket, a 10L jerrican, 3.8L of

bleach, a cloth, a scrubbing brush and an instruction book (Gartley et al. 2013). Self-reported use of the disinfection kits was 98%, with 94% of recipients reporting the instructions were clear and simple; however, no verification on correct use or reduced transmission was reported. A significant increase in use ($p<0.05$) was reported when the hygiene session explained how to use the contents together and encouraged sharing with friends and family.

Environment Clean-up

No evaluation on improving local environment conditions was identified in the review, although several organizations reported activities or results such as “improved garbage practices” (Dinku 2011), construction of solid waste areas and drainage improvements (Pennacchia, Poidatz, and Hearne 2011, Plan 2013) and decongestion and rehabilitation of sewer pipes (Neseni and Guzha 2009).

Environmental Hygiene Summary

Environmental health evaluations were limited to jerrican disinfection interventions with weak high bias research designs (Table 29). Household disinfection and environment clean-up are common emergency response activities, but no evaluations of these interventions was identified in the review except for one household disinfection kit distribution evaluation with only self-reported outcomes where families were intended to clean their home themselves. Jerrican cleaning and household spraying are not clearly efficacious at reducing disease and require further discussion and research.

Table 29: Environmental Hygiene Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	4	Very Low	Reduced disease transmission – reduced morbidity and *E. coli.*
Use	1	Low	High self-reported usage rates (>90%) from targeted distribution and clear instructions.
Non-health	3	Low	Chlorine solution needs constant monitoring for jerrican disinfection campaigns. Household spraying not recommended without further evidence.

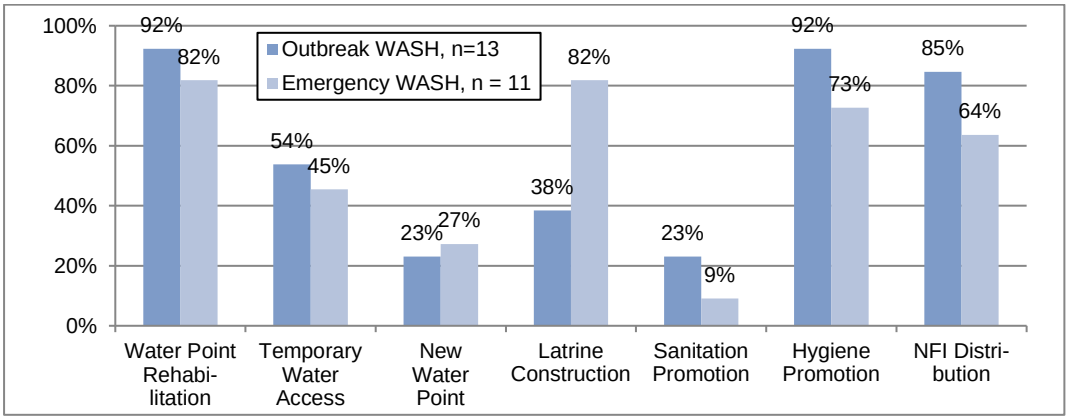
4.7 WAsh package

WASH interventions are regularly implemented in combination by responders, to address multiple possible transmission routes and provide comprehensive protection to beneficiaries. Overall, 24 WASH Package evaluations from 12 countries were identified in this review; all 24 are grey literature documents with 22 of the 24 being field commentary documents with little to no quantitative or qualitative analysis.

The specific intervention activities included in the WASH Package mirrors the results above, with more water and hygiene interventions completed than sanitation

interventions. However, the water interventions included in WASH Package were more likely to be well rehabilitation and water trucking which are described as activities but not evaluated for outcomes or impacts. In outbreak response, sanitation activities were not regularly carried out (Figure 22).

Figure 22: WASH Package Activity Comparison



The heterogeneity of the WASH interventions did not make for a suitable side by side comparison; however, details are presented in Appendix A and identified themes are described herein, including: health and behavioral impacts, expert staffing and response timing.

Health Impacts – Clinic reported decrease in diarrhea and waterborne diseases were reported in the D.R.C. from three different WASH interventions (Pennacchia, Poidatz, and Hearne 2011, Baker and Mbogha 2009, van der Wijk 2010). Similarly, the weekly ministry of health reported cholera attack rate "continued to decrease" with the WASH Package intervention in South Sudan (Gauthier 2014); and the case fatality rate "dropped significantly" after the WASH Package intervention in Somalia (ACF 2007).

Behavior Impacts – Improved hygiene behavior was self-reported by 90% of beneficiaries in outbreak and endemic contexts, in Zimbabwe (DeGabriele and Musa 2009) and D.R.C. (Pennacchia, Poidatz, and Hearne 2011), respectively; although respondents in Zimbabwe acknowledged the improvements were not consistently practiced. Improved water collection, handwashing and environmental hygiene practices were also self-reported in an acute watery diarrhea response in Somalia (Dinku 2011).

Water interventions also reduced the time needed to collect water (Dinku 2011, Pennacchia, Poidatz, and Hearne 2011, Plan 2013, Visser 2012, Alem 2004) and NFI provided "psychosocial support" to cholera affected communities (Neseni and Guzha 2009). Changes in people's attitude, especially toward open defecation, were also noted in Sierra Leone (Ngegba 2002).

Unique to the NGO WASH Package evaluations, two practical factors for program success were identified: expert staffing and rapid response timing.

Expert staffing – The importance and usefulness of expert staffing was documented in three evaluations, despite added costs (Simpson, Bazezew Legesse, and Mubayiwa 2009, El-Mahmid and Roussy 2009, Baker and Mbogha 2009). Integrating epidemiological experts into response was also noted in a D.R.C. evaluation (Grayel 2014). Expert staff were identified as offering surge capacity (Gauthier 2014) to increase the scale and speed of work from non-emergency times while offering knowledge of interventions not previously used in country.

Rapid response timing – Pre-positioned hygiene kits were useful for quick initial distributions of hygiene kits (Lantagne and Clasen 2012, Ruiz-Roman 2009, Neseni and Guzha 2009, DeGabriele and Musa 2009, Simpson, Bazezew Legesse, and Mubayiwa 2009), but difficulty in procuring items led to delays thereafter (Neseni and Guzha 2009, Wango 2011). Having flexible emergency funding facilitated response in South Sudan and Haiti (Gauthier 2014, Condor and Rana 2011), while securing adequate funding and knowing when to trigger rapid scale-up were identified as challenges (Simpson, Bazezew Legesse, and Mubayiwa 2009).

WASH Package Summary

Water point rehabilitation, NFI kit distributions and hygiene promotion were the most frequently included individual activities in WASH Package interventions for outbreak and non-outbreak emergencies. The qualitative field commentaries had consistent descriptions of anecdotal health impacts and non-health behavior change impacts (Table 30). Expert staffing and rapid response timing were consistently identified as critical factors for program success.

Table 30: WASH Package Summary

Outcomes	# of Studies	Quality of Evidence	Summary
Health	6	Low	Anecdotal descriptions of disease reductions.
Use	-	No Evidence	
Non-health	13	Low	Anecdotal descriptions of behavior adjustments and psychosocial support; staffing and timing consistently identified as important factors for program success.

4.8 Beyond the scope of review

WASH in emergencies is an intentionally broad scope; however, some interventions were just beyond the scope of this review, including: WASH in nutrition emergencies and interventions that interact with health interventions specific to outbreaks.

WASH and nutrition

Synergies between WASH and nutrition are known, with dedicated manuals and strategies on the topic (USAID 2015, Mercedes 2013, WHO 2015). Numerous documents of WASH and nutrition interventions were generously shared by ACF with examples spanning different contexts in Africa, including: Burkina Faso (Barbiche 2014), Nigeria (Egbuta 2014), Somalia (DeGabriele 2008), Chad (Ngarmarde 2014, 2015) and the DRC (2013, Watson, Gayer, and Connolly 2007). A notable example was a ready-to-use-food evaluation with PuR sachets and with ready-to-use-food only. High PuR use (>95% confirmed use) translated to improved weight gain and four days less spent in care, recovering 90% of the increased cost of the PuR sachets (Pietzsch et al. 2014, UNHCR 2015).

The context to create a nutrition emergency is often long-term, developing out of drought or prolonged insecurity. With the known synergies and slow onset, nutrition specific interventions were beyond the scope of this review.

WASH and Health – Outbreak Specific Responses

The separation between WASH and health in outbreak contexts was difficult to differentiate; three interventions considered *beyond the scope of the review* are briefly described below: disinfection of contaminated wastewater, dead body management and contact tracing.

Hospital-based Hygiene **–** Researchers found that seven consecutive days of hygiene education given to cholera patients and caretakers had significant disease reduction in an RCT in Bangladesh (George et al. 2016). The intervention, Cholera-Hospital-Based-Intervention-for-7-Days (CHoBI7), was held within the hospital and included equipping families with a hygiene kit to facilitate safe drinking water and handwashing.

Hospital Wastewater Disinfection – Two wastewater disinfection methods were trialed in Haitian cholera treatment units using pH adjustment and coagulation/flocculation (Sozzi et al. 2015). Both methods achieved a >90% (1 log) removal in chemical oxygen demand (COD), suspended solids and turbidity. There was also a >99.9% (3 log) removal in thermotolerant coliforms.

Dead Body Management – The 2014-2015 Ebola outbreak in West Africa highlighted the risks of dead body management and unsafe burial practices. Cultural norms and the desire for culturally normal burials add a critical community component to dead body management (Nielsen et al. 2015, ACF 2015a, Global Communities 2015, Flachenberg et al. 2015, Mercedes 2013, WHO 2015).

Contact Tracing – Contact tracing, the identification and diagnosis of people who may have come into contact with an infected person, was described as a WASH activity by organizations but is part of health surveillance. One example of a strong contact tracing component was ACF's CLEME that was also considered to be part of community activities (ACF 2015a).

4.9 Economic analysis

No evaluation in the review conducted cost-effectiveness analysis. Many documents included unsupported comments such as ‘costly,’ ‘too expensive’ or ‘cost too much’, but without a rationale or alternative intervention appropriate for the context. Examples of economic and cost related information in the review include:

Costs of items: HWT (Imanishi et al. 2014, Dunston et al. 2001, Tokplo 2015, Handzel and Bamrah 2006, Clasen and Boisson 2006), hygiene kits (Gartley et al. 2013, Plan 2013) or large scale treatment options (Dorea et al. 2009).

Cost per outcome: Acute chlorine HWT interventions cost about $1/day for a household with confirmed FCR in Nepal and Kenya (Lantagne and Clasen 2012).

Willingness to pay: Evaluating the potential for sustainable HWT interventions ($0.027/PuR sachet; ‘almost all were not willing to buy it’) (Hoque and Khanam 2007, Colindres et al. 2007).

Cost-recovery: In a chlorine solution project in Madagascar, a bottle of chlorine solution able to treat 1,000L cost about $0.46 (Dunston et al. 2001). However, this price did not include promotion and indirect cost and was estimated to have 46% cost recovery.

Cost of a latrine: Project related costs to build latrines (Private latrine: $130, Private latrine with shower: $220, Communal latrine: $850) (Pinera, Reed, and Njiru 2005) or approximate costs of a temporary latrine on a monthly basis (Initial cost: $25/unit/day with desludging; later negotiated to $9-13/unit/day with a six month contract) (Eyrard 2011) or just material costs (~$6.75) (Singh 2012).

Costs per beneficiary: Overall costs per beneficiary were reported, but without the value of the gift in-kind materials – the primary component of the intervention (Result 1: 3.54 Euro/person, Result 2: 6.80 Euro/person; in-kind cost not reported) (Gauthier 2014).

Vouchers: Vouchers valued at $70 were used in a special market day, where beneficiaries (2,184 households) could negotiate prices and select their own items (Pennacchia, Poidatz, and Hearne 2011).

Total project costs: NGO reports also noted absolute costs to a donor (Grayel 2011, Pennacchia, Poidatz, and Hearne 2011, Martin 2011).

As can be seen, some cost-related outcomes were included in the review, but the outcomes were too heterogeneous for analysis. There was also uncertainty if reported ‘project costs’ included staffing, indirect costs or headquarters costs.

4.10 Methodological quality and risk of bias in included studies

Overall, the quality of evidence was low which was attributed to weak study designs that lacked control groups high likelihood of spillover effects. The weak study designs were expected from the onset of the protocol development, but still greatly undermine

the ability to establish a strong evidence base. The protocol methodology was intended to include weaker study designs that would complement stronger designs; however, only 9% of studies (10/106) had any type of control group. Less than 4% (4/106) were randomized control trials and none were in the same intervention category. The majority of quantitative study designs were weak cross-sectional designs relative to true experimental designs. Formal heterogeneity analysis with I^2 could not be completed as reported outcomes remained too different for direct comparison. For example, confirmed use of a HWT intervention was the clearest outcome measure identified by measuring FCR; however, reporting thresholds varied by: 'detectable,' >0.0 mg/L, >0.1 mg/L, ⩾0.2 mg/L and ⩾0.5 mg/L. The low quality and heterogeneous studies were thus better suited for a synthesis of results as presented above.

5. Discussion

A systematic process was used to identify 106 WASH evaluations (114 contexts) in 39 LMIC countries affected by an emergency. Emergency WASH includes a broad scope of activities, which we categorized into 13 interventions. Of these 13 interventions, we found that 12 could theoretically be efficacious at reducing the risk of disease transmission. Meta-analysis strategies were not appropriate or applied due to the heterogeneity of the emergency contexts, the intervention activities and the data reporting. Across the evaluations, we found that the emergency context and social conditions are critical in determining the actual real-world effectiveness of individual WASH interventions; with pre-existing conditions and cultural conditions particularly important. While developing selection criteria for when to implement WASH interventions in emergencies is beyond the scope of this review, there is evidence of efficacy and effectiveness of emergency WASH interventions.

In Table 31 and Table 32, evidence is summarized across health, use, and non-health outcomes as was carried out in Section 5. Overall evidence was similarly assessed with the procedure described in Section 4.7 to give the reader an indication of confidence in the results by labeling interventions as: *very low*, *low*, *moderate*, and *high* quality evidence.

Table 31: Intervention Summary - Water

Intervention	Quality of Outcomes			Conclusions	Overall Evidence
	Health	Use	Non-health		
Saltwater Intrusion Cleaning	No Evidence	No Evidence	High	Evidence suggests that well pumping after a saltwater intrusion is NOT effective. Waiting for seasonal rains, naturally reduced salinity faster compared to pumping.	High
Well Disinfection	No Evidence	No Evidence	Moderate	Pot chlorination with pressed chlorine tablets can maintain FCR for 3-4 days in a well; pot chlorination with powdered chlorine also had some success. (Inconsistent evaluation methods)	Moderate
Source Treatment – Large Scale	No Evidence	No Evidence	Low	BWT – Well established treatment methods (not evaluated) requires well-trained staff and regular monitoring. Water Trucking – A common activity in acute emergencies. FCR and microbiological contamination were inconsistent with limited evaluations.	Low
Source – Treatment Small-Scale	No Evidence	Moderate	No Evidence	Variation in reported, confirmed and effective use – criteria for favorable contexts outlined through case studies. Speaking with Promoter and easy access to Dispenser associated with increased use.	Moderate
HWT – Chlorine Tablets	Very Low	Moderate	Moderate	Reported use range: 1-84%, n=9 Confirmed use range: 1-87%; n=11 Chlorine taste/smell, ease-of-use and familiarity influence use and acceptance.	Moderate
HWT – Liquid Chlorine	No Evidence	Moderate	Moderate	Reported use ranged: 6-88%; n=6 Confirmed use ranged: 1-69%; n=6 Familiarity of liquid chlorine was beneficial; flexibility to be scaled-up from development projects.	Moderate
HWT – Flocculant/ Disinfectants	Low	Moderate	Moderate	Reported use ranged: 6-83%, n=3 Confirmed use ranged: 4-95%, n=6 Taste and ease of use varied, consistently preferred over other HWT options.	Moderate
HWT–Filtration	No Evidence	Moderate	Moderate	Acute use (<3 months since emergency) ranged: 53-100%, n=3, Sustained use (≥3 months since emergency) ranged: 0-96%, n=7, although effective use was lower. Improved taste consistent among populations.	Moderate
HWT – SODIS, Safe Storage, Alum and Boiling	Low	Very Low	Moderate	Limited evaluations and impact. Not widely used in acute emergency response, ease of use and community acceptance reported.	Low

Table 32: Intervention Summary - Sanitation, Hygiene and WASH Package

Intervention	Quality of Outcomes			Conclusions	Overall Evidence
	Health	Use	Non-health		
Sanitation – Output-Driven	Low	Low	Moderate	Reduced diarrheal rates with increased coverage and use. Latrines: Vulnerable targeting increased use. Latrine alternatives: Reported use ranged: 8-91%; interventions promoting use in the home had higher rates of use. Ease of access, cleanliness and privacy are important non-health considerations.	Low
Hygiene Promotion	Low	Low	Moderate	Descriptions and documentation of disease or disease risk reductions. Personal communication and radio are preferred and trusted by the community. Community trust and ownership important factors.	Moderate
Hygiene Kits	No Evidence	Low	Moderate	Reported use of contents is high. Quantity of materials and timeliness of distribution are key factors	Low
Environmental Hygiene	Very Low	Low	Low	Unclear reduction in disease transmission risk and increased community expectations on effectiveness. Chlorine concentration monitoring is necessary.	Low
WASH Package	Low	No Evidence	Low	Anecdotal descriptions of disease reductions, behavior adjustments and psychosocial support; staffing and timing also important factors.	Low

The following section is used to describe the research objectives (Section 6.1), completeness and applicability of evidence (Section 6.2), quality of evidence (Section 6.3), limitations (Section 6.4) and agreement with other reviews (Section 6.5).

5.1 Summary of objectives

To determine the efficacy and effectiveness of emergency WASH interventions, we investigated: interventions that increase the use of WASH services, reduce the risk of disease via outcomes and/or impacts, the consideration of non-health related outcomes, design and implementation characteristics associated with more effective programs and economic outcomes.

Objective 1: Use of interventions in emergency WASH

Emergency WASH interventions are implemented in a variety of contexts and there is no ‘silver bullet’ intervention that is universally applicable in all circumstances (Clarke and Steele 2009). Through this review, we identified 13 WASH interventions and found that 12 could be ‘efficacious’ – theoretically able to increase access to safe water and sanitation or improving hygiene and thus reduce the risk of disease

transmission. Well pumping to reduce salinity after a coastal flood was the only intervention that had evidence that it was not efficacious and therefore is not recommended. The efficaciousness of jerrican disinfection and household spraying are unclear and require further investigation. For the 10 interventions that improved WASH conditions, effectiveness varied and outcomes were conditional based on the emergency context and cultural and social preferences (Table 33).

Table 33: Intervention efficacy and effectiveness

Intervention	Efficacious	Effectiveness	Outcomes and Impact
Saltwater Intrusion Cleaning	✘	Not Reported	All documents advise not to pump wells.
Well Disinfection	●	Not Reported	FCR can be maintained for several days in some contexts.
Source Treatment – Large Scale	✓	Not Reported	Established technology able to consistently provide safe water.
Source – Treatment Small-Scale	✓	●	Dispenser use varies with context; bucket chlorination effectiveness not reported.
HWT – Chlorine Tablets, Liquid Chlorine, PuR	✓	●	Population's previous exposure, taste and ease-of-use are major factors.
HWT – Filtration	✓	●	Effective use declines over time; improved taste.
HWT – Other (SODIS, Safe Storage, Alum and Boiling)	✓	●	SODIS, alum and boiling not always effective in field setting, recontamination likely.
Latrines	✓	●	Location (proximity), cleanliness and privacy are factors to use.
Latrine Alternatives	✓	●	Location (in home), privacy and ease-of-use are factors.
Hygiene Promotion	✓	●	Face-to-face and radio preferred communication; social mobilization beneficial.
Hygiene Kits	●	●	Population, timing, items and quantity of items influence effectiveness.

Environmental Hygiene	●	●	Jerrican cleaning can be efficacious; HH spraying was ‘not recommended’.
WASH Package	●	●	Each component varies, also staffing, funding, preconditions are factors.

✓ Evidence • Conditional Evidence × Evidence against intervention

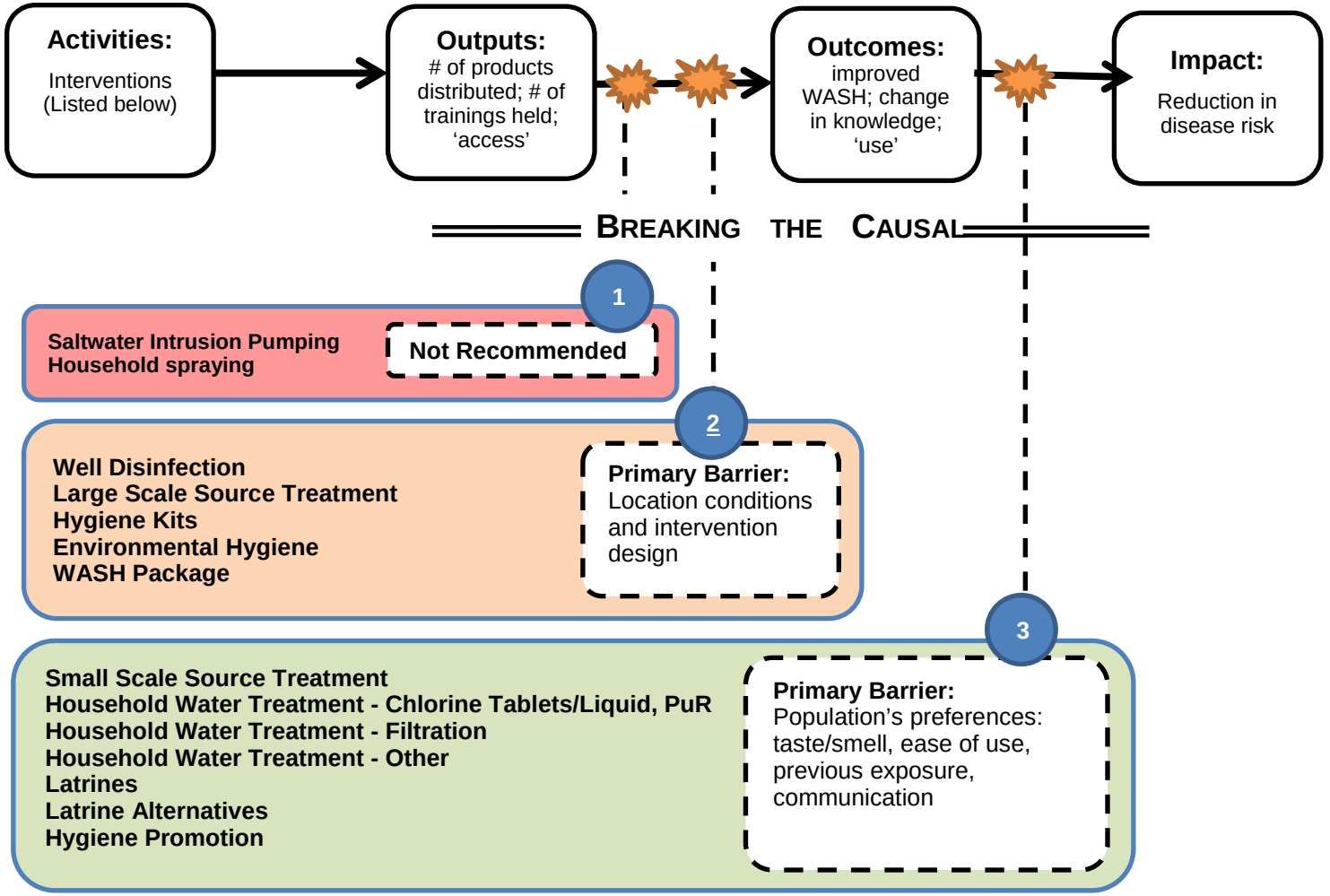
The evidence from this review validates the causal chain developed for this review and presented in Section 1.2, Box 1. Interventions with access to WASH services and measured high use also had large and significant reductions in diarrhea (Johnston 2008, Doocy and Burnham 2006, Meyer Capps and Njiru 2015, Puddifoot 1995, Roberts et al. 2001). Breakages along the causal chain are also apparent due to context and social barriers. Through this review, we identified 3 common breakages along the WASH causal chain (Figure 23).

Causal Chain Break 1 – There was one intervention that was not efficacious and would likely have a negative impact on WASH conditions: saltwater pumping. Saltwater intrusion pumping was clearly ineffective and likely delayed the time before beneficiaries could use the well. Additionally, although there was less evidence, household spraying was also suspected to be ineffective with negative social effects. These interventions are not known to improve the WASH conditions of beneficiaries and therefore *not recommended*.

Causal Chain Break 2 – Five interventions had minimal beneficiary involvement but known efficacy, thus intervention design and implementation were primary barriers to impact. Source treatments like bulk water systems or well disinfection can be efficacious but were not evaluated at the beneficiary household level. Effectiveness for disease impact were not evaluated and remain a gap in the literature.

Causal Chain Break 3 – The barrier between effective outcomes and impact (disease reduction) is primarily behavioral preferences that impact use. Wide variation in use was documented for the remaining interventions (HWT, small scale source treatment, latrines, latrine alternatives and hygiene promotion) and was dependent on familiarity of products, ease-of-use, personal preferences to taste/smell and culture. Education and promotion were also key factors that could facilitate or hinder impact of emergency WASH.

Figure 23: Causal Chain Intervention Evidence



Objective 2: Health Impact in Emergency WASH Interventions

Evidence that WASH interventions reduce the disease burden in an emergency is limited, but is seen through: reduced disease risk and reduced transmission risk.

Reduced Disease Risk – Interventions directly measuring a health impact were few and mostly in HWT: PuR, chlorine tablet, SODIS and safe storage and assessed as low or very low quality of evidence as there was only one to two evaluations for each intervention type. While a disease risk reduction was observed in all interventions, often significantly, the limited number of studies limited broader application of results. Additionally, latrine use and a CLTS intervention also documented reduced disease risk, but were also very low quality evidence.

Reduced Transmission Risk – Interventions that evaluate the risk of transmission through non-health indicators were more often evaluated in emergencies. Interventions documenting FCR in drinking water are known to reduce disease transmission and had *Moderate Quality of Evidence*; including: well disinfection, Dispensers and HWT (liquid chlorine, chlorine tablets and PuR). Environmental hygiene interventions using chlorine to clean jerricans reduced short-term transmission risk with measurable FCR and had *Low Quality of Evidence.*

Objective 3: Impact of Non-Health Related Outcomes

In the review, five community perceptions and preferences that affect the success of emergency WASH interventions were established.

Taste and Smell – Aesthetic changes to water taste and smell from HWT product use can hinder use in some populations (particularly with chlorine-based HWT products) or encourage use in others.

Preferred Communication – Radio and face-to-face communication were consistently reported as “most trusted” and/or “most valued.”

Overestimation of Effectiveness – Community perception severely overestimates the outcomes and impacts of some WASH interventions, particularly household spraying and well disinfection.

Trust/Fear – Social mobilization and open communication between the community members and responders can build trust and community cohesion. By listening to communities’ concerns (i.e. fears, stigmas), responders can adapt and improve programs.

Ease of Use – Communities preferred interventions that are simple and easy to use, which require minimal steps to use and changes in behavior.

Objective 4: Program Design and Implementation Characteristics Associated with More Effective Programs

Six program design and implementation characteristics were identified in the review as associated with more effective programs; these include, simplicity, timing,

experienced staff, communication, being community driven and having linkages to development programs.

Simplicity – Some of the simplest interventions (HWT with basic filters, safe water storage with the provision of jerricans, jerrican disinfection) reported high use and positive health impact. These incremental improvements required little to no promotion, and reduced the risk of disease. The success of simple interventions is attributed to the fact little behavior change is required by the beneficiaries.

Timing – Prepositioned stock, quick release of funding and early triggers for rapid scale up were important factors leading to an effective response, particularly with hygiene kit distribution and HWT interventions.

Experienced Staff – Experienced staff that could rapidly scale up appropriate interventions were identified as critical to success in Dispensers and WASH Package programs.

Communication – Multiple modes of communication that reinforce key messages, with strong radio and face-to-face components and simple clear instructions, were found to be most preferred by communities.

Community driven – Engagement in the community empowers and builds trust. Community driven interventions can increase awareness, trigger behavior change and find local solutions (i.e. CLTS, CLEME).

Linking Development and Relief – Development contexts with weak WASH infrastructure, overcrowding and poor hygiene practices have high potential for disease transmission and often have on-going WASH programming. Linking development programs to emergency response activities was found to be successful for chlorine projects in Haiti and Madagascar and a CLTS project in Liberia.

Objective 5: Economic Outcomes of WASH Interventions in Outbreaks

Economic outcomes of WASH interventions in emergencies were not able to be assessed as there were only minimal economic outcomes in the evaluations included in the review.

5.2 Overall completeness and applicability of evidence

It is clear from the results of the review that some of the most commonly implemented WASH interventions in emergencies are severely under-researched. We need additional research for: bucket chlorination, bulk water treatment, household spraying, water trucking, environmental clean-up and formal economic analysis of all WASH interventions. With some interventions (e.g. bulk water treatment) efficacy of the treatment is not doubted; however, the consistency and impact at the household level could be further explored. For example, we know the bulk water treatment unit could produce clean water in ideal conditions, but will it in an emergency context, and will that water be accepted and used by the beneficiary community (Luff and Dorea 2012)?

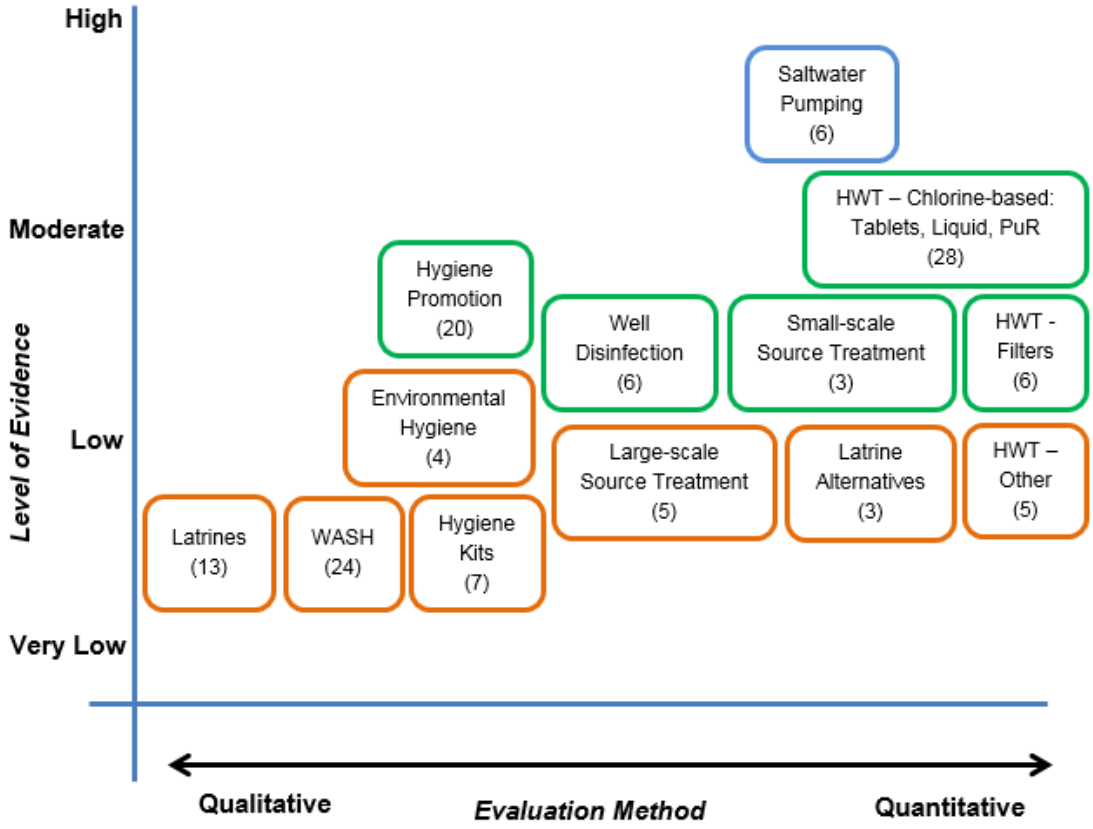
While we need more research on specific WASH interventions that are under-researched, it is anticipated that the implementation and psychosocial aspects would remain critical, especially for more complicated or complex WASH interventions.

5.3 Quality of the evidence

The state of evidence identified in this review is presented below in Figure 24. The quality of evidence is shown against the methodology identified within each intervention. The colors serve to help differentiate the level of evidence between interventions (blue: high evidence; green: moderate evidence; orange: low evidence). The positioning of the interventions is relative to the interventions identified and is simply intended to orient the reader within the body of evidence. Studies could also be included in more than one intervention category. There is no separation between published or grey literature.

Evidence *against* pumping wells contaminated with saltwater was the only intervention with high level of evidence. Water interventions, source-based treatment and HWT, had more evaluations, better evidence and were assessed more quantitatively. Hygiene, sanitation and WASH Package had lower quality and were more qualitative. Overall, the evidence remains low and lacking with several known interventions not identified in the review: bucket chlorination, bulk water treatment, household spraying, water trucking, environmental clean-up.

Figure 24: Summary Map of Evidence



(#) is the number of interventions per category, n=130 (16 documents included in more than one intervention)

5.4 Limitations and potential biases in the review process

This review has several limitations, including the potential for reporting bias, search bias, recall and courtesy bias, the use of proxy indicators, inconsistent outcome reporting and bias inherent in the protocol design.

Reporting Bias **–** Most organizations that submitted documents to the review provided only a select handful of reports. It is possible that provided reports were limited to those with favorable outcomes or innovative approaches, and reports detailing mundane activities or unfavorable results were not provided. One notable exception was the organization ACF, who shared thousands of documents spanning nearly 10 years of work. Additionally, several key organizations in emergency response did not submit documents, despite multiple efforts to collect information. It is likely that additional information is available, but was not submitted to the review process.

Recall and Courtesy Bias – Self-reported data (such as diarrheal disease incidence or use of HWT products) is subject to both recall and courtesy bias. Recall bias occurs when beneficiaries remember occurrences differently than actually occurred. Courtesy bias occurs when beneficiaries respond to questions with answers that are acceptable or correct, rather than accurate. These biases would likely over-estimate positive outcomes.
Use of Proxy Indicators – Diarrhea incidence and prevalence and *E. coli* microbiological results are limited by the fact they are proxies for the outcomes and impacts of disease outbreaks.

Inconsistent Outcome Reporting – Outcomes (such as FCR) were reported inconsistently, and this limited the potential for comparison across evaluations. Additionally, WASH interventions that are intended to prevent or reduce disease transmission may have difficulty showing impact because of the difficulty in proving a negative (i.e. disease reduction) and the uncertainty of knowing future or potential disease rates. While rigorous study designs can account for these issues, they often require a control group and this leads to ethical concerns in emergency contexts.

Bias Inherent in Protocol Design **–** Some biases were inherent in the search strategy as defined in the protocol Appendix B including:

- Database searching was completed in English, French and Spanish. It is likely there is additional information in other languages not searched.
- The web-based searches were limited by the fact that organization websites were structured differently, and to the authors' knowledge there is no single web repository for research in emergencies.
- Only WASH interventions implemented in acute emergency settings were included; as many WASH interventions are derived from other sectors (development, emergency response), it is likely that studies with relevant information were excluded.
- The inclusion criteria permitted a greater quantity of lower quality less technical studies that is traditional to systematic reviews. This increased the knowledge gained, but precluded meta-analysis.

- In conducting the review, it was more difficult than expected to:
  - Identify whether an intervention was a WASH intervention, as activities (such as dead body management) can be considered WASH, but also can be health, nutrition and/or community mobilization;
  - Assess whether the WASH intervention was in the same geographic location as the emergency;
  - Compare interventions conducted at different times of the emergency, as interventions quickly transition from acute to recovery situations, with different WASH interventions carried out in each stage; and
  - Search and extract information from grey literature, as grey literature documents often included information beyond the scope of evaluation and lacked consistency in format, definition, structure and objective.

Despite these limitations, the strength of this review is in its broad inclusion criteria and assessment of intermediary outcomes and final impacts that led to a comprehensive review of available evidence that is policy-relevant and actionable.

5.5 Agreements and disagreements with other studies or reviews

This review is in general agreement with other recent reviews in emergency WASH (Taylor et al. 2015, Ramesh et al. 2015). There were included studies common to all three reviews and all reviews were focused on water interventions, particularly HWT interventions. Previous systematic review efforts reported only health impacts have been limited by small sample size and few lessons learned. The broad inclusion criteria here led to additional outcomes and impacts, particularly from sanitation and hygiene that were not included in other reviews. While the quality of included studies was low, the practical application for agencies working in emergency WASH is increased through the inclusion of grey literature.

6. Conclusions

A systematic review process was used to identify more than 15,000 documents; ultimately, 114 evaluations in emergency WASH contexts were included in the review. The majority of evaluations focused on water interventions, particularly HWT. NGO documents (grey literature) made up half (50%) of the included studies, contributing to the overall evidence base. Below we discuss implications for practice and policy, implications for research and the review summary.

6.1 Implications for practice and policy

Three themes identified in the review have direct implications for policy and practice: field evidence, expectations of reporting and evaluation and enabling conditions.

Field Evidence – Overall, the evidence for WASH in emergencies is low and lacking. However, results and recommendations were able to be collated from: 1) consistent and common themes identified across multiple contexts and interventions; and 2) multiple low-quality, high risk studies with similar results. Thus, unpublished field evaluations with weak research methods are a valuable resource in establishing field evidence.

Expectations for Reporting and Evaluation – Despite all WASH interventions aiming to reduce disease risk, the indicators measured across interventions were inconsistent and varied and most evaluations did not attempt to measure impacts of disease reduction and cost-effectiveness. This is likely due to lack of resources, time or evaluation expertise in emergency response, as well as the common belief that study types with control groups are unethical to conduct in emergency response. It is recommended to continue to collect outcome indicators, but to collect consistent indicators to facilitate comparison. It is also recommended to dedicate specific resources and funding to collect impact indicators in an ethical manner in order to broaden the evidence base available.

Enabling Conditions – Pre-positioned stock, previous familiarity with HWT products, connections to development interventions and fast/flexible funding were all identified as facilitators to more successful programs. These facilitators identified through the review indicate that potential for impact is often a function of pre-existing conditions. Previously implemented development projects and preparedness are thus important considerations for emergency response.

6.2 Implications for research

There is ample opportunity to fill research gaps identified and advance the knowledge base of WASH in emergencies. Suggestions for future research include:

Consistent Field Non-Experimental Design Evaluations – Non-experimental design studies (such as case studies) provided valuable evidence for this review, as long as they had consistent indicators and were conducted with similar methodology across differing contexts. Lantagne and Clasen (2012) and Yates et al. (2015) are two examples of non-experimental design field research that draws strength from consistency, rather than evaluation methodology. Both papers utilized the same or similar evaluations in different contexts to highlight differences in use and also barriers and facilitators for a specific intervention. It is recommended additional consistent field research on the under-researched interventions identified in this review be conducted.

Research Methods with Control Groups in Emergencies – Research methodology that requires significant time and resources (e.g. randomized control trials) are generally not appropriate for emergency WASH interventions. Several practical research methods, with control groups, for emergency contexts include:

- *Stepped-wedge* research design – A stepped-wedge design takes advantage of the natural constraints of delivering assistance in a large area. While all participants in the research will receive the intervention by the end of the study, the intervention is distributed in a stepwise fashion, with participants receiving the intervention at different time points. The control group is the group of people who have not yet received the intervention (100% of participants at outset, 0% at evaluation end), and is compared to the intervention group of those who have received the intervention (0% of participants at outset, 100% at evaluation end).
- *Retrospective control groups* – Retrospective groups, similar to some case-control designs, may be an option in some situations; for example, note the

CLTS Ebola evaluation in Liberia by Meyer Capps and Nijiru (2015). (Meyer Capps and Njiru 2015).

- *Natural experiments* – Natural experiments occur without planning, but pose unique research opportunities. An example natural experiment was in the SODIS health impact study when a cholera outbreak started just after the end of ongoing development impact research (Conroy et al. 2001).

WASH Package Evaluations – Water interventions (HWT, source treatments) were well established in the academic literature. On the other hand, grey literature contributed most significantly to sanitation, hygiene and WASH Package interventions. The opportunity for synergies in WASH programming is often discussed; yet the WASH Package interventions had no published evaluations. WASH Package interventions are complex and pose difficult considerations for research; however, the lack of any published WASH Package evaluation is representative of a disconnect between academic research and field evaluations and research on WASH Package interventions is needed.

Behavior Change Research – A greater research emphasis on behavior change and effectively engaging communities is needed. The technical efficacy of most interventions is well established from the laboratory or development settings; the 'human factor' remains a primary hurdle to many interventions. Evaluating how the beneficiaries use the WASH intervention, what they like and don't like, and other barriers or facilitators, is necessary to understand the strengths and weaknesses of interventions. Improved understanding of behavior through social sciences is necessary to increase use and improve impact.

Best Practice Comparisons – There are numerous best practice and guidance documents available (from UN agencies, donors and individual NGOs) on how to conduct WASH in emergency activities. An analysis to identify inconsistencies between 'best practice,' and 'evidence-based interventions' is needed to align actives across the sector.

6.3 Review Summary Statement

We found that some WASH interventions are successful at increasing access to water and sanitation services and reducing the risk of disease via outcomes and impacts. However, program design, implementation characteristics and community psychosocial aspects are critical to program success. Interventions should be simple with open communication between responders and beneficiaries. The importance of quick and flexible funding, pre-positioned stock and linking development interventions to acute emergency response are also considerations. Improved understanding of previous development projects and social influences could improve emergency interventions. Overall, in emergency contexts, WASH interventions consistently reduce disease risk through improved access to services and have a potential for positive non-health impacts. Improved understanding of previous development projects and social influences could also improve emergency interventions. As the humanitarian needs increase globally, continuing to improve the field evidence for emergency WASH interventions remains imperative.

7. Plans for updating the review

There are no current plans for updating the review.

8. Acknowledgments

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9. The review team and contributions of authors

Travis Yates – Searching, project organization, review documents, analysis and writing

Jelena Allen – Review documents and writing

Myriam Leandre Joseph – Review documents

Daniele Lantagne – Project organization, review documents and writing

10. Statement concerning conflict of interest

There were no conflicts of interest in the writing of this report. Authors of this report are also authors of several included evaluations in this review (Lantagne and Clasen 2012, Lantagne and Clasen 2013, Yates, Armitage, et al. 2015). As with all documents, we maintained the systematic review procedure as outlined in the protocol and ensured a review team member that was not a part of the three documents listed above also approved studies these studies for inclusion.

Appendix A: Detailed description of included documents

Intervention	Quantitative	Qualitative	Field Commentary	Published or Grey Literature (P:G)
Water	**52**	**4**	**3**	**43:16**
Well Disinfection	4	2	0	6:0
Well Rehabilitation	5	1	0	6:0
Water Tankering	2	0	1	2:1
Source-based Treatment	3	0	2	4:1
HWT – Chlorine Tablets	12	0	0	7:5
HWT – Liquid Chlorine	9	0	0	6:3
HWT - PUR®	6	1	0	3:4
HWT - Filtrations	6	0	0	4:2
HWT - Other	5	0	0	5:0
Sanitation	**3**	**1**	**12**	**12:4**
Latrines	2	1	10	9:4
Latrine Alternatives	1	0	2	3:0
Hygiene	**9**	**6**	**16**	**11:20**
Hygiene Promotion	3	2	4	4:5
Social Mobilization	1	1	7	1:8
Handwashing	1	1	0	2:0
Hygiene Kit Distribution	2	0	5	0:7
Environmental Hygiene	2	2	0	4:0
WASH Package	**0**	**9**	**15**	**0:24**
WASH - Outbreaks	0	3	10	0:13
WASH – General Emergency	0	6	5	0:11
Totals	**63**	**20**	**47**	**66:64**

Note: Interventions can be in more than one category.

Water

Well disinfection

Author and Title *Published/Grey Lit*	Context Project Date	Description of Activities	Evaluation	Key Impacts	Bias
Cavallaro (2011) Evaluation of pot-chlorination of wells during a cholera outbreak, Bissau, Guinea-Bissau, 2008 *Published*	Cholera – Outbreak Guinea-Bissau 08/2008	Pot chlorination with 1.5 L plastic bottles, sodium hypochlorite, gravel, and sand	Quantitative – Cross-sectional with randomization 30 wells – FCR and TCR measured daily for 1-3 days after inserting chlorinator	Effectiveness described as a sustained FCR above 1.0 mg/L (WHO outbreak guidelines) After 24 hrs: 15% had FCR >1.0 mg/L After 48 hrs: 4% had FCR >1.0 mg/L After 72 hrs: 0% had FCR >1.0 mg/L Deemed costly and ineffective	Low Risk Consistent collection procedures
Garandeau (2006) Chlorination of hand-dug wells in Monrovia *Published*	Cholera – Endemic Liberia No Date	4 well chlorination techniques assessed: 1) Floating pot chlorinators; 2) Jerry can pot chlorination-with calcium hypochlorite powder; 3) Liquid chlorine 'bleach' - 5% solution twice per day; 4) Pot chlorination with local pressed calcium hypochlorite tablet 70g in bag of sand	Qualitative 12 wells (3 protected and 9 unprotected) used over 9 weeks with different chlorination techniques, FCR measured	1) Floating pot chlorinators - fairly effective and appropriate but less sustainable 2) Simple pot - appropriate but ineffective as the tablets dissolved too quickly, high spike in FCR 3) Liquid bleach - fairly effective but FCR did not stay above 0.2 mg/L all day 4) Pressed tablet pot chlorination with local pressed tablet - effective and appropriate FCR 0.2-1.0 mg/L in all wells for 3-6 days, local materials and cheap Locally pressed calcium hypochlorite tablets in bag of sand was most effective with sustained FCR for several days.	High Risk of Bias Unspecified methodology and sampling

Guevart (2008) Handmade devices for continuous delivery of hypochlorite for well disinfection during the cholera outbreak in Douala, Cameroon (2004) *Published*	Cholera - Outbreak Cameroon 10/2004 - 11/2004	Pot chlorination with perforated plastic bag, sodium hypochlorite, and sand	Quantitative – Cross-sectional 18 wells (2 villages – 9 wells each) 36 chlorinations – FCR measured daily	FCR remained above 0.2 mg/L for 3 days, after 4 days half of the wells were below 0.2 mg/L. Maximum concentration occurred after 1 day in 31/36 tests, after 2 days for 5/36.	Low Risk of Bias Clear well selection criteria, clear methods and reporting
Libessart (2000) Integrated chlorination campaign in Mogadishu *Published*	Cholera – Endemic Somalia 10/1998 – 1/2000 (Different strategies over timeframe.)	Shallow wells treated with 3 different chlorine treatment methods: 1) 1% liquid chlorine 'shock,' 2) jerry can pot chlorination with powdered chlorine, 3) pot chlorination with immersed pressed tablets (125g HTH).	Quantitative – Cross-sectional FCR measured at different times over several programming cycles: 1) 1% Liquid Chlorine: 173 wells over 1 year; 2) Jerry can pot chlorination: 919 tests over 3 month; 3) Pressed tablet pot chlorination: 98 tests (duration not reported)	Liquid chlorine: 69% measured FCR >0.1 mg/L (28% >0.6 mg/L) Jerry can pot chlorination: 87% measured FCR >0.1 mg/L (27% >0.6 mg/L) Pressed tablet pot chlorination: 96% measured FCR >0.1 mg/L (45% >0.6 mg/L) Pressed tablet pot chlorination deemed best option.	High Risk of Bias High number of samples, inconsistent/non-comparable methods of evaluation for each treatment

Luby (2006) Chlorine spot treatment of flooded tube wells, an efficacy trial *Published*	Flood Bangladesh 08/2004	Chlorination of 13 tube wells hypochlorite (35g per 100ft of well mixed with 10L water) compared with 13 control tube wells	Quantitative - RCT 15 intervention wells, 15 control wells – TTC was measured after 30min, 60min, and 7-14 days	Bleach spot treatment had no effect on microbiological quality. 0% success rate of disinfection with chlorine (77% of the intervention wells were contaminated before; 77% were contaminated after)	Low Risk of Bias Consistent collection procedure, clear reporting of results
Rowe (1998) Chlorinating well water with liquid bleach was not an effective water disinfection strategy in Guinea-Bissau *Published*	Cholera – Endemic Guinea-Bissau 11/1994	Liquid chlorine ('bleach' sodium hypochlorite) 'shock' dose added to shallow wells to achieve about 30 mg/L	Qualitative 10 wells monitored every 24 hours until FCR cessed	40% (4/10 wells) had FCR after 24 hours (Median 24 hours; range 0-6 days) Perception of protection in the community after 'well shock' is beyond the protective capabilities of the treatment 'Well shock' may not be effective for disinfecting water	High Risk of Bias Low sample size, collection procedures quesionable

Well Rehabilitation

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
Fesselet (2006) Saline Wells in Aceh *Published*	Tsunami Indonesia 2/2005 – 6/2005	289 wells monitored after cleaning	Quantitative Cross-sectional; 289 wells	14% had salinity levels <2,500 µS/cm; 1.7% below the taste threshold of 900 µS/cm (repeated cleanings had not effect) Cleaning improved the turbidity, but did not reduce salinity levels suitable for drinking, heavy rains reduced salinity	Low Risk of Bias Clear selection criteria and reporting of results
Lipscombe (2007) Groundwater salinity	Tsunami	9 wells – salinity measured before and after pumping;	Quantitative	Pumping had no effect and possibly increased salinity.	High Risk of Bias

and hand dug wells in Ampara, *Published*	Sri Lanka 3/2005 – 11/2005	20 wells measured salinity over time	Cross-sectional	Over and repeated pumping not useful – only to remove silt and debris. Community expectations were not met.	Unclear methods and reporting of results
Lytton (2008) Deep impact: why post-tsunami wells need a measured approach *Published*	Tsunami Sri Lanka 1/2005	Clearing and pumping of 64 wells to reduce salinity	Quantitative Cross-sectional: 5 wells – salinity (TDS) monitored during pumping	Monitoring showed no reduction in salinity Pumping was stopped after 5 (of 64) wells, because there was no apparent effect on salinity and possible damage to well structures	Low Risk of Bias Inconsistent data collection
Saltori (2006) Challenges of tsunami and conflict affected rural water supply in Sri Lanka *Published*	Tsunami Sri Lanka 1/2005 – 1/2006	Cleaning and pumping of well after tsunami, 122 wells by ACF for microbiological contamination. Sets of 50 and 30 wells monitored by ICRC for salinity	Quantitative Cross-sectional with randomized selection	Perception from community that the more the well is pumped the faster and better the recovery would be Taste of water (psychological) was main hurdle - despite safe levels of salinity Waiting for the rainy season is best option - well pumping had no effect; well pumping can be hazardous to the integrity of the well	Low Risk of Bias Clear reporting of findings
Villholth (2007) Tsunami impacts on groundwater and water supply in eastern Sri Lanka *Published*	Tsunami Sri Lanka 1/2005 – 1/2006	~150 well in three villages monitored. Well pumping and chlorination carried out.	Quantitative Cross-sectional; 120 wells	Pumping wells to remove salinity was not recommended because it was deemed to be ineffective and, in some cases, worsened the salinity. The majority of flooded wells were unfit for drinking 7 months after the tsunami. 65-83% of HH reported problems with diarrhea when all HH had returned to well 2 years after tsunami	High Risk of Bias Limited methods, mostly commentary

Vithanage (2009) Effect of well cleaning and pumping on groundwater quality of a tsunami-affected coastal aquifer in eastern Sri Lanka *Published*	Tsunami Sri Lanka 10/2005	2 transects observed: Disturbed transect (15 hand dug wells with piezometers, 4 wells were abandoned) Undisturbed transect (20 piezometer wells)	Qualitative Case Study	Salinity decreased 5 fold from Jan to Sep (rainy season) with no disturbance. This decrease was smaller with pumping. With saltwater flooding, it is better to let the wells be.	Low Risk of Bias Clear methods and reporting of results

Water Trucking

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
Gupta (2006) Inadequate drinking water quality from tanker trucks following a tsunami disaster, Aceh, Indonesia, June 2005 *Published*	Tsunami Indonesia 1/2005	Water tankering – 40 tanker trucks collecting water from safe source; wait times were long, and trucks occasionally collected from unsafe sources to avoid the line	Quantitative Cross-sectional	17% of 54 samples were contaminated (E.coli); 1 in 6 trucks had E.coli present 56% of 75 sample for FCR had 0.1 mg/L or above Median wait time at safe water source for truck: 2.75 hours	High Risk of Bias Inconsistent reporting, spillover effects likely
Lantagne (2013) Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake *Published*	Earthquake Haiti 1/2005 – 10/2005	25 E.coli and 22 FCR samples taken from tanker trucks	Quantitative Cross-sectional	56% (n=25) had microbiological contamination 77% (n=22) had no measurable FCR	Low Risk of Bias Clear methods and reporting of outcomes

Martin (2011) Rapport final - Water trucking DINEPA-ACF, Zone métropolitaine de Port-au-Prince, mai 2010 - 15 mai 2011 *Grey Literature*	Earthquake Cholera – Outbreak Haiti 3/2010 – 3/2011	Water trucking in the area of Port-au-Prince. About 1500-2000 m^3 distributed daily during one year; 156 distribution points in August 2010	Field Commentary Organizational reflection	End-of-intervention strategy defined late Good knowledge of intervention area; extended coverage Collaboration with at least 10 partners in the WASH cluster (sharing information)	High Risk of Bias Unclear data collection methods

Source-based Treatment

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF (2014) Feasibility study and piloting of a Decentralized safe water access solution dedicated to emergency and natural catastrophes through a pre-trained community based Emergency Response Team (ERT) "Aquasure" *Published*	Flood Bangladesh 7/2013 – 11/2013	Water treatment units (WTU): 583 field batches of water treatment	Field Commentary Case study	FCR: more than 98% of samples/batches >0.2 mg/L Majority of batches had more than 0.5 mg/L FCR - people complained of smell Most people were not used to chlorine treatment, but accepted it eventually 1000 L/ batch - but only 900 L usable - flocculent/settling and chlorine treatment	High Risk of Bias Case study description
Dorea (2009) Up-flow Clarifier for emergency water treatment *Published*	Tsunami Typhoon Indonesia, Haiti No Date	Treatment of high yield water sources with the Clarifier, a coagulant-based system, to reduce turbidity	Field Commentary Case Studies	Capable to treat variety of turbid waters and reduce natural organic material (thus less chlorine demand) Approximate 2 log reduction in thermotolerent coliform (TC) Simple, robust, capable of being managed with minimal to no training Clarifier unit cost about 5,000 Pounds (low cost compared to other options explored in 1995)	High Risk of Bias Commentary – personal observation
Yates (2015) Effectiveness of chlorine dispensers in	Cholera – Endemic	Chlorine Dispenser	Mixed-methods; cross-sectional	52% and 9% reported use (initial and sustained)	Low Risk

emergencies: Case Study DRC *Published*	D.R Congo 4/2013 – 12/2013	installed on paths near river/lake with promotion	randomized clusters for HH 300 HH (initial and sustained); FGD; KII	34% and 5% confirmed use (initial and sustained) 28% and 0% effective use (initial and sustained)	Clear methods and reporting; Large difference in municipal water supply access between evaluations
Yates (2015) Effectiveness of chlorine dispensers in emergencies: Case Study Sierra Leone *Published*	Cholera – Endemic Sierra Leone 03/2013 – 9/2013	Chlorine Dispenser installed at community wells with promotion	Mixed-methods - cross-sectional randomized clusters for HH 300 HH (initial and sustained); FGD; KII	17% and 22% reported use (initial and sustained) 11% and 18% confirmed use (initial and sustained) 10% and 10% effective use (initial and sustained)	Low Risk Clear methods and reporting.
Yates (2015) Effectiveness of chlorine dispensers in emergencies: Case Study Haiti *Published*	Cholera – Outbreak Haiti 5/2011 – 11/2011	Chlorine Dispenser installed at high risk sources. Pilot program	Mixed-methods-cross-sectional randomized clusters for HH 298 HH (sustained); FGD; KII	12% reported use (sustained) 9% confirmed use (sustained) 5% effective use (sustained)	Low Risk Clear methods and reporting.

Household Water treatment – CHLORINE Tablet

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF (2009) Household NFI monitoring Report (PDM) May 2009 *Grey Literature*	Cholera – Outbreak Zimbabwe No Date	Aquatabs® distributed to HH as part of an NFI kit with bucket and lid (~33,000 – kits, other contents not described)	Quantitative Cross-sectional: 218 HH (Random)	26% of HH reported use 17% of HH confirmed use (> 0.5 mg/L) Low Aquatab® use because water was collected from a borehole 'safe water' 75% of HH used the bucket Overdosing, with smell and taste being issues.	High Risk of Bias Inconsistent reporting, self-reported information, FCR was measured but not fully reported.

ACF (2014) Hygiene Kits Post Distribution Monitoring Report *Grey Literature*	Cholera – Outbreak South Sudan 5/2014	Aquatabs distributed in NFI kits to 7,348 HH. Kit also included: bucket, PuR® Purifier of Water packets and filter cloth	Quantitative Cluster Cross-sectional: 351 HH	87% confirmed use (>0.1 mg/L) in HH with Aquatabs (6% of HH FCR >0.5 mg/L) >90% of HH had FCR in Juba (range 83-100%) 78% of HH could demonstrate correct use of PuR HH without FCR said they get water from a treated tanker, or are saving the Aquatabs for when cholera outbreaks again.	High Risk of Bias Inconsistent reporting. Spillover effects likely.
ACF - Topklo (2015) Projet de reprise communautaire de la lutte contre le choléra et les maladies hydriques dans les zones de santé de Minova (Sud Kivu) et de Kirotshe (Nord Kivu), R.D. Congo *Grey Literature*	Cholera – Endemic D.R. Congo 3/2013 – 8/2013	Chloramine tablets with hygiene promotion	Quantitative Cross-sectional Before/After: 384 HH	14% reported use of tablets. 14% confirmed use (54/ 54 HH had FCR 0.3-0.6 mg/L) Reduction from 11 to 0 and from 30 to 7 cholera cases (monthly basis) in the intervention areas	Low Risk of Bias Well-defined sampling strategy; limitations clearly stated
Hoque (2007) Efficiency and Effectiveness of Point-of Use Technologies in Emergency Drinking Water: An Evaluation of PUR and Aquatab in Rural Bangladesh *Grey Literature*	Flood Bangladesh 9/2006 – 2/2007	Distribution of Aquatabs and PuR in relief packages to 4,800 HH with demonstrations of use	Quantitative Cross-sectional; 200 HH (random); TTC and FCR measured	100% of water samples tested negative for TTC (n=200) The mean and median values of FCR in samples treated with Aquatabs were 1.45 mg/L and 1.08 mg/L respectively – higher than PuR samples Beneficiaries reported a significant preference to PuR over Aquatabs	High Risk of Bias Spillover effects likely
Imanishi (2014) Household Water Treatment Uptake during a Public Health Response to a Large Typhoid Fever Outbreak in Harare, Zimbabwe *Published*	Typhoid – Outbreak Zimbabwe 11/2011 – 2/2012	Chlorine tablet distributed to 51,000 HH (3 different doses); 3,500 HH received NFI kits with soap, WaterMaker (floc/dis), and jerry can in addition to HWT	Quantitative Cross-sectional: 458 HH	31% reported use 22% confirmed use (FCR $\geqslant 0.2\ \mathrm{mg/L}$) 73% of HH reported using HWT before outbreak, 83% reported using HWT during the outbreak 97% of HH with stored water had covered containers	Medium Risk of Bias Carried out in worst hit areas, peak of outbreak already declining

Johnston (2008) Point-Of-Use water treatment in Emergency Response: Experiences in cyclone Sidr *Grey Literature*	Typhoon Bangladesh No Date.	Distribution of 5 million of WPT (Water purification tablets)	Quantitative Cross-sectional; 126 HH	65% had WPT in house, 10% had treated water All samples tested negative for TTC Over 40% of beneficiaries reported unacceptably high chlorine smell and taste; over 60% said they were not at all satisfied with the product WPT is unpopular among respondents – PuR is preferred HH reporting diarrheal disease cases in children under 5 was 5.7% (RR 0.45 (0.19 – 1.03)) for those using PuR compared to 12.7% in the control group	High Risk of Bias Unclear methods and reporting of results
Lantagne (2012) Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Indonesia *Published*	Earthquake Indonesia 11/2009	International NGOs providing HWTS to 1,578 HH – received chlorine tablets (Rotary) but also Air Rahmat liquid chlorine	Quantitative Cross-sectional: 270 HH	1.4% of HH reported use (Liquid chlorine 'Air Rahmat' 6.2%, Boiling 88.1%) 1.4% of HH confirmed use (Liquid chlorine 'Air Rahmat' 0.9%)	Low Risk of Bias Selection bias not likely. Clear and consistent reporting of outcomes.
Lantagne (2012) Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Nepal *Published*	Cholera – Outbreak Nepal No Date	Local NGOs using pre-positioned stock. 1565 HH – received Aquatabs® but also liquid chlorine (Water Guard, Piyush)	Quantitative Cross-sectional: 400 HH	8.3% reported use (Liquid Chlorine: WaterGuard: 6.3% Piyush: 15.8%) 6.8% confirmed use (FCR $\geqslant 0.2\ \mathrm{mg/L}$) (Liquid Chlorine: WaterGuard: 3.5%; Piyush: 8.3%)	Low Risk of Bias Spillover between several similar interventions
Lantagne (2012) Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Kenya *Published*	Cholera – Outbreak Kenya No date	Pre-positioned stock. Distribution of Aquatabs® and PuR® Purifier of Water in an NFI kit to 5,592 HH.	Quantitative Cross-sectional: 409 HH	12.7% reported use (PuR® Purifier of Water: 5.9%) 7.9% confirmed use (PuR®: 3.7%) (FCR $\geqslant 0.2\ \mathrm{mg/L}$) 5.3% effective use <1 CFU/100mL (PuR: 2.3%)	Low Risk of Bias Selection bias not likely, consistent reporting of outcomes

Lantagne (2013) Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake – DSI program *Published*	Earthquake Haiti No Date	Aquatabs distributed to 2880 HH	Quantitative Cross-sectional; 182 HH surveyed within 8 weeks of emergency onset (acute) and 143 HH 10 months after onset (recovery)	Acute: 84% of HH report Aquatab use 72% of HH confirmed use (FCR >0.2 mg/L) Recovery: 52% of HH report Aquatab use 48% of HH confirmed use (FCR >0.2 mg/L)	Low Risk of Bias Clear methods and reporting of outcomes
Lantagne (2013) Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake – HRC program *Published*	Earthquake Haiti 1/2010 – 3/2010	Aquatabs distributed in an NFI kit to 87 HH in an IDP camp	Quantitative Cross-sectional; 87 HH surveyed within 8 weeks of emergency onset	Acute: 22% of HH report Aquatabs use 15% of HH had FCR >0.2 mg/L No promotion	Low Risk of Bias Clear methods and reporting of outcomes
Sirajul Islam (2007) Faecal contamination of drinking water sources of Dhaka city during the 2004 flood in Bangladesh and use of disinfectants for water treatment *Published*	Flood Bangladesh 8/2004 – 1/2005	Field trial of Halotab (15 mg chlorine tablet) and bleaching powder (calcium hypochlorite); 300 water samples from 20 drinking water sources	Quantitative 300 samples – total coliforms (TC), faecal coliforms (FC), faecal streptococci (FS) tested	81.5% and 64.7% effectiveness against TC (Halotab, bleaching powder) 77.1% and 72.4% effectiveness against FS (Halotab, bleaching powder)	Low Risk of Bias Clear and consistent methods

Household Water Treatment – Liquid Chlorine

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF (2014) Projet pilote de l'approche de marché pour la promotion du chlore liquide *Grey Literature*	Cholera – Endemic D.R. Congo 11/2013 – 1/2014	Promotion and distribution of liquid chlorine with vouchers to 834 HH.	Quantitative Cross-sectional: 32 HH	*No reported use*. Voucher redeemed by 88% of HH 69% confirmed use (FCR $\geqslant 0.2$ mg/L; Average FCR 0.5 mg/L) 97% of HH (31/32) reported being satisfied with liquid chlorine as a HWT	Medium Risk of Bias Potential spillover and selective reporting
Dunston (2001) Collaboration, cholera, and cyclones: A project to improve point-of-use water quality in Madagascar *Published*	Cholera – Outbreak Madagascar 1/2000 – 6/2000	Liquid Chlorine marketed to community (Safe Water System-WaterGuard). Jerry cans available but not distributed.	Quantitative Cross-sectional randomized before/after: 375 HH – 15 communities stratified by mobilization strategy	19.7% reported use (increased from 8.4% baseline, 6 months after mobilization dropped to 11.2%) *No confirmed use* - FCR in HH using SwS 0.23 mg/L (median), compared to 0.1 mg/L in HH not using (p=0.005)	High Risk of Bias Selective reporting, incomplete outcomes.
Gupta (2007) Factors associated with E. coli contamination of household drinking water among tsunami and earthquake survivors, Indonesia *Published*	Tsumani, Earthquake Indonesia 4/2004 – 5/2004	Safe Water System (SwS) consisting of 1) locally-made sodium hypochlorite solution, 2) safe water storage, and 3) behaviour change communication 16,002 HH across 3 districts (Aceh Besar, Nias, Simeulue)	Quantitative Cross-sectional staged clusters then randomized; 1,127 HH	23% reported use (across Aceh, Nias, and Sim) 11.3% confirmed use (FCR >0.1 mg/L) (across Aceh, Nias, and Sim) Boiling water was highly promoted, but was found to make no change in E.coli contamination	Medium Risk of Bias Controlled for factors, limited conclusion
Lantagne (2012) Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Indonesia *Published*	Earthquake Indonesia 11/2009	International NGOs providing HWTS to 1578 HH – received liquid chlorine (Air Rahmat) but also Rotary chlorine tablets	Quantitative Cross-sectional randomized proportion: 270 HH	6.2% reported use 'Air Rahmat' (Tablet 'rotary' 1.4%, Boiling 88.1%) 0.9% of HH confirmed use 'Air Rahmat' (Tablet 'rotary' 1.4%)	Low Risk of Bias Selection bias not likely. Clear and consistent

					reporting of outcomes.
Lantagne (2012) Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Nepal *Published*	Cholera – Outbreak Nepal No Date	Local NGOs using pre-positioned stock. 1565 HH – received liquid chlorine (WaterGuard®, Piyush®) but also Aquatabs®.	Quantitative Cross-sectional randomized proportion: 400 HH	22.2% reported use (2 products: WaterGuard®: 6.3% Piyush®: 15.8%) (Aquatabs®: 8.3%) 11.8% confirmed Use (2 products: WaterGuard®: 3.5%; Piyush®: 8.3%) (Aquatabs®: 6.8%) (FCR $\geqslant 0.2$ mg/L)	Low Risk of Bias Selection bias not likely, clear and consistent reporting of outcomes
Macgregor-Skinner (2005) Preventing diarrhea following water emergencies: An evaluation of home-based chlorination in West Timor, Indonesia, 2004 *Grey Literature*	Flood Indonesia 4/2004 – 10/2010	SwS project including liquid chlorine and training – emergency-affected population (# of HH not mentioned)	Quantitative 2 stage random; 320 people in Betun and Panite – HH visited 2x/week for 7 weeks	70-94% ('Peak rates' for Betun and Panite areas) of HH confirmed use (FCR >0.0 mg/L) Bleach users had a lower risk of diarrhoea compared to non-users Betun: (RR=0.13, 95%CI 0.1-0.3) Panite: (RR=0.3, 95%CI 0.2-0.5)	High Risk of Bias Unclear methods and reporting of results
Mong (2001) Impact of Safe Water System on Water Quality in Cyclone-Affected Communities in Madagascar *Published*	Cholera – Outbreak Madagascar 4/2000 – 8/2000	Liquid chlorine and 5 gallon flexible jerry can distributed to 11,700 HH with some education about use.	Quantitative Cross-sectional randomized: 123 HH	65% reported use (n=123); 'ever used' 85%; SwS already promoted in the area 45% confirmed use (n=40) (FCR $\geqslant 0.2$ mg/L) 76% report receiving jerry can; 76% reported using	High Risk of Bias Selective reporting and outcomes.
Plan International (2013) Emergency Assistance to Typhoon Usagi-Affected Populations in Central Luzon *Grey Literature*	Typhoon Philippines 9/2013 – 11/2013	4000 HH NFI distribution with hygiene promotion: Hyposol (sodium hypochlorite) and hygiene kit	Quantitative Cross-sectional: 105 HH 2 FGD	54% confirmed use (had measurable FCR). Respondents reported an aversion to taste and lack of education on use	High Risk of Bias Unclear methods and reporting
Sirajul Islam (2007) Faecal contamination of drinking water sources of Dhaka city during the 2004 flood in Bangladesh and use	Flood Bangladesh 8/2004 – 1/2005	Field trial of Zeoline□-200 (commercial liquid chlorine); 300 water samples from 20 drinking water sources	Quantitative 300 samples – total coliforms (TC), faecal coliforms (FC), faecal	83.8% effectiveness against TC 72.6% effectiveness against FS	Low Risk of Bias Clear and consistent methods

of disinfectants for water treatment *Published*			streptococci (FS) tested		

Household Water Treatment - pUr® pURIFIER OF wATER

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF (2014) Hygiene Kits Post Distribution Monitoring Report *Grey Literature*	Cholera – Outbreak South Sudan 5/2014 – 6/2014	Aquatabs® distributed in NFI kits to 7,348 HH. Kit also included: bucket, PuR® Purifier of Water packets and filter cloth.	Quantitative Cluster Cross-sectional: 351 HH	>90% of HH had FCR in Juba (range 83-100%) (PuR or Aquatabs) 78% of HH could demonstrate correct use of PuR HH without FCR said they get water from a treated tanker, or are saving the Aquatabs for when cholera outbreaks again.	High Risk of Bias Inconsistent reporting. Spillover effects likely.
Colindres (2007) After the flood: an evaluation of in-home drinking water treatment with combined flocculent-disinfectant following Tropical Storm Jeanne — Gonaives, Haiti, 2004 *Published*	Typhoon Haiti 10/2004	PuR (410,000 sachets) and PuR-related education provided to 9,000 HH	Quantitative Cross-sectional: 100 HH chosen randomly from 3 clusters	58% of HH reported using PuR post-flood compared to 37% of HH using any type of treatment before the flood 41% (9/22) samples had FCR between 0.2 and 2 mg/L	High Risk of Bias High risk of spillover, small sample size
Doocy (2006) Point-of-use water treatment and diarrhoea reduction in the emergency context: an effectiveness trial in Liberia *Published*	Cholera Liberia Endemic 7/2004 – 9/2004	PuR® Purifier of Water sachets (weekly distributions) with 2 10 L buckets compared to HH given just buckets.	Quantitative RCT: 200 HH intervention and 200 HH control	95.4% confirmed use – “compliant” with FCR and reported use Diarrhoea incidence reduced by 67% (ARR 0.33; 95%CI 0.30-0.37); diarrhoea prevalence reduced by 77% (ARR 0.23; 95%CI 0.21-0.25). Covered stored water alone was also protective for diarrhoea incidence (ARR 0.84; 95%CI 0.82-0.86). Improved visual appearance and taste from PuR group	Low Risk of Bias Weekly visits for 12 weeks prone to courtesy bias; rainy season over – less diarrhoea.

Handzel (2006) Evaluation of Pilot Intervention to Improve Household Drinking Water *Grey Literature*	Flood Vietnam 8/2006 – 11/2006	Distribution of 90 PuR sachets (intended to last 3 months) to 2,500 HH	Quantitative Cross-sectional; 30 HH visits	IEC monitors confirmed daily use of PuR by all HH in evaluation Avg FCR level was 0.25 mg/L (n=32) 10.5% (2/19) of samples had FCR =0 mg/L 53% (10/19) of samples had FCR <0.2 mg/L 0.90 USD per month to purchase PuR compared to 0.1 USD per month to purchase alum (plus cost of boiling) Very high satisfaction with PuR – easy to use, acceptable taste	High Risk of Bias Unclear methods
Hoque (2007) Efficiency and Effectiveness of Point-of Use Technologies in Emergency Drinking Water: An Evaluation of PUR and Aquatab in Rural Bangladesh *Grey Literature*	Flood Bangladesh 9/2006 – 2/2007	Distribution of PuR and Aquatabs in relief packages to 4,800 HH with demonstrations of use	Quantitative Cross-sectional; 200 HH (random); TTC and FCR measured	100% of water samples tested negative for TTC (n=200) The mean and median values of FCR in samples treated with PUR were 0.28 mg/L and 0.19 mg/L respectively Beneficiaries reported a significant preference to PuR over Aquatabs	High Risk of Bias Spillover effects likely
Johnston (2008) Point-Of-Use water treatment in Emergency Response: Experiences in cyclone Sidr *Grey Literature*	Typhoon Bangladesh No Date.	Distribution of 120,000 sachets of PuR	Quantitative Cross-sectional; 131 HH	100% had PuR in house, 72% had treated water All samples tested negative for TTC About 45% of beneficiaries reported being 'highly satisfied' with the product, about 40% reported being 'satisfied' PuR is much preferred to WPT HH reporting diarrheal disease cases in children under 5 was 2.9% (RR 0.23 (0.07 – 0.72)) for those using PuR compared to 12.7% in the control group	High Risk of Bias Unclear methods and reporting of results
Lantagne (2012) Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Kenya *Published*	Cholera - Outbreak Kenya No date	Pre-positioned stock. Distribution of Aquatabs® and PuR® Purifier of Water in an NFI kit to 5,592 HH.	Quantitative Cross-sectional randomized proportion: 409 HH	5.9% reported use 3.7% confirmed use (FCR ≥ 0.2 mg/L) 2.3% effective use <1 CFU/100mL	Low Risk of Bias Selection bias not likely. Clear and consistent reporting of outcomes.

household water treatment – filtrations

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
Clasen (2006) Household-Based Ceramic Water Filters for the Treatment of Drinking Water in Disaster Response: An Assessment of a Pilot Programme in the Dominican Republic *Published*	Flood Dominican Republic 2/2004	Ceramic candle filter (ceramic element and granulated activated carbon in a 20L bucket) distributed to 40 HH	Quantitative Randomized control trial followed by a cross-sectional study 16 months later; 80 HH (40 control, 40 intervention)	38% self-reported using filter after 16 months. 51% of those were still drinking from other sources. Breakage and lack of access to replacement filters were reported as reasons for disuse 70.6% of water samples met WHO guidelines for 0 TTC/100 mL compared to 31.8% of samples from control HH's	High Risk of Bias Selection bias likely
Ensink (2015) Assessment of a membrane drinking water filter in an emergency setting *Published*	Conflict Pakistan 9/2007 – 4/2008	Intervention group using the Nerox microfiltration system compared to a control group using a Stefani porous ceramic filter	Quantitative Cross-sectional 3,075 HH. 2,997 HH intervention (before/after 6 months), randomized 78 HH control with different filter	10% self-reported use of filter after 6 months 5.7% confirmed use -- HH had a functional filter on visual inspection Filters were not compatible with turbid water (clogged easily) No filter eliminated TC	High Risk of Bias Inconsistent methods, possibility of selection bias
Lantagne (2013) Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake *Published*	Earthquake Haiti 1/2010 – 3/2010	Distribution of FilterPure Ceramic filter to 350 HH	Quantitative Cross-sectional; 43 HH surveyed within 8 weeks of emergency onset (acute) and 28 HH 10 months after onset (recovery)	Acute: 72% (31) HH report any treatment, 72% (31) HH report filter use No confirmed or effective use in the acute context Recovery: 61% (17) HH report any treatment, 32% (9) HH report filter use, 7% (2) report use of chlorine	Low Risk of Bias Clear methods and reporting of outcomes; small sample size
Lantagne (2013) Effective Use of Household Water Treatment and Safe	Earthquake Haiti 1/2010 – 3/2010	Distribution of Biosand filter to 238 HH	Quantitative Cross-sectional; 51 HH surveyed within 8 weeks of emergency onset (acute) and 47	Acute: 53% (27) HH report any treatment, 53% (27) HH report filter treatment, 8% (19) had E.coli <1 mg/L Recovery: 72% (34) HH report any treatment, 45% (21) HH report filter use	Low Risk of Bias Clear methods and reporting of outcomes; small sample size

Storage in Response to the 2010 Haiti Earthquake *Published*			HH 10 months after onset (recovery)	(22% (10) with chlorine), 74% (17) had FCR >0.2 mg/L, 28% (6) had E.coli had <1 mg/L	
MEDAIR (2015) Post-Distribution Assessment Report for Point of Use Water Filter Distribution in Palei *Grey Literature*	Population Displacement – Conflict South Sudan 6/2015	Distribution of Sawyer PointONE filter and one pre-drilled bucket (12L or 14L) to 206 HH	Quantitative Cross-sectional – 85 HH randomly selected	100% self-reported daily filter use 84% confirmed use by demonstrating how to use filter correctly 86% complained that the filters were too slow. 72% complained that the buckets were too small. Highly turbid surface water caused filters to clog after every use.	High Risk of Bias Limited methods
Palmer (2005) Community Acceptability of Household Water Filters in Sri Lanka After the Tsunami *Grey Literature*	Tsunami Sri Lanka No Date	Largescale distribution of candle-style and pot-style filters	Quantitative Cross-section randomized. FGD and 79 KII in HH with community members	75% (59/75) reported use of daily use of filter 75% (55/73) confirmed use, had a sufficient amount of treated water to fill a cup 75% (6/8) of those given both types of filters preferred the pot chlorinator – better taste, holds more water	High Risk of Bias Inconsistent methods and reporting of results

household water treatment – Other

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
Conroy (2001) Solar disinfection of drinking water protects against cholera in children under 6 years of age *Published*	Cholera - Outbreak Kenya No Date	1.5L clear plastic bottle distributed with instructions (SODIS project) – targeted children under <5	Quantitative 67 HH intervention and 64 control; HH had child under 5 years for original study then monitored a year after (Case-control out of an RCT)	*No reported use.* (67/131 used SODIS) Health impact: Self-reported cases of cholera: <6 yr: (RR 0.12; 0.02-0.65; p=0.014); 6-15 yr: (RR 1.09; 0.58-2.05); Adults: (RR 1.2; 0.59-2.5)	High Risk of Bias Inconsistent results, unclear intervention impact

Doocy (2006) Point-of-use water treatment and diarrhoea reduction in the emergency context: an effectiveness trial in Liberia *Published*	Cholera – Endemic Liberia 7/2004 – 9/2004	200 HH distribution of 2 10L buckets compared to 200 HH given buckets AND PuR sachets (weekly distributions)	Quantitative RCT: 200 HH intervention and 200 HH control	Covered stored water alone reduced incidence of diarrhea by 16% compared to the preceding week (OR 0.84, 95%CI 0.82-0.86)	Low Risk of Bias Weekly visits for 12 weeks prone to courtesy bias; rainy season over – less diarrhea.
Roberts (2001) Keeping clean water clean in a Malawi refugee camp: a randomized intervention trial *Published*	Cholera – Endemic Malawi 1/1993 – 5/1993	Improved bucket distribution to intervention group, only told not to put hands in the buckets. Compared to standard buckets.	Quantitative RCT: 100 intervention HH and 300 control HH	*No reported use.* 8.4% lower diarrhoea attack rate with improved buckets (p=0.26); children <5, 31.1% lower diarrhoea attack rate with improved buckets in children (p=0.06) 53.3% lower (69% lower with geometric mean) faecal coliforms in improved vs. control buckets over several hours (measured at 6 time steps) n=604	Low Risk of Bias HH visited 2x per week for diarrhoea rates; loss to follow-up significantly different
Einarsdbttir (2001) Health Education and Cholera in Rural Guinea-Bissau *Published*	Cholera – Endemic Guinea-Bissau 7/1994	Promotion of boiling and lemon as HWT: radio, TV, health staff, poster, word-of-mouth, song, theatre group	Quantitative Cross-sectional, randomized: 53 HH	66% reported use of lemon to treat water; 40% reported boiling water; no one reported only drinking treated (boiled/lemon) water. Not consistent use of treated water.	High Risk of Bias Small sample size, open-ended questions, self-reported results
Sirajul Islam (2007) Faecal contamination of drinking water sources of Dhaka city during the 2004 flood in Bangladesh and use of disinfectants for water treatment *Published*	Flood Bangladesh 8/2004 – 1/2005	Field trial of alum potash; 300 water samples from 20 drinking water sources	Quantitative 300 samples – total coliforms (TC), faecal coliforms (FC), faecal streptococci (FS) tested	73.0% effectiveness against TC 29.7% effectiveness against FS	Low Risk of Bias Clear and consistent methods

Sanitation

Latrines

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
Bastable (2012) Innovative designs and approaches in sanitation when responding to challenging and complex humanitarian contexts in urban areas *Published*	General Emergency Haiti, Philippines, Pakistan No Dates	Various latrine types used in three emergency contexts	Field Commentary 3 Case Studies	Temporary latrines often become long-term solutions Privacy barrier could be constructed to increase women's ability to use latrines without shame Additional consideration needed for desludging	High Risk of Bias Case study description
de Lange (2014) Keeping it simple: a gender-specific sanitation tool for emergencies *Published*	Population spike in existing camp setting South Sudan 7/2012 – 8/2012	147 women's latrines built using a gender-specific 'tool' providing technical guidance and instructions compared with 69 latrines built using normal methods	Quantitative Mixed methods; control (1800 people) and intervention (3300 people) group 4 FGD; 7 KII	High involvement from women in the community – added and cancelled parts of the project based on their input Observed latrine usage: 13.2% and 13.5% (control and intervention) Tool added 7.5% cost from a normal latrine Incidence Diarrhea Rate (confirmed – clinic test) Control: 3.8 and 4.8 cases/1000/week Intervention: 11.4 and 7.9 cases/1000/week	High Risk of Bias Data collection methods questionable
Eyrard (2011) Portable toilets in emergencies: lessons learned from Port-au-Prince, Haiti *Published*	Earthquake Haiti 1/2010 – 6/2010	Construction of 400 public portable toilets (Port-a-potties)	Field Commentary Lessons Learned	Viable option in an emergency Initial cost: $25/unit/day with desludging; Negotiated later: $9-13/unit/day (with 6 month contract) Needs daily service/desludging No handwashing unit Final destination of the sludge is a critical thought before the intervention	High Risk of Bias Commentary – unclear reporting

Fortune (2010) British Red Cross – Mass Sanitation Module 2010 Haiti Earthquake Response Post Deployment Learning Evaluation *Grey Literature*	Earthquake Haiti 1/2010 – 5/2010	300 latrines in IDP camps (525 planned) 13 handwashing stations (66 planned); 11 bathing units (65 planned); 103 rubbish bins (525 target) Hygiene promotion - transmission, handwashing, how to use a latrine, safe water practices	Field Commentary Lessons Learned	Scale of work needed - MSM response intended for up to 20,000 people - needs were more than 2.5 times that Hygiene volunteers not from within the camp and were seen as outsiders Limitations of space within the camp and a high population density complicated latrine construction	High Risk of Bias Commentary – limited methods
Howard (1996) Rethinking the unthinkable—effective excreta disposal in emergency situations *Published*	Multiple Emergencies India, Bangladesh, Malaysia No Date	Various methods of human waste containment: sewage ponds, collection in plastic bladders, gravity systems	Field Commentary 3 Case Studies	Several options are usually available for each situation People will use safe, clean, private latrines Point of contact for beneficiary is important, more so than involving beneficiary in design of intervention Use machines to make deeper/bigger trenches	High Risk of Bias Case study description
Kinstedt (2012) The Application of Ecological Sanitation for Excreta Disposal in Disaster Relief *Grey Literature*	Multiple Emergencies Bolivia, Haiti, Chad, Phillipines, Bangladesh No Date	EcoSan (Ecological Sanitation) toilets in disaster relief: Urine-diverting dry toilets (UDDT); Composting toilets; Arborloo toilets Also, PeePoo bags (see Latrine Alternatives)	Field Commentary Several Case Studies	Composting toilets showed good results, but the complicated process was a barrier to extended use. UDDT had widest implementation amongst the EcoSan options – flexible and possible for high groundwater. Arborloo: simple system that uses few resources, but not possible in areas where excavation is impossible or groundwater is high	High Risk of Bias Unclear methods, limited analysis
Lin (2008) Rapid evaluation on the risk of vector and emergency vector control after the earthquake *Published*	Earthquake China 5/2008	Rehabilitation of latrines and construction of pit latrines where rehabilitation of old latrines was impossible; sanitation of fecal matter storage areas using chlorine	Quantitative Cross-sectional	Diarrheal disease decreased from 11.22 cases per 1,000 to 3.61 cases per 1,000 nine days after the intervention period Prevalence of improper garbage disposal and open defecation decreased	Medium Risk of Bias Selection bias possible, clear reporting of outcomes

Moyenga (2011) Sanitation solutions for a refugee camp: Field trial of sanitation for the vulnerable *Grey Literature*	Population displacement – Conflict Liberia No Date	Construction of 10 latrines designed for vulnerable people (handicapped, elderly, pregnant, children) and rehabilitation of 17 public latrines	Qualitative 18 FGD; 14 KII	Increased access to vulnerable groups (4% of the camp) High community involvement; handrails and seats most requested upgrade Small changes can have a big impact	High Risk of Bias Limited methods
Mwase (2006) The Potential of Ecosan to Provide Sustainable Sanitation in Emergency Situations and to achieve "quick wins" in MDGs *Grey Literature*	Multiple Emergencies Pakistan, Afghanistan, El Salvador No Date	UDDTs trialed in several emergency contexts	Field Commentary 3 Case Studies	Challenging to provide access to mobile populations Ease of transportation and quick installation of assembled units Works better in long term phase of disaster rather than the acute phase	High Risk of Bias Commentary – bias in reporting likely
Puddifoot (1995) Improved drainage - stakeholders said it reduced dengue and accidents related to flooding *Published*	Population Displacement – Conflict Nepal 3/1993 – 6/1994	8000 vented improved double pit latrines constructed from prefab kits with beneficiary contribution Personal hygiene messaging	Field Commentary Case Study	Diarrhoea rates: 6.6 cases/100 people dropped to 3.5 cases/100 when latrines were done (measured at same time in the year) Latrine cost less than $50 USD - concrete rings, superstructure - 1 latrine for 2 families 98% said they stopped traditional practice of open defecation 80% report washing hands after defecation Desludging needed after 500 days not 1 year like they assumed - natural decomposition	High Risk of Bias Commentary – personal experience
Pinera (2005) Restoring sanitation services after an earthquake: Field experience in Bam, Iran *Published*	Earthquake Iran 1/2004 – 6/2004	Targeting of HH without toilet for new or upgraded latrine and shower – 153 toilets constructed/repaired, 68 and 47 showers constructed (private and communal) Detailed needs assessment done with village leader; community volunteers	Field Commentary Case Study	Cost of construction: Private: $130 (45 to mason), Private bathroom (w/shower): $220 (60 to mason), Communal bathroom: $850 (150 to mason) Using resources within community gave authority to leaders, money to masons, and recovery for families as they rebuild.	High Risk of Bias Case study description

		used for unskilled labor; utilization of local materials		Finding enough skilled labor (masons) was difficult	
Pinera (2006) Water and sanitation in camps on the Andaman Islands *Published*	Tsunami Andaman Islands No Date	Construction of 1962 toilets and bathing facilities (1 per family) Built in blocks of 6 cubicles in all communities except one where the cubicles were built in front of people's homes	Field Commentary Case Study	Sanitary blocks granted little privacy, were poorly lit, and far from people's homes – few people used them Beneficiaries were used to open defecation – hard to change behavior When water is available (24 hours, like in the one exception camp) and latrines and bathing facilities are convenient - people will use and maintain them	High Risk of Bias Commentary – personal experience
Singh (2012) Note from the field: The Pakistan floods: Success of the household trench latrine *Published*	Flood Pakistan 8/2010 – 9/2010	Construction of temporary trench latrines – more than 6000 latrines in 2 months	Field Commentary Case Study	Cheap – ~4.5 GBP per latrine paid by organization Speedy construction – 2 hours per latrine Suitable for high water table – no lining	High Risk of Bias Case study description

Latrine Alternatives

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
Coloni (2012) Biodegradable bags as emergency sanitation in urban settings: the field experience *Published*	Earthquake Haiti 4/2010 – 7/2010	Distribution of biodegradable bags for sanitation in emergency context – 22,000 individuals using for 16 weeks	Field Commentary Case Study	Use of plastic bags for defecation already widely adopted (locally referred to as "flying toilets") Temporary cubicle facilities were modular and easy to install quickly (no digging) No biogas issues reported Smell not an issue A good solution to waste collection is needed Bags have short self-life	High Risk of Bias Case study description
Parsa (2014) Human waste management in first phase response,	Typhoon Philippines 12/2013 – 1/2014	Distribution of PeePoo Personal Packs (28 biodegradable bags, 1 disposal bag, 1 seat) to	Field Commentary Case Study	74% of beneficiaries 'observed' use by organization 280 HH Prepositioned PeePoo stocks preferred to ensure quick response	High Risk of Bias Commentary – limited

protecting groundwater and human health: case study from Haiyan 2013 *Published*		2,580 HH and 700 school children from 3 different NGOs		Paying local workers for collection is a good resource, but proper disposal mechanisms should be defined An exit/continuous sanitation plan must be in place before the end of the intervention	reporting of results
Patel (2011) Excreta disposal in emergencies: Bag and Peepoo trials with internally displaced people in Port-au-Prince *Published*	Earthquake Haiti 4/2010 – 5/2010	2 week trial of Peepoo bags followed by 2 weeks of normal plastic bags in one IDP camp 4 week trial of Peepoo bags in another camp Hygiene promotion messaging with IEC materials	Quantitative Cross-sectional, simple random Before/after: 151 HH pre-emergency, 146 HH post-emergency 19 FGD; KII (not described)	Both Peepoo and standard bags were generally accepted and had high reported use Peepoo bags contained odor, but had inadequate circumference to spread over a container. Children, disabled, and elderly found it difficult to use. Hygiene and bag removal are critical PreTrial: 42% of HH experienced diarrhea, PostTrial: 36% of HH; (X2=1.32, p<0.03)	High Risk of Bias Inconsistent methods and reporting

Hygiene

Hygiene Promotion

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF – Matemo (2014) Use Of H2S To Support Hygiene Promotion *Grey Literature*	Cholera/Help – Spike in Cases Kenya 6/2013 – 12/2013	H_2S used as part of hygiene promotion	Field Commentary 2820 HH tests – methods unclear	Use of H_2S used a visual aid to assist hygiene messaging as well as test water samples. Proof to community that 'clear doesn't mean safe'	High Risk of Bias Unclear methods and reporting
Contzen-Mosler (2013) Impact of different promotional channels on handwashing behaviour in an emergency context: Haiti post-earthquake public health	Cholera Haiti Outbreak No Date	Various communication strategies from many organizations	Quantitative Cross-sectional: 811 HH across several regions	For both faeces and food related handwashing, the most effective were material distributions with demonstrations, and radio spots. Spontaneous/unplanned promotions by friends and neighbours also influential.	Medium Risk of Bias Large sample size, but possibility of courtesy bias

promotions and cholera response *Published*				For food related handwashing, community clubs and theatres were also relevant. Better targeting of messages could be done - washing prevents diarrhoea; severity of cholera Focus groups, hygiene days, and stickers/posters/paintings were rated at less likeable, less convincing, and less trustworthy than other methods.	
Date (2013) Evaluation of a Rapid Cholera Response Activity—Nyanza Province, Kenya, 2008 *Published*	Cholera Kenya Endemic 3/2008 – 9/2008	Distribution of HWT and hygiene kits (not described); environmental investigations, cholera case management.	Quantitative Cross-sectional: 358 intervention HH and 365 control HH matched by region	Social contacts (friends, family, and neighbours), which suggests that social networks can be a valuable resource. *No reported use* (Reported any water treatment: Intervention: Control 56%: 37%; p<0.001) *No confirmed use* ('Detectable' FCR 17% in intervention and 14% in control groups; NS)	High Risk of Bias Intervention overlap, intervention loosely described, convenience sample, 3 month recall time
Einarsdbttir (2001) Health Education and Cholera in Rural Guinea-Bissau *Published*	Cholera Guinea-Bissau Endemic 7/1994	Hygiene promotion: radio, TV, health staff, poster, word-of-mouth, song, theatre group	Quantitative Cross-sectional: randomized 53 HH	94% (50/53) respondents reported hearing hygiene messages 68% (34/50) of respondents could identify at least 1 cholera prevention method promoted. 38% (19/50) could identify 3 or more. 66% reported use of lemon to treat water; 40% reported boiling water; no one reported only drinking treated (boiled/lemon) water.	High Risk of Bias Small sample size, open-ended questions, self-reported results
Khan (2008) Assessment of hygiene communication plan in the aftermath of the 2005 earthquake in Pakistan *Grey Literature*	Earthquake Pakistan 10/2005 – 3/2006	Promotion messaging (radio, TV, house to house) Key messages: ODF spreads disease, construct a latrine, hand washing, risk of feces	Field Commentary FGD, KII, HH surveys (quantity not described)	IE materials mostly text based - not good for illiterate populations TV programming was not as relevant because most TVs were destroyed in earthquake Radio, face to face communication, and 'entertainment events' best mode of communication because that was accessible	Medium Risk of Bias Clear reporting of outcomes, observational

Wall (no date) Ann Kite Yo Pale (let them speak) Best Practice and Lessons Learned in Communication with Disaster Affected Communities: Haiti 2010 *Grey Literature*	Earthquake Cholera - Outbreak Haiti 1/2010 – 1/2011	Various communication strategies from many organizations	Qualitative 15 FGD, KII (not described)	Immediately after earthquake, local radio stations disseminated key information and reunited families Communication was effective at improving trust, mitigating conflict, developing relationships, and gaining insights to community perceptions and values. 2-way communication was key – asking a question, sharing stories, discuss an issue (face-to-face was key); technical and medical messages did not address fears and perceptions of the disease. Cholera treatment centres were initially rejected due to fears about the origin and response to the disease. The assessments of overall effect on communication efforts on cholera, as "too many organizations were involved and too many techniques used."	Medium Risk of Bias Unclear methodology and selective reporting.
WHO (no date) Guidance on communication with respect to safe drinking water and household hygiene Literature review, interviews and case studies; CASE STUDY - South Africa *Grey Literature*	Cholera – Outbreak South Africa No Date	Hygiene campaign: Messages: Water storage, personal hygiene, safe refuse disposal, food handling, use of HWT Mode: health workers, schools, religious leaders; some religious services use to recruit volunteers	Field Commentary Case Study	Red Cross (working in specific areas) observed a sharp decline in mortality rates following education program. Hygiene messages were known beforehand	High Risk of Bias Case study commentary
WHO (no date) Guidance on communication with respect to safe drinking water and household hygiene Literature	Cholera – Outbreak Zimbabwe No Date	Cholera prevention, control, food prep, hand washing, use of HWT (tablets/sachets) Mode: T-shirts and dramas used, 310000 flyers, 14000	Field Commentary Case study	Change in behaviour - not attending funerals, reducing physical contact (hugs, shaking hands) Response built on existing organizations Unwillingness to drink chlorinated water Lack of resources and worthless currency	High Risk of Bias Case study commentary.

review, interviews and case studies; CASE STUDY – Zimbabwe *Grey Literature*		posters in 3 languages distributed to 250,000 people			
Williams (2015) Perceptions of health Communication, Water Treatment and Sanitation in Artibonite Department, Haiti, March-April 2012 *Published*	Cholera - Outbreak Haiti 11/2010 – 11/2011	Evaluation of WASH preferences in regional cholera response.	Qualitative 18 FGD	Most valuable source of information - Community Health Worker (CHW); Megaphone and CHW going house to house was the best way to reach the communities. Most 'trusted' vender of HWT products – pharmacies Increase in handwashing as a result from messaging	Medium Risk of Bias Inconsistent language definitions, Self-reporting

Social Mobilizaiton

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF (2015) Trigger Behavioural Change to strengthen community's resilience to Ebola Outbreaks *Grey Literature*	Ebola – Outbreak Sierra Leone 5/2014 -	Community Led Ebola Management and Eradication (CLEME), as modified CLTS approach with community driven action. ACF also involved in other aspects of the response.	Field Commentary Case study	CLEME approach and 'triggering' deemed successful in many aspects: 80% of communities planned isolation rooms; tippy tap handwashing widely promoted; and community ownership and trust were shown to be very important project results. Time, staff requirements, and prerequisites limit wider applicability.	High Risk of Bias Case study description.
WV – Khan (2012) CLTS in 2010 post-flood emergency response effort *Grey Literature*	Flood Pakistan No Date	CLTS in 10 pilot communities (~10,000 people) Clean up campaigns following flood – repairing piping, drainage	Field Commentary Case study	525 latrines built within 4 months Low-cost building materials made available to poor members of the community CRP mobilized community for hygiene promotion	High Risk of Bias Case study description

		Creation of Community Resource Persons (CRP) to each 500 HH			
Meyer Capps (2015) Open Defecation Status, Community-Led Total Sanitation and Ebola Virus Disease (EVD) in Voinjama and Kolahun Health Districts, Lofa County, Liberia (2014) *Grey Literature*	Ebola – Outbreak Liberia 5/2010 – 4/2015	CLTS project (running for 5 years – carried on through Ebola outbreak) in 6,865 HH.	Quantitative Matched controls: 239 Project HH: 312 non-Project HH, Mixed Methods: 16 FGD, KII	HH in CLTS communities 17 times less likely to have cases of Ebola than non-CLTS communities (OR=0.06, p<0.001) Beneficiaries trusted: 1) Health workers, 2) radio, then 3) NGOs for sources of info by both CLTS and non-CLTS communities	Medium Risk of Bias Spillover effects unclear.
Miziniak (No Date) Sustainable Relief Programming for dispersed communities Case Study: Zambia Floods 2007 *Grey Literature*	Flood Zambia No Date	Community-driven approach: Voluntary Water Sanitation Hygiene and Education (VWASHE)	Field Commentary Case Study	761 latrines built in 3 months Use of local materials and flexibility of design Latrines could be built at no cost to household	High Risk of Bias Commentary – personal experience
IWSD - Neseni (2009) Evaluation of the WASH Response to the 2008- 2009 Zimbabwe Cholera Epidemic and Preparedness Planning for Future Outbreaks *Grey Literature*	Cholera - Outbreak Zimbabwe No Date	Social mobilization: production materials and dissemination of IEC, awareness raising, mobilization of communities, distribution of NFIs	Field Commentary Case study	Social mobilization considered most impactful to reduce disease transmission	High Risk of Bias Case study – commentary, limited methods
Polo (2010) CATS: Community Approaches to Total Sanitation Pilot in Haiti *Grey Literature*	Earthquake Haiti 3/2010	Pilot CATS project in 5 IDP camps – emphasis on reducing open defecation Transect walk ('taboo walk') and education about food/water contamination from flies; introducing community-ownership of latrines	Field Commentary Case Study	1 camp had a strong positive reaction, 2 camps had promising results Quality of facilitation more important than the site; previous concern if camps would not have the same cohesion as an established village.	High Risk of Bias Case study description

				Land availability in camps/urban setting and availability of materials were strained Culture of waiting for latrines to be built by NGO's; individuals not shocked by talking about 'shit'	
IFRC - Rees-Gildea (2013) Sierra Leone Cholera ERU Operation Review *Grey Literature*	Cholera – Outbreak Sierra Leone 2/2012 – 10/2010	Cholera surveillance and hygiene promotion through social mobilization	Field Commentary Case study (limited evaluation)	Decrease in CFR deemed to be more influenced by social mobilization than case management	High Risk of Bias Organization review; case study commentary.
Wall (No Date) Ann Kite Yo Pale (let them speak) Best Practice and Lessons Learned in Communication with Disaster Affected Communities: Haiti 2010 *Grey Literature*	Earthquake Cholera - Outbreak Haiti 1/2010 – 1/2011	Social mobilization; communication strategies from many organizations	Qualitative 15 FGD, KII (not described)	Communication was effective at improving trust, mitigating conflict, developing relationships, and gaining insights to community perceptions and values. 2-way communication was key – asking a question, sharing stories, discuss an issue (face-to-face was key)	Medium Risk of Bias Unclear methodology and selective reporting.
Waterkeyn (2005) Rapid sanitation uptake in the internally displaced people camps of northern Uganda through community health clubs *Published*	Cholera – Outbreak Uganda 1/2005 – 5/2005	Community mobilization through Community Health Club and PHAST approaches: Community trainers, drama presentations, 20 hygiene topics, delivered in groups, peer pressure to keep them. Certificate if attended 20 sessions. Community provided own materials but would receive a concrete 'sanplat' (latrine floor).	Field Commentary Case study	Group cohesion and peer pressure adjusted hygiene behaviour and improve hygiene practices Motivation of > 15,000 beneficiaries built 8500 latrines, 6000 bath shelters, 3400 drying racks, and 1550 handwashing stations in a 4 month timeframe Rapid, scalable, and cost-effective	High Risk of Bias Case study description.

Handwashing

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
Cabezas (2008) Efectividad del uso de alcohol glicerinado para la descontaminación de manos en una población sin aceso al agua potable posterremoto en Pisco, Perú *Published*	Earthquake Peru 8/2007	Promotion of handwashing with alcohol-based sanitizer	Quantitative Cross-sectional Before and after 20 kitchen staff in IDP camp	A significant reduction in bacterial load on the hands ($p<0.001$), but did not eliminate all bacteria 'Successful' for area without access to potable water	High Risk of Bias
Husain (2015) A pilot study of a portable hand washing station for recently displaced refugees during an acute emergency in Benishangul-Gumuz Regional State, Ethiopia *Published*	Population Displacement – Conflict Ethiopia 2/2012 – 8/2012	Distribution of handwashing bag (HWB) with soap	Quantitative Cross-sectional: 211 HH baseline survey; 4, 8, 12 week monitoring visits; 222 HH 6 month follow-up 6 FGD	Self-reported use: 91% of HH stated that HWB purpose was for handwashing, but 46% report HWB was their primary handwashing device, and 31% report that no one in their family uses it. Confirmed use: 93% of newly sampled HH had original HWB, 72% were observed hanging, 38% had water in them. Respondents said the amount of soap provided was insufficient	Low Risk of Bias Clear reporting of results

Hygiene Kit Distribution

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF (2014) DRM and WASH Post Distribution Monitoring	Flood Pakistan No Date	1500 HH NFI distribution: Bath and laundry soap, bucket, water cooler, nail	Quantitative Cross-sectional; 10% of	83% of HH reported that items were NOT culturally appropriate (Males 93%, Females 67%) 100% of HH reported that the items were of good quality	High Risk of Bias

Report KPK, Pakistan- November 2014 *Grey Literature*		cutter, toothbrush, toothpaste, sanitary cloth	distribution (random)	Reported use: 99% of HH reported they have soap, 100% of HH reported covering containers Confirmed use: 80% observed soap available, 76% of HH observed bucket for latrine, 67% of HH had toothbrushes	Unclear methods and reporting
ACF (2015) Non Food Items and Emergency Shelter Post Distribution Monitoring Report, Yobe State, Nigeria *Grey Literature*	Conflict Nigeria No Date	1,350 HH NFI distribution: bathing soap, laundry soap, jerry can, sanitary cloth, Aquatabs®	Quantitative Cross-sectional: random sampling of 295 HH	100% of HH received hygiene education before receiving the kits 99.75 of HH report being satisfied with kits (Aquatabs distribution 58.3% satisfaction) 98% of respondents report washing hands with soap 65% of respondents always treat water, 32% sometimes, 3% do not treat	High risk of bias Unclear methods and reporting
Bonnaud (2014) Typhoon Haiyan – Post Distribution Monitoring Report *Grey Literature*	Typhoon Philippines 12/2013 – 1/2014	20,220 HH NFI distribution: 1 hygiene kit (including soap and other undescribed items), 2 10L jerry cans, 2 sets of bed sheets and mosquito nets, 2 sleeping mats	Quantitative Cross-sectional: 1011 HH	87% of distributed items were used by the beneficiaries Most useful: Hygiene Kit (29%), Sleeping mat (29%), Bedding (22%), Mosquito net (12%), Jerry Can (8%) People 'preferred' non-collapsible (rigid) jerry cans Time changes need of beneficiary: hygiene kits preferred at first, later tarpaulins.	Medium risk of Bias Selection bias not likely, possibility of spillover effects
Khan (2008) Assessment of hygiene communication plan in the aftermath of the 2005 earthquake in Pakistan *Grey Literature*	Earthquake Pakistan 10/2005 – 3/2006	NFI kits (washing and laundry soap, toothbrushes, nail cutter, sanitary pads, towels, combs, water container, mug, and radios)	Qualitative FGD, KII, HH surveys (quantity not described)	Pre-existing stock took 1 month to distribute (mid-Nov), Hub distribution in mid Dec. (2 months after) Lead times of 3 months to get NFI materials Distribution from men was not appropriate for women to collect 'Western' design sanitary pad and underwear not culturally appropriate	Medium Risk of Bias Clear reporting of outcomes, observational
Mountfield (2011) SMS Survey *Grey Literature*	Earthquake Haiti No Date	Hygiene kit distribution: bath soap, laundry soap, sanitary pads, toothpaste Amount of HH's not described	Quantitative Cross-sectional: 2200 phone numbers sent survey	Only 75 responses (3.4% response rate) Men and women value different items. Men prefer bath soap, toothpaste, laundry soap Women prefer sanitary pads, bath soap, laundry soap	High risk of bias Collection procedure questionable.

CRS - Pennacchia (2009) Bridging the Gap: Providing Water and Sanitation and Non-Food Item Assistance to Returnees, IDPs and Host Communities in North Kivu *Grey Literature*	Cholera – Endemic D.R. Congo 7/2009 – 11/2010	NFI Vouchers - $70 for 2,184 beneficiaries (HH) – set a market day. Also WASH activities, including construction/rehabilitation of water sources and hygiene stations and hygiene promotion.	Quantitative Cross-sectional: 332 HH survey 3 months after. Case study results	3 months after voucher market, interviewed with vulnerability score - was 3.2 but 1.6 after. 3.0 is the threshold for emergency intervention Voucher - beneficiaries 'empowered' to choose their own needs More than $150,000 USD pumped into local economy Beneficiaries thought prices (via voucher market) were competitive, 80% thought prices were at or below market 85% of vendors said they reduced prices out of negotiation	High Risk of Bias Commentary – limited methods
Unicef - Ruiz-Roman (2009) Evaluation of the blanket distribution of non-food items as part of the cholera response in Zimbabwe *Grey Literature*	Cholera – Outbreak Zimbabwe 2/2009 – 3/2009	~200,000 HH NFI distribution (1 - 20L bucket, 1 - 20L bucket w tap, 30 - water purification tablets, 3 ORS sachets and 1 pack of IEC materials)	Quantitative Cross-sectional: 307 HH	87% of 307 surveyed HH reported receiving a hygiene kit; only 33% reported receiving all 5 recommended items (Differences in kits). 59% of HH requested additional quantities – mostly from families of 6 or more. Soap was most used item.	High Risk of Bias Spillover effects likely, selective reporting.

Environmental Hygiene

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
Gartley (2013) Uptake of household disinfection kits as an additional measure in response to a cholera outbreak in urban areas of Haiti *Published*	Cholera – Outbreak Haiti 12/2010 – 2/2011	1,220 NFI/household disinfection kits given to cholera patients or caregivers (0.5-1 kg soap, 14L bucket, 10L jerry can, 3.8L bleach, cloth, scrubbing brush, instruction book)	Quantitative 208 HH in sequence	98% of HH reported using contents at time of survey Training changed 1/3 way through program - there was a significant ($p<0.05$) difference in use of materials with increased training focusing on using all items in the kit together and sharing with family members and neighbours. 94% of HH said instructions were clear and simple	High Risk of Bias Sequential sampling, likely courtesy bias.

Roberts (2001) Keeping clean water clean in a Malawi refugee camp: a randomized intervention trial *Published*	Cholera – Endemic Malawi 1/1993 – 5/1993	Improved bucket distribution to intervention group, only told not to put hands in the buckets. Compared to standard buckets.	Quantitative RCT: 100 intervention HH and 300 control HH	*No reported use.* Health impact: 8.4% lower diarrhoea attack rate with improved buckets (p=0.26); children <5, 31.1% lower diarrhoea attack rate with improved buckets in children (p=0.06) Non-health impact: 53.3% lower (69% lower with geometric mean) faecal coliforms in improved vs. control buckets over several hours (measured at 6 time steps) n=604	Low Risk of Bias HH visited 2x per week for diarrhoea rates; loss to follow-up significantly different
Steele (2008) Impact of jerry can disinfection in a camp environment - experiences in an IDP camp in Northern Uganda *Published*	Population Displacement – Conflict and Cholera Uganda 7/2007	Disinfecting jerry cans with 3% chlorine solution using 2 methods of cleaning	Qualitative Jerry cans from 13 HH barrowed then revisited 3-5 days after cleaning	92% (11/12) had reduced *E.coli* after cleaning; 75% (9/12) had <5 *E.coli* after cleaning; 42% (5/12) had 0 *E.coli* after cleaning. Either method of cleaning with high strength chlorine solution was considered efficient at a one-time disinfection. One-time disinfection did not affect the recontamination after 3-5 days.	High Risk of Bias Small sample and inconsistent results.
Walden (2005) Container contamination as a possible source of a diarrhoea outbreak in Abou Shouk camp, Darfur province, Sudan *Published*	Shigellosis – Outbreak Sudan 6/2004	Disinfecting jerry cans with 5% chlorine solution. 13,224 over 5 days for about 88% IDP camp coverage. Loudspeaker and door to door.	Qualitative Case study - observation	Number of watery and bloody cases of diarrhea *continued to decline* after the disinfection (according to clinic records). Response deemed more important than random water testing to determine the source of contamination. 1 week later, observations were that people were keeping containers clean	High Risk of Bias Case study description.

Wash package

WASH - Outbreaks

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF (2011) Emergency Water, Sanitation, and Hygiene Interventions for AWD and Drought Affected Pastorial Communities in Borana Zone, Ethiopia *Grey Literature*	Acute Watery Diarrhoea (AWD) – Endemic Ethiopia 2/2010 – 1/2011	Rehabilitation of wells, sanitation promotion, NFI kits (with WaterGuard®) to 10,059 HH	Field Commentary Case study	"Reduced risk of water and sanitation related morbidity and mortality among AWD and drought affected pastoral communities." Reported improvements in time to collect water, water collection practices, handwashing, latrine use, garbage practices.	High Risk of Bias Case study description
IOM- Condor (2011) Evaluation of the International Organization for Migration's Ongoing Activities on Support to the Flash Appeal for the Haiti Earthquake and Cholera Outbreak (Sida/IOM Agreement January 2010 – May 2011) *Grey Literature*	Cholera – Outbreak Haiti 1/2010 – 5/2011	Improvement of 250 sites through hygiene promotion (Community Action Groups), Radio Tap Taps, and cartoon newspaper. WASH facility construction/rehabilitation /cleaning (including hand washing stations, water tanks and latrines) to support efforts of ORS focal points.	Field Commentary Case study	"Two-way communications with affected populations and the general public is a critical factor in achieving scale in cholera prevention health messages." Low staff turnover Quick and flexible funding – realistic approach built on experience with 'no false expectations' 'High value for money' with Community Action Groups (paid hygiene promoters for 12 months), other NGOs did not appreciate paying for a 'volunteer' job.	High Risk of Bias Limited methods
DeGabriele (2009) An emergency response to humanitarian WASH-	Cholera – Outbreak	Hygiene kit distribution (8000 HH), Aquatabs to 3,300 HH for 3 weeks,	Qualitative	90% of respondent claimed to have changed hygiene behaviour as a result of	High Risk of Bias

related emergencies in Zimbabwe *Grey Literature*	Zimbabwe 5/2008 – 1/2009	'cat litter' method promoted, well rehabilitation and water trucking	34 KII, FGD (not described)	promotion, but may not be practiced consistently Aquatabs inconsistent but accepted by community; Leaflet not enough to educate on Aquatab use	Inconsistent methods
ACF – Dunoyer (2012) Le choléra au Tchad en 2011 et les stratégies d'intervention associées *Grey Literature*	Cholera – Spike in Cases Chad 9/2010 – 2/2011	Water: 320 water sources disinfected Hygiene: 29,593 HH receive a hygiene kit (contents not specified) with education/sensitization – public spaces; HH spraying in 7749 HH	Field Commentary Case Study	HH spraying deployment delay in intervention area is 6.05 day. Spraying agents had to travel to pirogues in flooded areas and were able to disinfect an average of 8 households per day. 57.29% of drinking water samples (583) had FCR >0.5mg/L	High Risk of Bias Case study description
ACF – El-Mahmid (2009) Zimbabwe Emergency Response 01/05/2008 – 30/06/2009 Capitalization Report *Grey Literature*	Cholera Zimbabwe Outbreak 1/2009 – 6/2009	Water: 13 bladders and 3 rigid tanks at CTUs with some taps; Water trucking to supply bladders/tanks at CTUs; 18 water points repaired and disinfected with 2% HTH; Repaired 5 springs; 81 Boreholes repaired (19 in schools) - water committees and spare parts too; 5 new boreholes in health clinics Hygiene: Hygiene promotion to 29,000; Training on chlorine solution for health volunteers; 4000 hygiene kits (1 water container 30L with lid and cap, 1 plastic bucket	Field Commentary Case Study	Emergency experts in the field were an added value Bladder used to establish safe drinking water for 34,912 people (4L/p/d) Distribution point: FCR 0.1-1.3 mg/L; turbidity <5 NTU HH (54 samples) Avg: 0.25 mg/L; NTU <5; 84 samples 0.1-0.6 mg/L	High Risk of Bias Commentary – limited methods

		15 L with lid, 1 kg of green soap, 2 stripes of Aquatabs with leaflets)			
ACF – Gauthier (2014) A Real-time Evaluation of ACF's Response to Cholera in Juba, South Sudan *Grey Literature*	Cholera – Outbreak South Sudan 5/2014 – 8/2014	Borehole rehabilitation; 'Support' community building latrines; Hygiene promotion – megaphone, house to house, groups; NFI kit; HH/environmental disinfection	Qualitative 28 Staff KII	NFIs not aligned with Sphere or South Sudan and sized not adequate for large families, rapidly used Surge capacity and 'kick off' funds were effective HH disinfection actually spraying community latrines and high risk areas – but not a priority by cluster	High Risk of Bias Lack of consistent data
ACF Grayel (2011) Evaluation externe - Réponse d'urgence à l'épidémie de choléra en Haïti *Grey Literature*	Cholera – Outbreak Haiti 11/2010 – 3/2011	Water - Distribution of HHWT kits / ceramic filters for turbid waters; mobile drinking water station; Antenna WATA. 260 water supply points. Sanitation – Construction of 20 public latrines Hygiene - Sensitization/ education ~250,000 people; distribution of hygiene kits (soap, Aquatabs® for 15 days); chlorination of water buckets; disinfection of meeting/public spaces (spraying)	Qualitative Informal interviews with local stakeholders and beneficiaries	Improved water quality (no systematic assessment) Legal/political difficulties HH/public chlorine spraying planned but stopped.	High Risk of Bias Expert opinion. "informal conversations" limited number of site visits
Grayel (2014) Programme d'intervention pour limiter et prévenir la propagation de l'épidémie de choléra en	Cholera – Endemic D.R. Congo	Water: Rehabilitation of water 10 sources and 3 networks, chlorination in 3 water networks	Qualitative 7 FGD; 34 KII	Local volunteers for hygiene promotion and disinfection	Medium Risk of Bias High likelihood of

République Démocratique du Congo *Grey Literature*	12/2012 – 12/2014	and 15 high risk water points, pilot promotion of HWT with chlorine Sanitation: Improvement of access to sanitation for 2,500 HH Hygiene: Soap distributed (not described), disinfection of households (spraying), hygiene promotion and epidemiological surveillance/control.		The influence of the project on cholera prevalence is not as strong as hoped; "little change from 2012 to 2013" In the future, integrate epidemiological experts to better understand cholera transmission pathways and dynamics; work on longer term (3-5 yrs).	spillover bias and reliance on expert opinion
IWSD -Neseni (2009) Evaluation of the WASH Response to the 2008-2009 Zimbabwe Cholera Epidemic and Preparedness Planning for Future Outbreaks *Grey Literature*	Cholera – Outbreak Zimbabwe No Date	Water trucking, drilling boreholes, rehabilitation of wells, HWTS, water quality monitoring Latrine construction was limited, rehab of latrines, sewer decongestion, rehab sewer pipes Hygiene: door to door, dramas, traveller information, print and electronic media, 'revitalization of volunteers and health workers, NFI distribution HH spraying done by gov't	Field Commentary Case study	Social mobilization considered most impactful to reduce disease transmission NFI gave 'psychosocial support'; blanket distribution late; prepositioned stocks were helpful Errors in IEC materials, soap was scarce	High Risk of Bias Case study – commentary, limited methods
Tearfund – Ngegba (2002) Water and Sanitation Programme February-December 2002	Bloody diarrhoea – Outbreak Sierra Leone	Water: 8 new wells dug, 6 rehabilitated, 10 spring boxes, Sanitation: 652 pit latrines	Field Commentary Case Study	Social cohesion observed. Community Management Committees and training; CHVs engage in communal activities and help one another in times of need.	High Risk of Bias

Jaluahun Chiefdom, Kailahun District Eastern Province, Sierra Leone *Grey Literature*	9/2001 – 1/2002	Hygiene: 8 laundry areas, developed Community Management Committees and Community Health Volunteers		50% of interviewed demonstrated knowledge of diarrhoea transmission routes There has been considerable changes in the people's attitudes, especially toward open defecation. Clinic and Ministry of Health data shows diarrhoea reduction from 50% to 5% in intervention villages	Commentary – limited methods
CRS - Pennacchia (2009) Bridging the Gap: Providing Water and Sanitation and Non-Food Item Assistance to Returnees, IDPs and Host Communities in North Kivu *Grey Literature*	Cholera – Endemic D.R. Congo 7/2009 – 11/2010	Water: 25 spring rehabilitations; 3 new spring construction Sanitation: 20 shower blocks; 20 laundry stations; 2509 m of drainage; 20 - 15 m3 solid waste areas Hygiene: 20 hygiene promoters; 28 Water committee formed (1 for each water system); Promotion via: HH, schools, markets, churches, radio, drama, IEC book; Topics: handwashing, boiling of water, proper latrine usage. NFI Vouchers - $70 for 2,184 beneficiaries (HH)	Field Commentary Case Study	90% of HH thought personal hygiene improved (no sample mentioned) 74% decrease in diarrhoea cases in 5 months (35 cases in Sept : 9 cases in January); clinic records Time savings to collect water: average 322m before to 92m after (also less time in insecure environment) More than $150,000 USD pumped into local economy Beneficiaries thought prices (via voucher market) were competitive, 80% thought prices were at or below market 85% of vendors said they reduced prices out of negotiation	High Risk of Bias Commentary – limited methods
Simpson (2009) Real Time Evaluation of the Cholera Response in	Cholera – Outbreak	Water: Aquatabs in hygiene kit; Water tankering; Rehabilitation of wells; New boreholes	Qualitative 100 KII (some	Prepositioned stock key (with response scenarios)	High Risk of Bias

Zimbabwe 09 February – 19 February 2009 *Grey Literature*	Zimbabwe 9/2008 – 2/2009	Hygiene: Hygiene promotion - volunteers used (but other NGOs paid causing issues) 29,000 HH receive hygiene kits (not described further)	beneficiaries) and case study reporting	Existing public health program; decision to scale up to response difficult to assess – trigger needed NFI materials lacking, quantity (quality ok), beneficiaries appreciated Emergency staff available	Commentary – limited methods
ACF (2007) - UNOCHA Emergency Funding Water and Sanitation Program in Kebri Dehar District, Somali Region *Grey Literature*	Diarrhoea – Outbreak Somalia 1/2007 – 3/2007	Water: 6 community wells rehabilitated (7095 people); 120 m3/day for 3 weeks for 3500 people with water trucking; Widespread well chlorination, 150 birkhats; 1554 bottles of WaterGuard® given to families with birkhats (259 HH); 45 bottles given to schools; 1 bottle treats 1000L NFI Kits: 500 kits: (4 pcs of soap, water container (no size), cup with handle, 4-6 bottles of WaterGuard® Hygiene: 4809 people, including 424 community people; Mostly women, children and 'community people'; Topics: Disinfection, storage, handling	Field Commentary Case Study	Case management improved, and the case fatality rate dropped significantly after the NGO's intervention, bringing it to an acceptable standard of < 5% (from 11.7% to 4.9% and 2.8%). Microbiological testing not sufficiently carried out on rehabilitated/disinfected water sources; 7 were tested – all had 12-30 faecal coliform/100mL Hygiene kits had logistic delays; contract delays	High Risk of Bias Case study description.

WASH – General Emergency

Author and Title	Context	Description of Activities	Evaluation	Key Impacts	Bias
ACF (2014) Projet d'urgence d'amélioration des conditions d'accès à l'eau, hygiène et assainissement dans les camps de déplacés de Bangui - Document de capitalisation *Grey Literature*	Population Displacement – Conflict Central Africa Republic 1/2014 – 9/2014	Water: Installation of 4 bladders connected to the water distribution network in IDP camps; distribution of water through 2 mini-systems (7m3 tanks); rehabilitation/protection of 124 water sources (mostly boreholes); distribution of water treatment kits to households (number not given) Sanitation: Construction of latrines (188) with handwashing stations (0.05% chlorine) and showers (132) in two IDP camps Hygiene: Training of 40 hygiene promoters, targeting 1000 households	Field Commentary Case Study	Safety/instability issues made it difficult to stay on schedule Involving the beneficiaries helped cover WASH needs more widely in the community Having local partners is important and improves efficiency The daily presence of the team on site strengthened transmission of hygiene promotion messages	Medium Risk of Bias Limited methods and inconsistent reporting of results
Alem (2004) Evaluation of Emergency Water Supply and Sanitation *Grey Literature*	Drought Ethiopia No Date	Water: rehabilitation of 8 hand-dug wells (HDW) and 2 boreholes; construction of 1 new HDW Sanitation: Construction of 275 latrines Hygiene: 2 CHW stationed at each water point (1 male, 1 female)	Qualitative 16 FGD, KII (not described), 15 site visits	Communities reported reduced prevalence of diseases such as diarrhoea, vomiting in children, and intestinal parasites Fee collected for water, but still inadequate (.25-1 Birr/month or 5 Birr/month) hard where cash is not very prevalent Safe water coverage increased 9.5-17.3% Women workload in fetching water reduced, now 15 min instead of 30 min to 2 hours	High Risk of Bias Unclear data collection procedure

				Queuing time decreased and water availability increased	
Baker (2009) Final Evaluation Oxfam's North Kivu Emergency Response *Grey Literature*	Population Displacement – Conflict D.R. Congo 1/2009 – 9/2009	Water: Gravity-fed water system rehabilitated and extended in Lubero; 9 simple spring protections; 240 m^3 of water provided daily through water trucking; 2353 water filters distributed (out of 3000 planned); 70m^3 tank constructed in Remera/Kiringa Sanitation: 600 emergency family latrines constructed in households; 1,000 latrines constructed out of a planned 1,500 with community participation Hygiene: 13,179 HH hygiene kits (jerricans, buckets, basins, mosquito nets, jugs, cups, soap) and 5,180 female sanitary kits (bucket, underwear, string, cloth, soap) distributed in Lubero; 4,871 basic NFI and 4650 female hygiene kits distributed in Rutshuru	Field Commentary FGD, KII (quantity not described)	3 times more people arrived than originally planned. The additional 500 latrines could not be constructed due to budgetary constraints and rising cost of construction. Public health information and training increased handwashing after using latrines from 46% to 79%, and before eating or preparing food from 56% to 92%. Water quantities did not always meet Sphere.	High Risk of Bias Commentary – Unclear methods
Mattson (2013) Technical Review of Water, Sanitation and Hygiene Promotion Activities for T-Shelter Beneficiaries *Grey Literature*	Earthquake Haiti 5/2010 – 8/2013	Addition of WASH components to T-shelters – latrines, handwashing stations, water points, rain/spring catchment	Qualitative 8 FGD, desk review, online survey	Eco-san toilets were trialled but were thought to be low-quality by beneficiaries Respondents to survey indicated that they felt the project would be sustainable over the next 3 years Project failed to address desludging	Low Risk of Bias Clear reporting of results

				Latrine: $177 - $820 (not including labor/materials donated by community, RC indirect costs)	
ACF – Patinet (2010) Evaluation externe de la réponse d'Action Contre la Faim en eau, assainissement et hygiène à l'urgence post-séisme du 12/01/2010 en Haïti *Grey Literature*	Earthquake Haiti 1/2010 – 12/2010	Water: Distribution of drinking water (emergency mobile stations, truck tanks, bladders); 5 boreholes; 2 protected wells; rehabilitations were initially planned but mostly not realized Sanitation: Emergency sanitation systems (latrine, construction toilets, organization of emptying); support to 18 schools for sanitation; collection of solid waste Provision of water containers; distribution of NFI and hygiene kits; sensitization on hygiene, drinking water storage, sanitation and handwashing	Qualitative FGD, KII (quantity not described)	59% of people use drinking water from bladders / ACF trucks after the earthquake. Widespread lack of preparation regarding sanitation systems: specificity of urban context - complex population displacement dynamics, lack of space (e.g. for toilets), no urban planning Implemented solutions tend to become long-term instead of emergency response	Medium Risk of Bias Data collection from semi-structured interviews, clear reporting
Plan (2014) Building Back Batter in Tacloban: Post-Haiyan Community Rehabilitation *Grey Literature*	Typhoon Philippines No Date	669 water points rehabilitated, developed, repaired 635 latrines and 668 septic tanks repaired/built 630 handwashing stations with hygiene promotion on the school or community level	Field Commentary FGD, KII (not described)	Children said time to collect water reduced by more than 50% Community involved in Community Emergency Response Team (CERT) Stakeholders said improved drainage reduced dengue and accidents related to flooding	High Risk of Bias Commentary – unclear methods and reporting
Singh (2009) Evaluation Report "Sustaining the lives	Population Displacement	Water: 29 water points established (tube wells and open water bodies)	Qualitative 650 ppl FGD; 50 KII with	25-30% expressed they would not able to purchase items in the kits without assistance	High Risk of Bias

and dignity of IDPs in Purnea district – Bihar" *Grey Literature*	– Natural Disaster India 12/2008 – 10/2009	Sanitation: 187 latrines, 187 washing facilities (with solar lanterns, bucket, mugs), 1100 child potties Hygiene: promotion with plays and puppet shows, 3000 Hygiene kits, 1000 Dignity kits to women/girls (MHM)	village leaders; discussions with partner NGO's	Women and girls expressed appreciation for dignity (MHM) kit Hygiene education was widespread and received well	Unclear methods and reporting
van der Wijk (2010) Evaluation of the DEC-funded CAFOD Health and WASH Project in the DRC *Grey Literature*	Population Displacement – Conflict D.R. Congo 1/2009 – 12/2009	Water: construction of 2 gravity systems, rehabilitation of 1 gravity system; protection of 20 springs Sanitation: construction of 83 family latrines, 11 public latrines Hygiene: Water committee training, sensitisation of 22,000 HH	Qualitative 15 FGD, 25 KII	Health data showed a decline in waterborne diseases until August where there is a slight spike (but less than baseline). Provided WASH coverage to 4,400 HH Women estimate rape risk decreased by 80% because of WASH interventions	High Risk of Bias Collection procedures questionable
Varampath (2008) South Asia floods; WASH interventions/capacity review Focusing on key WASH interventions and capacity of agencies to deliver these *Grey Literature*	Population Displacement – Natural Disaster India 8/2008 – 10/2008	Water: various source-based treatment methods (microfiltration, UV, membrane filtration, chlorination) and HWT (Halozone and Zeoline tablets) Sanitation: various latrine types (pour flush, simple pit, shallow trench, overhung) Hygiene kits with promotion – especially focused on handwashing after defecation	Qualitative 1 KII, field observations	Latrine Use: 0-50% (poor maintenance, damage, unclean) HWT: only 7% of HH had FCR (2 of ~30) Soap: used for bathing rather than hands - was used up quickly with no replenishment	High Risk of Bias Unclear reporting
Visser (2012) WaSH Provision in Bahn Refugee	Population Displacement – Conflict	Water: Water trucking; Elevated tank eventually constructed for borehole and	Qualitative FGD (number not	Project designed with the expectation of 18,000 refugees – only 6,000 came	High Risk of Bias

Camp in Nimba, Liberia *Grey Literature*	Liberia 2/2011 – 12/2011	distribution system (replacing water trucking needs) Sanitation: Vented, gender-separated latrines (1:20 persons), 26 latrines for disabled Hygiene: NFI Kit (1 jerry can, 2 buckets with lid); Handwashing station with each latrine block - maintained by a volunteer; 100 community hygiene volunteers; Household visits	described), 12 KII, transect walk, desk review	Water provision met Sphere: 46,000L for 3000 (15.3 L/p/day) in February; 110,000L for 6000 (18.3 L/p/day) in August Water access within 500 m for all. Not more than 250 people per tap.	Commentary – unclear collection procedure
Wango (2011) SRCS/IFRC RESPONSE TO THE 2010/11 SOMALIA DROUGHT *Grey Literature*	Population Displacement – Natural Disaster Drought Somalia 2011	Refurbishment of boreholes (with fuel subsidy); Rehabilitation of 'Berkeds' (water pans); Shallow wells in IDP camp with hand pumps; chlorination of water points Also, distribution of NFI kit (contents not described)	Field Commentary KII (not described)	Development of long-term boreholes generally considered too expensive for emergency relief Refurbishment of boreholes ensured water availability when Berkeds and shallow wells were dry No operation and maintenance training provided NFI kits - too expensive relevant to impact (procurement and shipping)	High Risk of Bias Commentary – incomplete reporting, no comprehensive findings

Appendix B: Research protocol

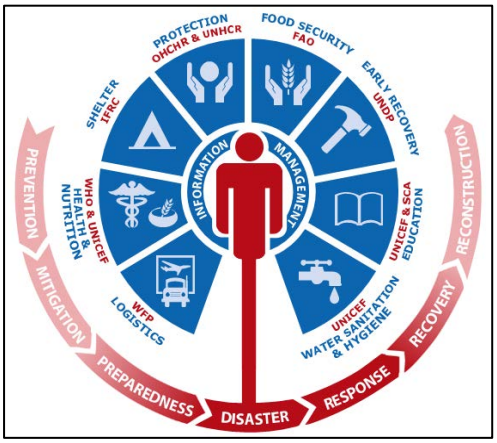
1. Background

1.1 Description of the problem

Emergency contexts originate from a range of causes that includes natural and man-made disasters. Natural disasters affect more than 200 million people annually and include earthquakes, hurricanes, flooding, disease outbreaks, or drought [1]. Man-made disasters include complex emergencies that often have components of armed conflict, livelihood instability, and political disturbance. Humanitarian emergencies are a result of a singular or combination of disasters that disrupt the livelihood and normal way of life for the population. Often emergencies are associated with the displacement of large populations, as in the case with refugees fleeing over an international border, or internally displaced people (IDPs) that temporarily move to another place within their country.

Emergency response is a professional sector that addresses the needs of disaster-affected populations. In low and middle-income countries (LMIC), local governments are often overwhelmed and require outside assistance during or after a disaster. The United Nations (UN) has an agency dedicated to coordinating the emergency response effort, the UN Office for the Coordination of Humanitarian Affairs (OCHA) and the UN Disaster Assessment and Coordination System (UNDAC). OCHA only operates in emergency contexts with approval from the local government. It is dedicated to coordinating the emergency response between other UN agencies, non-governmental organizations (NGOs), and government bodies. In 2014, the OCHA funding appeal was $17.9 billion (USD) to support more than 50 million people in 31 countries [2]. OCHA operates with a system that differentiates various humanitarian needs into eight clusters, such as: health, shelter, or food security (Figure B25). OCHA's role is to coordinate the emergency response, with NGOs typically implementing specific interventions that can overlap several clusters. Often UN agencies head-up each cluster for technical oversight and coordination within a cluster, although NGOs or local government occasionally leading the cluster.

Figure B25: OCHA cluster system (UNOCHA, 2013)



Governments have varying levels of involvement in emergency response, but often work hand-in-hand with OCHA and the NGOs to ensure that objectives of the response are mutually determined and achieved. Depending on the country and its resources governments can play a critical role in small and medium sized disasters.

Emergency hygiene interventions include: water, sanitation, and hygiene interventions, commonly referred to as WASH, and also environmental hygiene interventions. The aim of emergency hygiene interventions is to promote safe practices that reduce preventable waterborne and communicable diseases [3], [4]. Emergency hygiene interventions are usually not initially intended to provide long-term sustainable solutions, but instead rapid relief within hours or days from the onset of an emergency [3]. In almost all emergency contexts there are emergency hygiene needs, the greatest needs are often in response to disease outbreaks, flooding, or large population displacements [5]–[7]. The United Nations Children's Fund (Unicef) is the primary UN body responsible for coordinating the emergency WASH cluster, including emergency hygiene interventions. The World Health Organization (WHO) can also be involved, as many hygiene interventions have a direct impact on a populations' health; and the United Nations High Commission for Refugees (UNHCR) can also take the technical lead in refugee settings. While the UN agencies play a lead role in the global cluster, local government and a wide range of humanitarian NGOs actively participate and influence the response for each cluster in each emergency.

According to a 3ie scoping report, the emergency response sector has a "general lack of evidence" and operational research [8]. In 1995, in response to failed humanitarian efforts after the Rwandan genocide, NGOs gathered together and developed experience-based recommendations which have been collated into the Sphere Handbook. The Sphere Handbook provides minimum international standards for most aspects of emergency response to protect the affected population [3]. For example, guidelines for emergency WASH interventions include the amount of water a person needs per day (7.5-15 L/person/day), and how many people should be able to use a single latrine (maximum of 20 people).

Evidence-based emergency hygiene strategies are needed to support decision makers, as there is an anticipated to be a growing number of people in need [9], [10]. Climate change is expected to increase the scale and frequency of natural disasters, and also expected to affect more people because of rapidly increasing urban and slum populations in disaster prone regions [11]. Populations are also affected by increasing rates of terrorist attacks and 1.5 billion people are potentially threatened by violence [12], [13]. For example, in 2014, there were more than 50 million displaced persons worldwide for the first time since World War II. Additionally, already in 2015, there are more than 60 million displaced persons worldwide, causing enormous strain on limited funds and resources [14], [15].

1.2 Description of the intervention

For the purpose of this review, we have differentiated emergency hygiene interventions into eight specific short-term emergency response intervention categories. These interventions were selected based on the scope of interventions that are most commonly implemented in acute situations (commonly defined within eight weeks of the onset of an emergency) in low and middle-income countries. These interventions can be implemented along-side or in combination with each other; however, all aim to reduce the disease burden during emergency situations. The eight emergency hygiene interventions included in this review cover: 1) hygiene promotion; 2) distribution of soap and/or hygiene kits; 3) environmental hygiene; 4) source-based water treatment; 5) household water treatment (HWT); 6) increasing water access; 7) installation of temporary or permanent sanitation facility; and 8) distribution of latrine alternatives.

1) Hygiene promotion

Personal hygiene in emergencies is important because normal hygiene practices might no longer be possible, due to destruction of a water point or latrine or displacement. Hygiene promotion is used to educate disaster -affected populations on the increased risks of disease transmission and mitigation strategies. Often in emergencies, hygiene promotion is condensed to key messages, such as hand-washing at critical times. Promotion can be at schools, large community groups, or at the household level (Figure B26). Handwashing promotion may also include handwashing stations or tippy taps installed near latrines, homes or schools.

Figure B26: Hygiene education in schools (Global Giving, No Date)

In recent years, there has been a sanitation strategy that focuses on hygiene education and community involvement to address the problem of open defecation. Community Led Total Sanitation (CLTS) has been widely promoted, mostly in development settings, to encourage communities to build their own latrines from locally available materials; specifically, no materials are given to the population.

Education through an outside facilitator is intended to influence the population to want to be open defecation free (ODF) and find their own solutions to address open defecation. Similarly, Community Approaches to Total Sanitation (CATS) also encourages social change and ODF communities; however, some assistance could be given in the form of materials or cash to help build latrines. Both CLTS and CATS are highly dependent on hygiene promotion to inform communities to the hazards of open defecation; thus, for this review, we will consider both interventions as hygiene promotion.

2) Distribution of soap and/or hygiene kits

During or after an emergency, access to soap or other hygiene items may not be possible due to supply chain disruptions for long periods of time. Hygiene-kit distributions provide affected populations with soap, buckets, toothbrushes, and other materials depending on the context. Additionally, Menstrual Hygiene Management (MHM) kits have recently been advocated for required inclusion in many hygiene distributions. Hygiene kits can be distributed as standalone packages, or a component of a large distribution of non-food items (NFIs) or core relief items (CRIs) that includes materials such as blankets, cooking pots, or other materials. An alternative to providing physical materials, subsidies, vouchers, and cash transfers offer flexibility to the disaster-affected households. These options enable the households to prioritize their own needs, but require access to markets.

3) Environmental hygiene interventions

The local environment (household, school, market) is often a route of disease transmission, and in many emergencies, there is a shift in local conditions that increase environmental hazards. Environmental hygiene efforts aim to protect populations from existing or new risks by reducing environmental pathways of disease. Two examples of environmental hygiene interventions are rubbish collection and household spraying. *Rubbish collection* is the removal, management, and disposal of rubbish, often most needed in a refugee camp or informal settlements to minimize vectors that spread disease, like flies and rats. *Household spraying* is when a team of people sanitize a home or building that has potential for risk for contamination; for example, a strong chlorine solution is used to sanitize an Ebola or cholera patient's home. Note: household spraying described above is not the spraying of insecticide (indoors or outside). Insecticide spraying is beyond the scope of this review.

4) Source-based water treatment options

In contexts where water access is secured, source-based water treatment aims to improve water quality during collection. Most source-based treatments use chlorine solution or chlorine tablets to treat water because it effectively protects against most waterborne diseases [16]. Source-based treatment interventions are differentiated by the chlorine delivery method and beneficiary involvement. *Bucket chlorination* is when a dedicated staff member is stationed by the water source and adds a dose of chlorine directly into the recipient's water collection container. *Chlorine Dispensers* are hardware installed next to a water source; recipients

collect water, and then turn the Dispenser valve to dose their own container (Figure B27). *Pot chlorination* is hardware installed in a well, intended to slowly disperse chlorine over an extended time; the beneficiary is not involved. *Temporary pumping and storage of surface water* is the pumping of river or lake water into large bladders or tanks, and then treated with a flocculent that helps to settle suspended solids, and dosed with chlorine; beneficiaries are not involved.

Figure B27: Chlorine Dispenser used in the D.R. of Congo (Armitage, 2013)

5) Distribution of household water treatment technologies

Household water treatment (HWT) interventions are another emergency hygiene intervention used in contexts where water access is secured but water quality is not adequate. HWT interventions are differentiated by consumable and durable treatments. Consumable items include *flocculent/disinfectant packets*, like PuR® Purifier of Water (Figure B28), or *chlorine tablets* like Aquatabs that are distributed to households to dose specific volumes of water typical for a household (20-25L). Durable HWT include water filters such as: *hollow fiber filters* like LifeStraw® *or filter systems* with ceramic elements are often used. Solar disinfection, SODIS, is another HWT technology that uses ultraviolet radiation and heat to disinfect household drinking water.

Figure B28: Beneficiary with PuR Purifier of Water sachets (World Vision, 2013)

6) Increasing water access

Access to both potable and non-potable water is critical for disaster-affected populations. Existing water sources can be damaged or rendered no long potable as a result of a disaster, or overwhelmed by a sudden influx of displaced persons. In the acute emergency, there is rarely time for new construction of water points. Thus the most common water access interventions are: 1) repair/cleaning; and 2) water tankering. *Repairing or cleaning existing sources*, like wells or springs, are often one-time interventions that restore water sources familiar to the local populations. *Water tankering* (Figure B29) hauls water from another source, bringing it to the affected population.

Figure B29: Water tankering in Syria (ICRC, 2015)

7) Installation of temporary or permanent sanitation facilities

Management of fecal waste is fundamental to minimize contamination and spread of disease. Human feces are a primary transmission route of many waterborne diseases. Proper management of both waste and disease vectors are necessary. In most emergency response situations, sanitation facility interventions are the installation of permanent or temporary latrines. Sanitation facility is a general term,

typically referring to a latrine (Figure B30). Construction of a *permanent latrine* may be with a concrete pad or a strong structure that is intended to last for several years. *Temporary latrines*, like transportable port-o-johns, can also be also used.

Figure B30: Latrine Construction in a refugee camp (IMC, No Date)

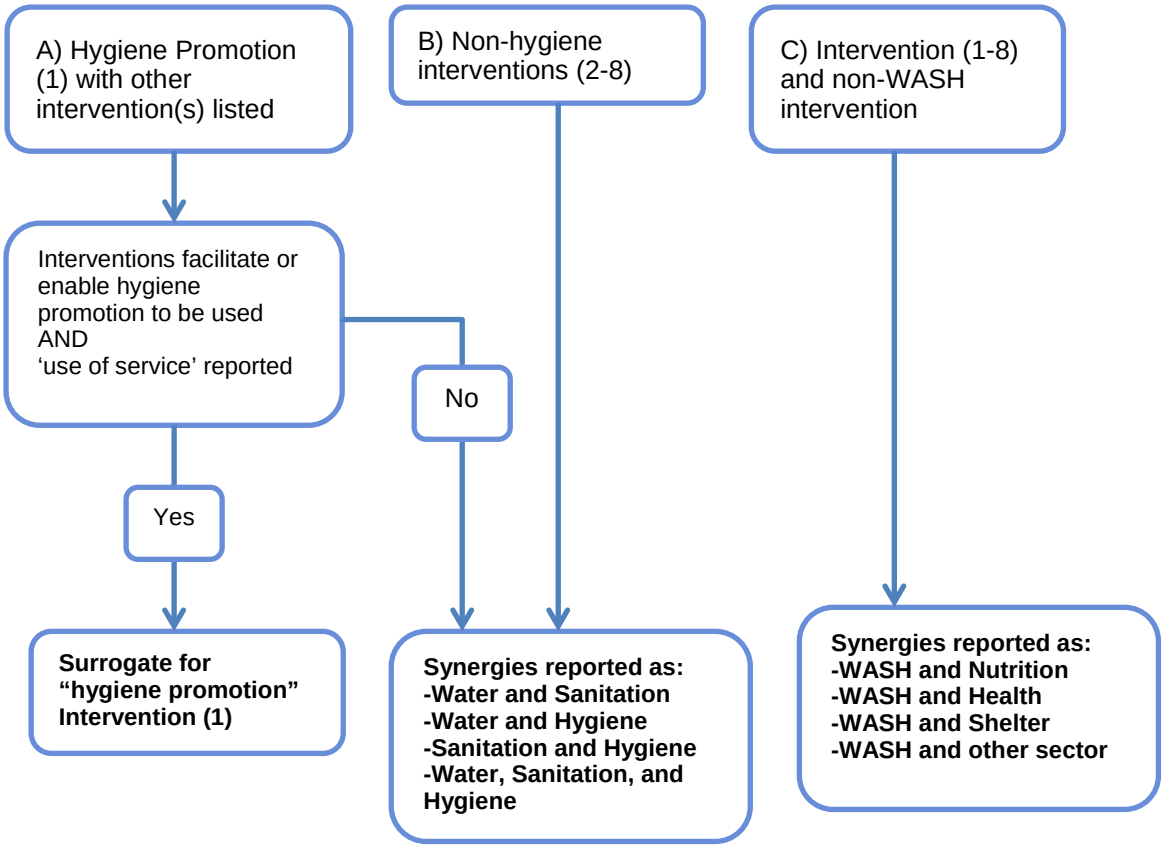
8) Distribution and management of latrine alternatives

In some contexts, formal sanitation facilities my not be a viable because of space, timing, or water table constraints. There is a significant amount of innovation in this space. One innovation is the distribution of bags to households intended for single use human waste needs (i.e. pee-poo bags).

Combination and synergies

In many contexts, several interventions described above could be implemented together or with other sectors like health or shelter. Following an emergency situation, the needs of emergency-affected populations are usually in excess of what a single intervention can address, thus it is common for one or more agencies to implement several interventions in combination. In some situations, WASH interventions are seen as package that addresses water, sanitation, and hygiene needs of a population. With interventions being carried out in unison, there can be synergies that have an additive or diminished effect. We will separate interventions where possible, but also acknowledge the synergies when separation cannot be achieved. Hygiene interventions are often highly dependent on other WASH interventions, for example, access to water and sanitation are often critical and necessary aspects of hygiene promotion interventions. Combination groupings of the WASH interventions listed above with a hygiene promotion intervention and a use of service outcome will be considered a surrogate for hygiene promotion (Box A, Figure 7). Synergies within the spectrum of WASH that are that are not in combination with hygiene promotion follow Box B, Figure 7. Finally, WASH interventions in combination with other sectors (i.e. nutrition or health) follow Box C, Figure B31.

Figure B31: Synergy specification



Non-health related interventions

There are many non-health related interventions that address the safety and well-being of disaster affected populations. This can be described as 'quality of life' aspects that are often expressed as protection (i.e. feeling 'safer') or some form of equality (i.e. being less marginalized or stigmatized). For example, women may report feeling safer and less stigmatized when they have MHM materials and a latrine nearby. Quality of life impacts are important for this review; however, will be only considered as a result of the interventions listed above.

1.3 How the intervention might work

To evaluate emergency hygiene interventions we will follow the assessment principles by Howard White (2009) including: 1) map out the intervention causal chain; 2) understand the context; 3) anticipate heterogeneity; 4) rigorous evaluation of impact using credible counterfactual evidence; 5) rigorous factual analysis; and 6) use of mixed methods [17]. For our impact evaluation, we use each of the six principles below to assess the eight emergency hygiene interventions.

1.3.1 Mapping the causal chain

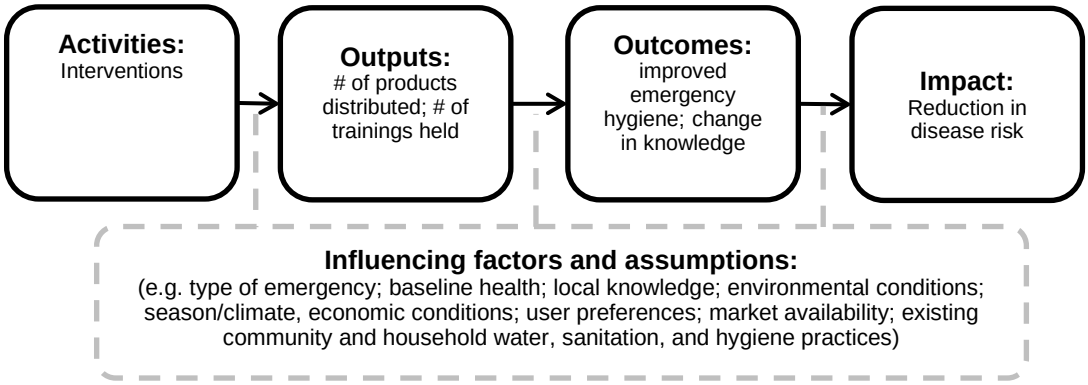
Beginning with the framework that emergency affected populations are at an increased risk of disease due to disruptions in their WASH provision, the theory of

change that underpins all short-term emergency hygiene interventions in emergencies is:

> *Short-term emergency hygiene interventions can reduce the risk of disease until such time as normal or new WASH systems are (re)established.*

This theory of change will be incorporated into the review by analyzing the outcomes and impacts that lead to risk reduction from short-term interventions in the emergency context. The logic progression is a framework that transitions between intervention activities that eventually lead to community impact (Figure B32).

Figure B32: Theory of Change



Source: Authors

Activities of short-term hygiene interventions in emergencies generally fall into one of two categories: 1) the distribution of products (i.e. soap, chlorine tablets); or 2) provision of services (i.e. well chlorination, handwashing promotion). Products and services can be provided with, or without, community involvement or training (i.e. nonfood item distributions compared to programs focused on community health workers reaching a wide population).

Outputs of short-term hygiene interventions are generally reported as the number of products delivered or services completed by the implementing agency; for example: the number of buckets distributed or the number families that attended a handwashing seminar.

Outcomes are the direct result of the intervention on the population; for example: use of the distributed product or service to improve drinking water quality, or a reduced exposure to contamination from the environment.

Impacts show the final result of an intervention. For short-term hygiene interventions, examples include: reductions in disease (such as diarrhea); quality of life improvements, increased school and work attendance; or increased economic productivity. Impacts are often mediated in interventions that depend on individual user behavior change (such as handwashing) by user acceptance and

compliance but can be subject to any number of know or unknown assumptions in the causal chain.

The wide variety of emergency hygiene interventions creates a complex causal chain that is difficult to analyze in sufficient detail as one intervention. For example, the activities and outcomes for a behavior change intervention, such as handwashing, is quite different than provision of services, such as a building a latrine or treating water. In order to properly assess activities and assumptions, we have developed a separate causal chain for each of the eight hygiene interventions.

A key step in all of the causal chains is the ‘use of service’ assumption. While many of the interventions are designed to provide access to materials or services, but unless the affected population uses the intervention as intended, the potential impact is drastically reduced. This review will focus on the use of services as a key step in the causal chain as well as the final impact of the interventions, disease reduction. The use of service assumption is highlighted in each of the eight causal chains presented below.

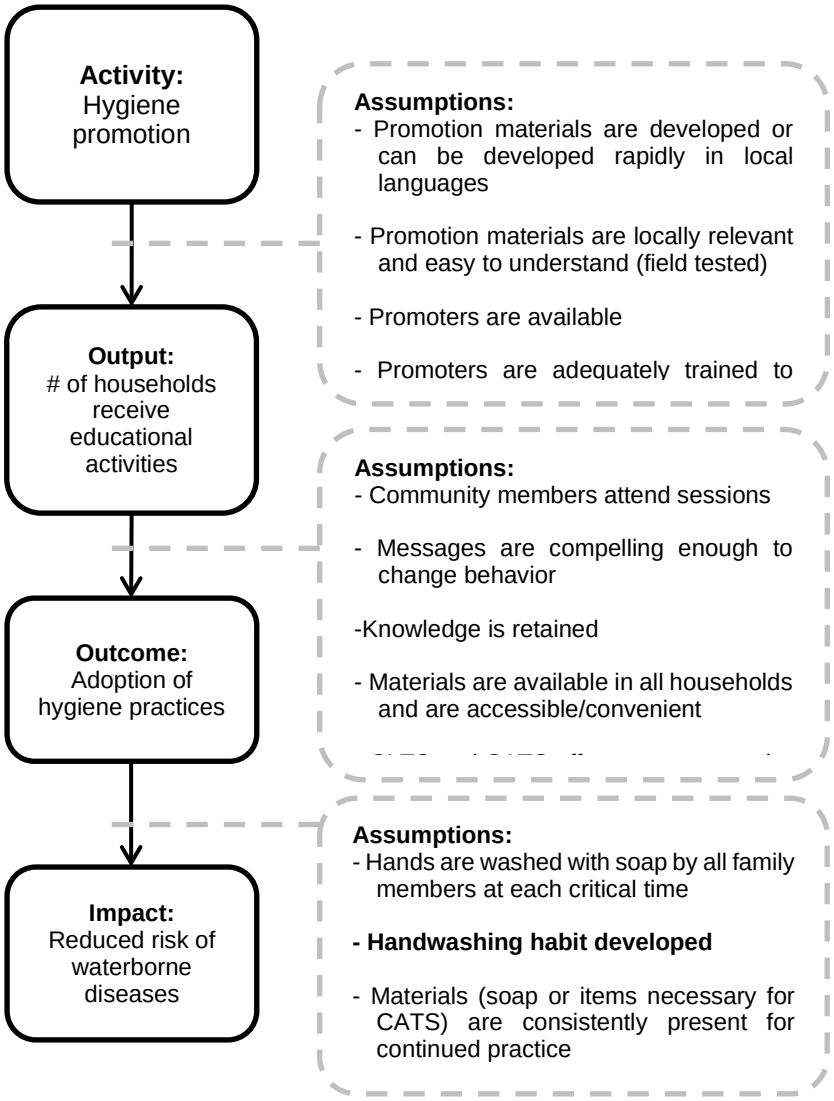
Non-health related impacts are final outcomes, similar to achieving disease reduction; however, we view non-health related results as secondary impacts, because in an emergency, disease reduction often is the primary concern and rationale. Thus, non-health related impacts are not exclusively shown in the causal chains shown below.

In keeping with the Theory Based Impact Evaluation by Howard White (2009), the causal chain is presented as separate interventions, but the remaining five criteria are presented together. We feel this is appropriate because while there are differences in interventions, the situation in which they are assessed and ability to be broadly applied is common among all the interventions.

1) Hygiene promotion

The program theory for hygiene promotion, especially hand hygiene at critical times, is dependent on breaking the fecal-oral route of contamination. The critical assumptions are that populations have access to soap or ash and populations quickly adopt hygiene messages, including latrine use in CLTS or CATS interventions.

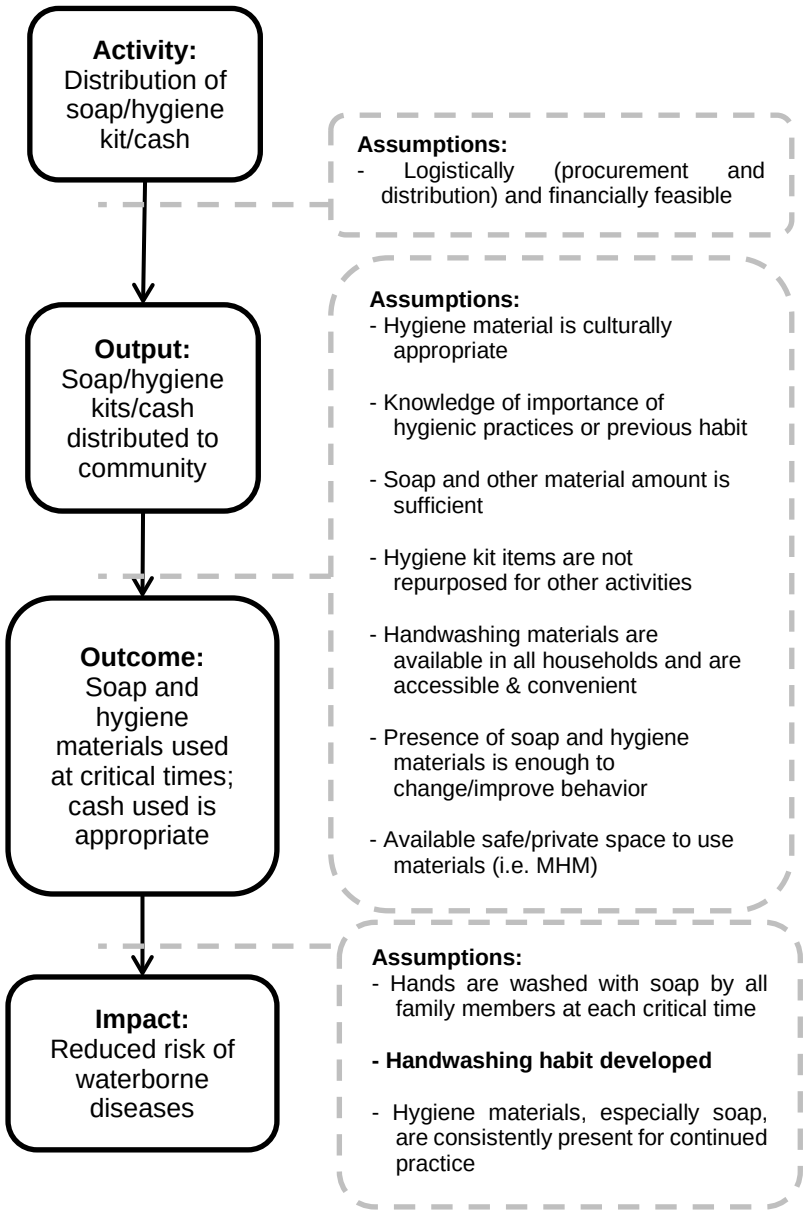
Figure B33: Hygiene promotion program theory



2) Distribution of soap and/or hygiene kits

The program theory for the distribution of soap and/or hygiene kits is that affected populations do not have access to markets (logistically or financially). The critical assumption is that populations already know how to correctly use or is able to quickly learn correct use of items in the kit, because distributions typically have little or no concurrent training components. Maintaining consistent supplies to households of different sizes or households with small children is also a challenge. With cash or vouchers, there are assumptions that hygiene materials can be acquired in the markets and prioritized by beneficiary, as opposed to food or other needs.

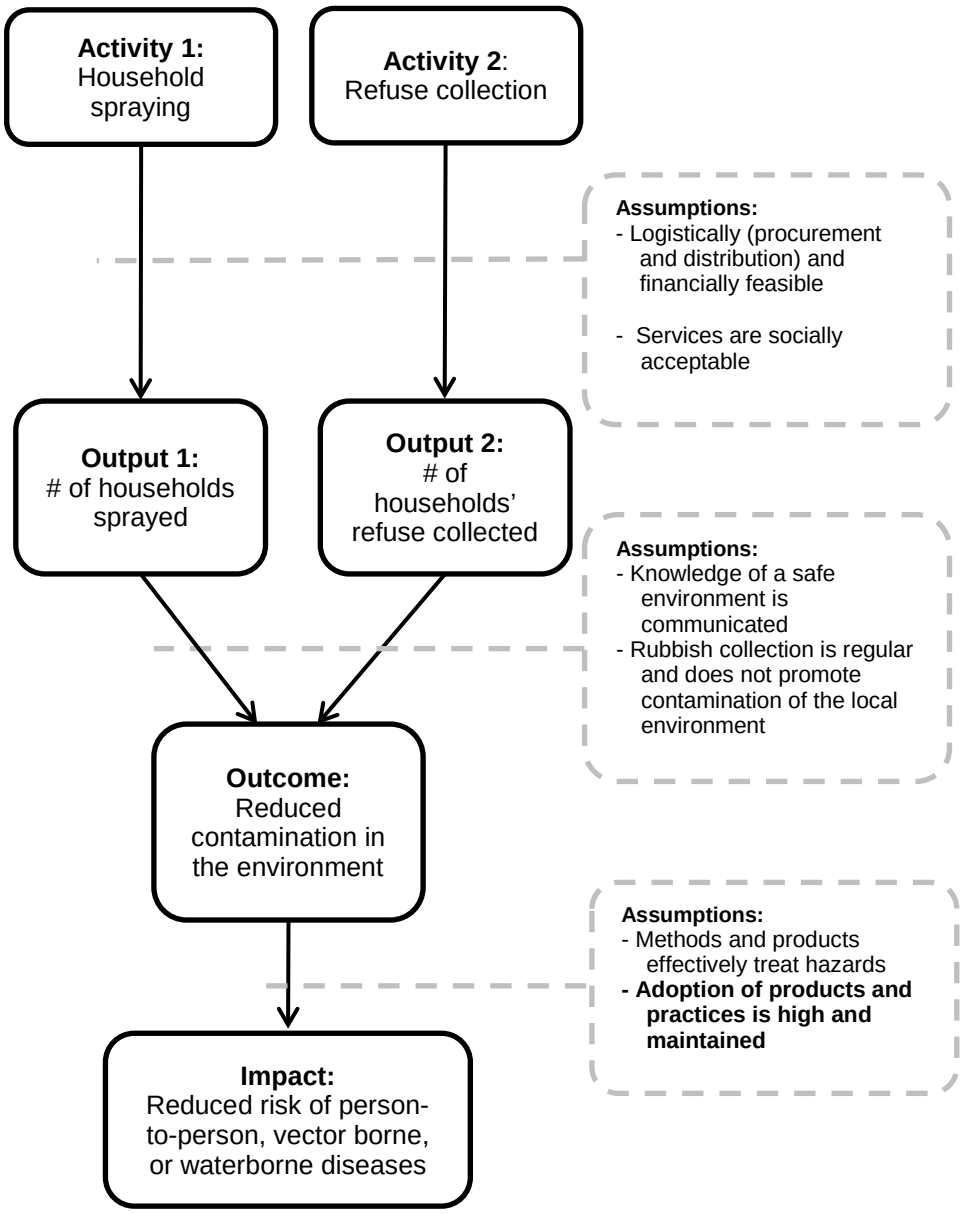
Figure B34: Distribution of soap and/or hygiene kit program theory



3) Environmental hygiene interventions

Environmental hygiene intervention program theory is based on the assumption that living in a clean environment reduces disease risk. Some of the basic assumptions are founded on good sanitation and personal hygiene practices, like no open defecation and handwashing at critical times. Education of households on likely hazardous routes of contamination relies on behavior change and households wanting to adopt new practices. Then, access to cleaning materials, i.e. chlorine solution, are necessary but may have limited effectiveness if used on dirt floors or non-durable surfaces.

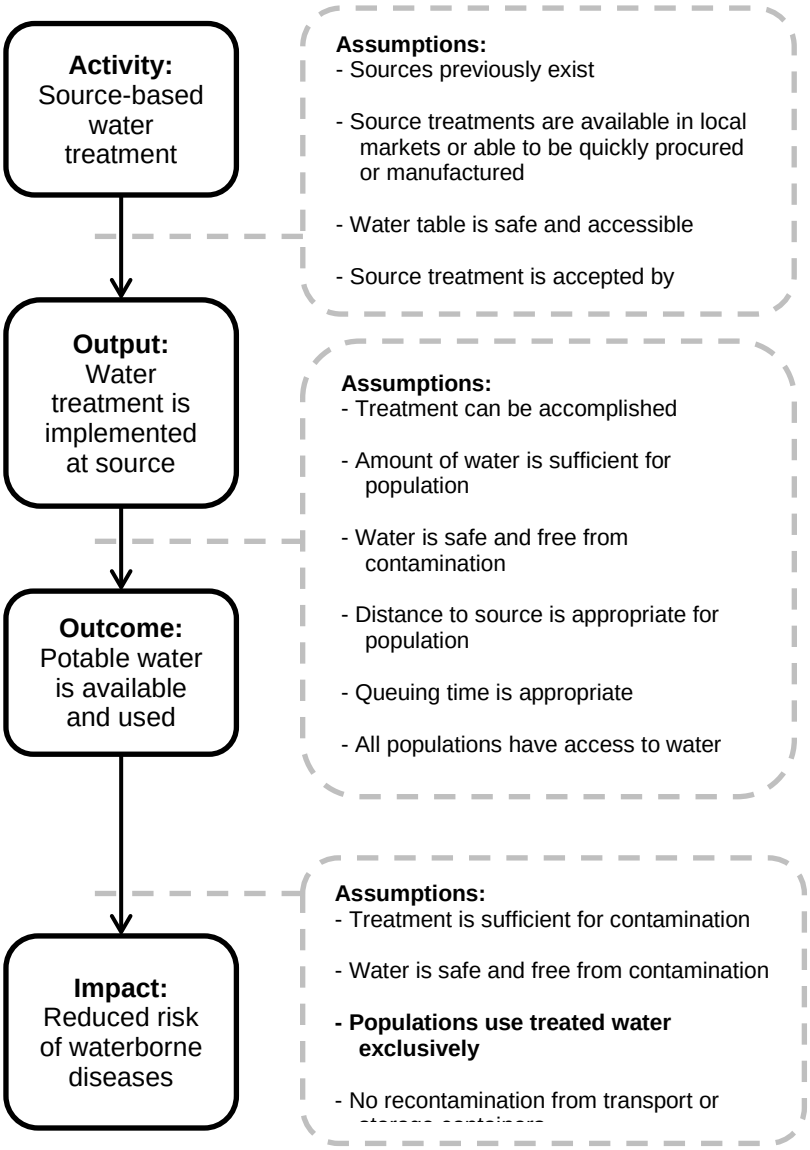
Figure B35: Environmental hygiene program theory



4) Source-based water treatment options

The program theory for source-based water treatment is that a sufficient amount of water quantity is accessible, but water quality is lacking at point sources (e.g. protected wells or springs) and surface water. The critical assumption is that access to the treatment is available at all the sources and at all the times the population collects water. Source based treatment, like Dispensers, may be a new treatment method for the population and require education on correct use.

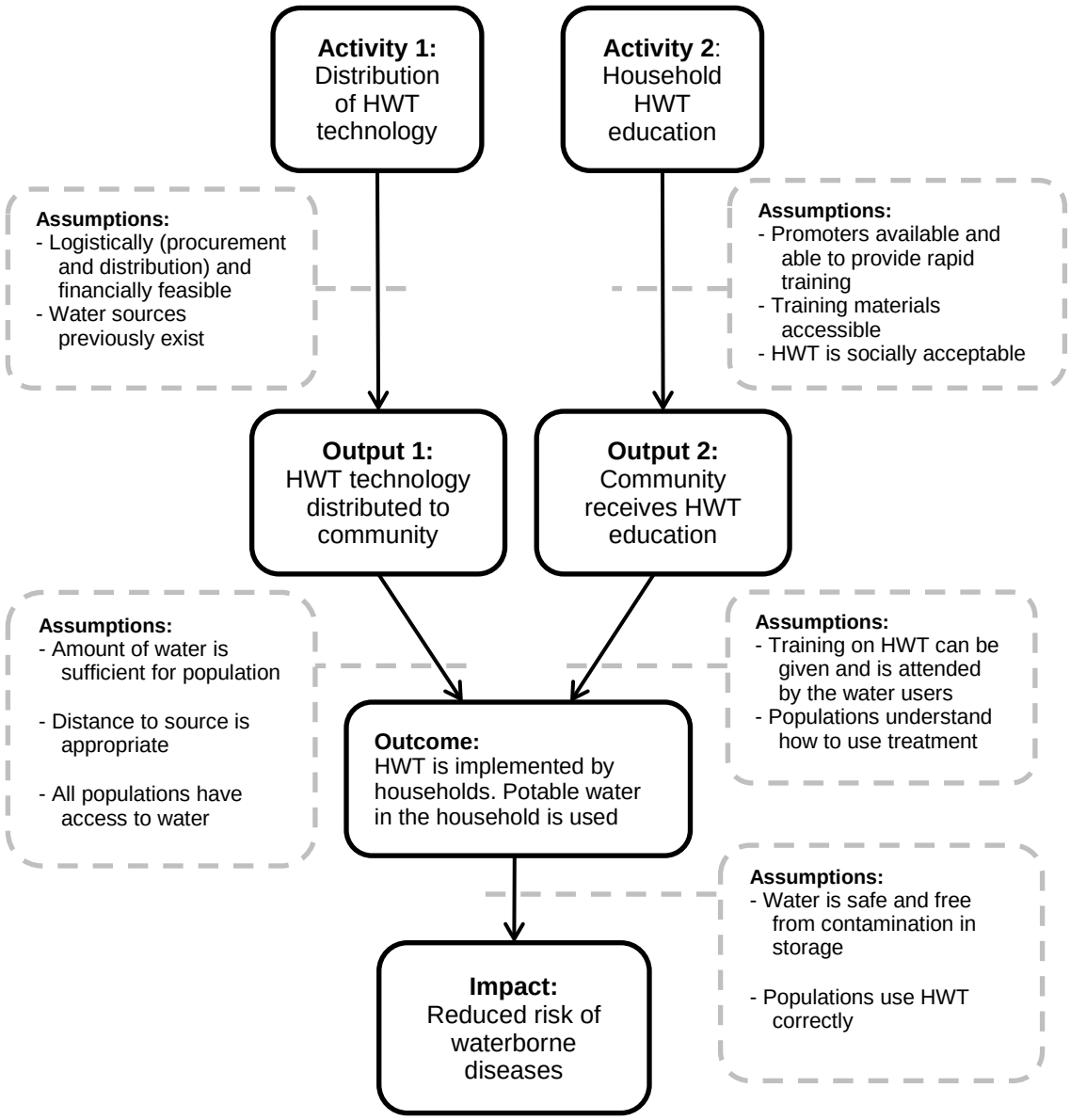
Figure B36: Source-based water treatment program theory



5) Distribution of household water treatment technologies

Household water treatment (HWT) program theory is based on adequate access to some water supply that is then treated at the home. This requires the one-time or continued distribution of treatment materials and also an understanding of how to use the treatment method. The critical assumptions are that the treatment is appropriate for the water conditions, households know how to use the treatment correctly, households use the treatment every day, and are able to acquire materials needed for ongoing use.

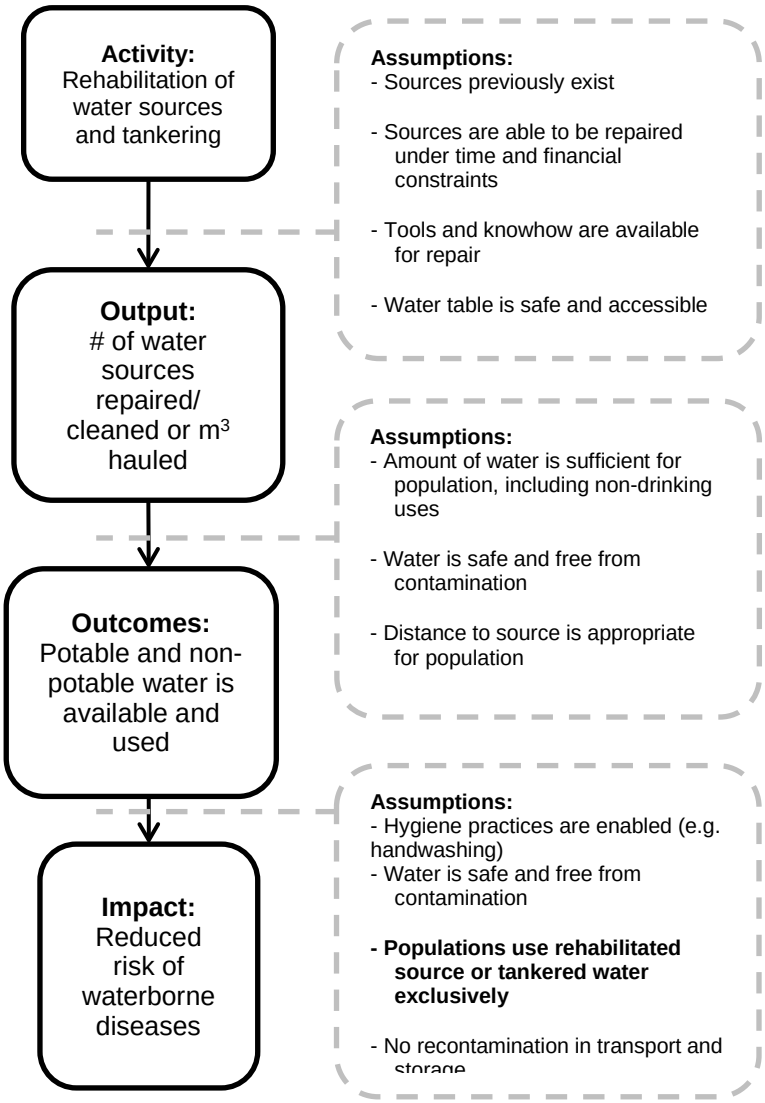
Figure B37: Household water treatment program theory



6) Increasing water access

The causal chain for the rehabilitation or cleaning of water sources relies on the feasibility and availability to repair damaged sources or clean contaminated sources. With the existing infrastructure, populations are likely familiar with the operation and use of the water source. Thus, critical assumptions are that the source can be repaired or cleaned, and that it provides an adequate amount of water for the population that is safe to drink. Water tankering is another intervention that increases water access. Critical assumptions for water tankering are that a source is available to collect water in a timely manner and road access for hauling.

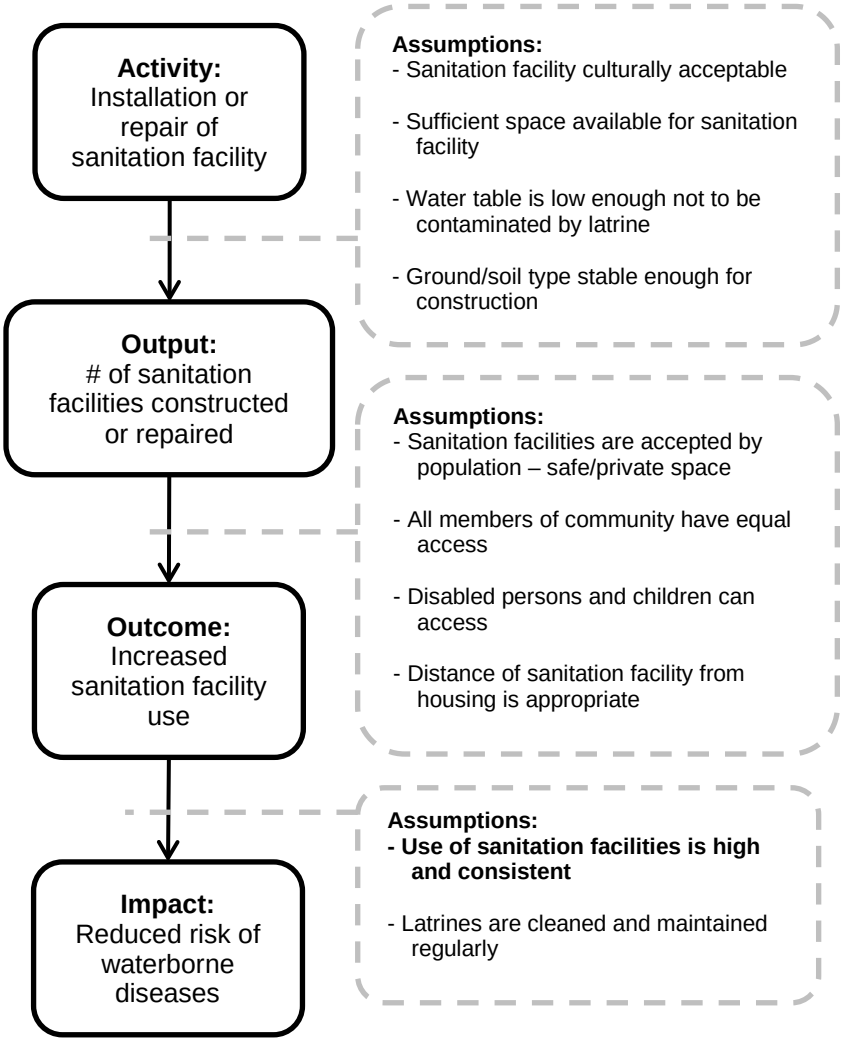
Figure B38: Rehabilitation of water sources program theory



7) Installation of temporary or permanent sanitation facilities

The installation of sanitation facilities (i.e. latrines) program theory, assumes that there is adequate and available space to install sanitation facilities close to living quarters but are not a potential contamination hazard. The soil type and depth of the water table must also be considered as critical assumptions. Further behavior change activities, like hand-washing and no open defecation, are critical assumptions needed to make an impact.

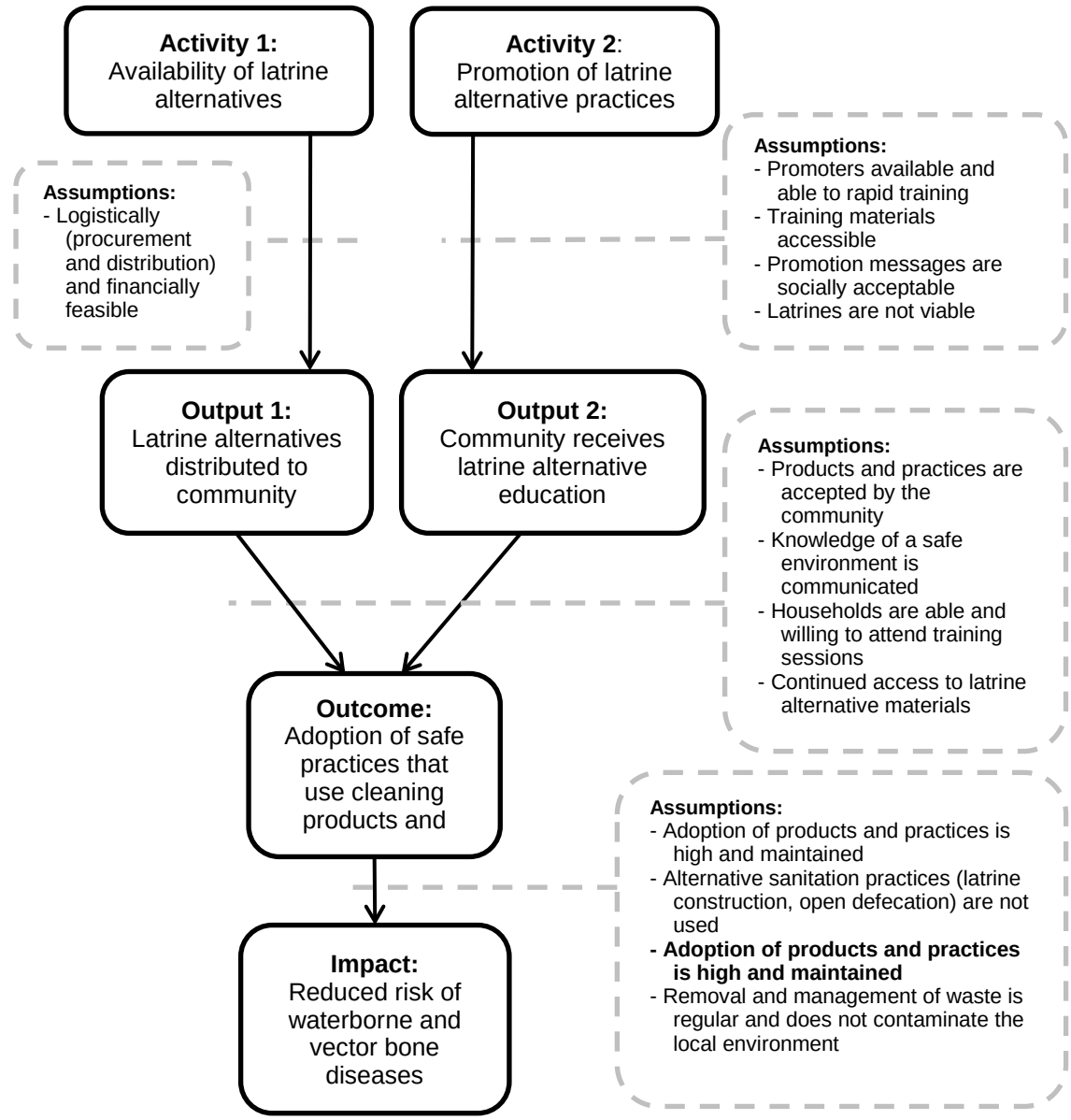
Figure B39: Installation of sanitation facility program theory



8) Distribution and management of latrine alternatives

Latrine alternatives are used in situations where latrines are not a viable option or will take too long to construct. Pee-poo bags are probably the best example of this intervention type, although some CATS could also be considered, it is included in hygiene promotion. The critical assumptions are that people will use the alternatives (with suitable training), but that there is a collection system that removes the waste from the household and is disposed in a safe place. The relatively new technology may limit the access in remote locations or willingness to use from traditional sanitation actors.

Figure B40: Latrine alternative program theory



1.3.2 Understand the context

To assess a wide range of interventions on a global scale, “Understanding context is crucial for understanding [intervention] impact” [17]. There are contexts in and after a disaster that may preclude some interventions from being possible or less effective. For example, some of the natural surface waters in the Democratic Republic of Congo have a relatively high pH, above 10, weakening the effect of many chlorine based treatments. Another general example could be access and/or availability of supplies that could be held at customs or the disaster destroyed primary logistic routes– forcing alternative interventions to be carried out. In an evaluation of household water treatment (HWT) in four separate acute emergencies (cholera in Nepal, earthquake in Indonesia, flooding in Kenya, and displacement in Haiti), effective use of different treatment strategies ranged from 0-

67.5% [18]. Installing chlorine Dispensers as a source-based treatment had a similar wide range of effective use (0-81%) in four emergency contexts (cholera in Sierra Leone, food security in Senegal, cholera in the Democratic Republic of Congo, and cholera in Haiti) [19].

The differences in contexts are foundational to this review. Previous knowledge of the intervention, existing behaviors, or type of disaster are just some of the contextual factors that can carry a large influence. There is no 'silver bullet' of WASH or emergency environmental hygiene programs that is applicable in all situations [20]. A dedicated portion of the data extraction is focused on contextual factors that affect the hygiene interventions like: time since disaster, training components, target population, and intervention partners. The full list of data collection is in Appendix B1: Data collection variables.

1.3.3 Anticipate heterogeneity

The heterogeneity of the interventions, contexts, and affected populations are expected to be high. The type and quality of research will also vary considerably. Initial scoping and previous research into short-term emergency hygiene interventions yielded few experimentally designed manuscripts from peer-reviewed journals. The majority of information is from quasi-experimental and non-experimental studies or grey literature. Some emergency hygiene interventions tend to have quality experimental designs (i.e. HWT interventions); however, other interventions, like handwashing, have more qualitative and non-experimental evidence. The primary sources of data for this review will therefore include: quasi-experimental and non-experimental manuscripts, agency documents from the UN or government body, and grey literature from NGOs.

We consider *agency reports* as an internally reviewed publication intended for an international audience. For example, agency reports could be a monthly situation report from the WHO in Senegal, or a global analysis from the World Bank. We consider *grey literature* as reports from NGOs that could be but is not typically expected to be made available on high-access external websites. Grey literature reports, for example, could be a project-specific impact analysis intended for a narrow audience, i.e. donor report. Within agency or grey literature, there will be a large variation in the scale of studies (global analysis to specific village impact) which also reflects the heterogeneity in study designs and quality of methodology.

In interventions with sufficient data, sub-group analysis will be completed by stratifying the data into relevant groupings. We will use the PROGRESS-Plus to frame the investigation into various general and equity based subgroup analyses[21]. PRGRESS-Plus represents a range of categories from place of residence to occupation to disabilities. Example groupings are: gender, age, disaster type; geographical region; disasters where people are displaced or not; grey literature compared to published literature; length of intervention; or complementary programing. The anticipation of heterogeneity is the catalyst for the comprehensive collection of context and study criteria. Careful consideration will be made to appreciate the heterogeneity and implications of results, with

respect to statistical characteristics (sample size, power) and generalizability. We will ensure to note which included data in each of the stratifications comes from which sources. With qualitative or less comparable data, we will clearly express the limits of any external comparisons.

1.3.4 Rigorous counterfactual analysis

Some of the most desirable studies are those that establish impact by comparing two or more groups found in experimental or quasi-experimental evaluation designs. These study designs help to minimize bias and can often better establish intervention impact by controlling for various factors [17]. Based on the initial scoping, it is expected that there will be a very limited number of experimentally designed studies, but a higher number of case-control studies with less quality counterfactual evidence. In health research, case-control study design is common, witnessed in our scoping assessment with many cholera studies. It is expected that there will be sufficient number of case-control studies to give confidence highlighting casual-chain assumptions. Another comparison method yielding counterfactual data will be with water quality testing, as some studies collect *E. coli* data of treated and untreated water, before and after an intervention or in household untreated and treated water pairs.

1.3.5 Rigorous factual analysis

Factual analysis compliments the impact analysis of comparison studies by following the causal chain logic described above. Investigating key assumptions along the chain establish the success or failure of an intervention. Examining the eight emergency hygiene interventions individually will help to narrow assumptions made in the causal chain. Case studies, as well as, including relevant grey literature and qualitative studies will also help to identify contextual factors of the interventions and potential implementation hurdles that break the assumed causal chain.

1.3.6 Use of mixed methods

This review will greatly benefit from the use of mixed methods. As described above, the analysis will include a variety of sources, from peer-reviewed journals to grey literature. These will include quantitative research designs, experimental, quasi-experimental, and non-experimental methodologies, providing a rich data set with statistical foundations. Investigating economic outputs also expands the assessment by adding another lens to view emergency hygiene programming.

Qualitative research and qualitative information will both be collected for this review.

Qualitative research is a research design that often involves interviews, focus group discussions, or simple observation. The information gathered is typically coded into themes and summarized as general thoughts and opinions of the persons involved.

Qualitative information, we define as ***contextual information***, will also be collected. Contextual information is the descriptive details that are important for this review; such as: country, type of disaster, implementation agency, and so on. Contextual information will be collected from both quantitative and qualitative research design of studies that meet the inclusion criteria.

1.4 Why it is important to do this review

The impact and effects of hygiene interventions in development contexts (including water supply, water treatment, sanitation, and hygiene) has been extensively studied and debated [22]–[25]. In contrast, the evidence on hygiene interventions in emergency response situations has not yet been systematically reviewed despite hygiene interventions being undertaken in the vast majority of emergency responses.

Due to the difficulties in conducting research in emergency situations (including limited staff capacity, need for immediate response, ethical considerations, and access), most of these commonly implemented interventions are severely under researched. Research has also shown that many emergency responders default to familiar interventions previously used, which may not be the most effective response [26], [27]. When faced with complex emergencies, ‘intuition’ and ‘if it worked before it will work again’ are mentalities of relief professionals faced with complex emergencies with unknown consequences [27], [28]. This implies that some interventions may be used in inappropriate contexts. Water treatment strategies have failed when used in contexts that are too different than the intended application [27], [29]. The effectiveness of interventions is a function of physical parameters, but also social factors, such as community acceptance and ease of use [9], [27], [30].

The variability of emergency situations is large, and insufficient understanding of the differences obscures appropriate response, as many emergency response interventions have been extrapolated from development contexts [9], [10]. There have been literature reviews of individual short-term hygiene interventions in the past (such as household water treatment) [31], but there has been no systematic review including all short-term hygiene interventions in emergencies - this work aims to fill this gap.

2. Objective of the review

This systematic review has a singular overarching objective in assessing the impact of emergency hygiene interventions. The primary research question will be answered through three secondary objectives that further evaluate: a) use of service, b) health-related outcomes, c) non-health related outcomes, d) barriers and facilitators to WASH interventions; and e) cost-effectiveness of emergency hygiene interventions.

Please note: identifying barriers and facilitators of design, as well as, implementation and uptake hurdles are a critical step in this review. We consider this information ‘context data’ which could be descriptive information from the

studies, quantitative, or qualitative data not necessarily related to the research objectives but will enable a clearer assessment of homogeneity for analysis. Contextual factors are not in the inclusion criteria, as they will be collected only after the selection of the studies.

Primary research question:

What are the **outcomes and impacts** of short-term hygiene interventions in emergency response situations in LMICs?

Secondary research questions:

a) What are the effects of short-term hygiene interventions on **use of service (e.g. use of soap, water treatment)** in emergency response situations? (quantitative analysis)

b) What are the effects of short-term hygiene interventions on **health-related outcomes** (i.e. morbidity and mortality) in emergency response situations? (quantitative analysis)

c) What are the effects of short-term hygiene interventions on **non-health related outcomes** (i.e. psycho-social, quality of life, behavior change) in emergency response situations? (quantitative analysis)

d) What contextual factors act as **barriers or facilitators** to implementation and uptake and the effectiveness of short-term hygiene interventions in emergency response situations? (qualitative analysis)

e) What is the **cost-effectiveness** of short-term hygiene interventions in emergency situations? (quantitative analysis)

Research questions a), b) and c) will be addressed through quantitative analysis of studies employing experimental, quasi-experimental, non-experimental and mixed-methods designs. Data drawn from all study designs are eligible to be included in the qualitative analysis that will address Question d). Question e) will be addressed using economic or cost analysis data. For more information on includable study designs, see section 3.1.5.

To meet the review objectives, a systematic process is described to identify and select studies in Section 3. Section 4 describes the methods of data extraction and synthesis that will be used to establish impact of emergency hygiene programs.

3. Selection of manuscripts

Manuscripts in this review meet specifications defined by the following PICOS protocol for inclusion criteria. Search methods for peer-reviewed and grey literature are described in section 3.2 and the selection process is explained in section 3.3.

3.1 Criteria for including studies in the review [PICOS]

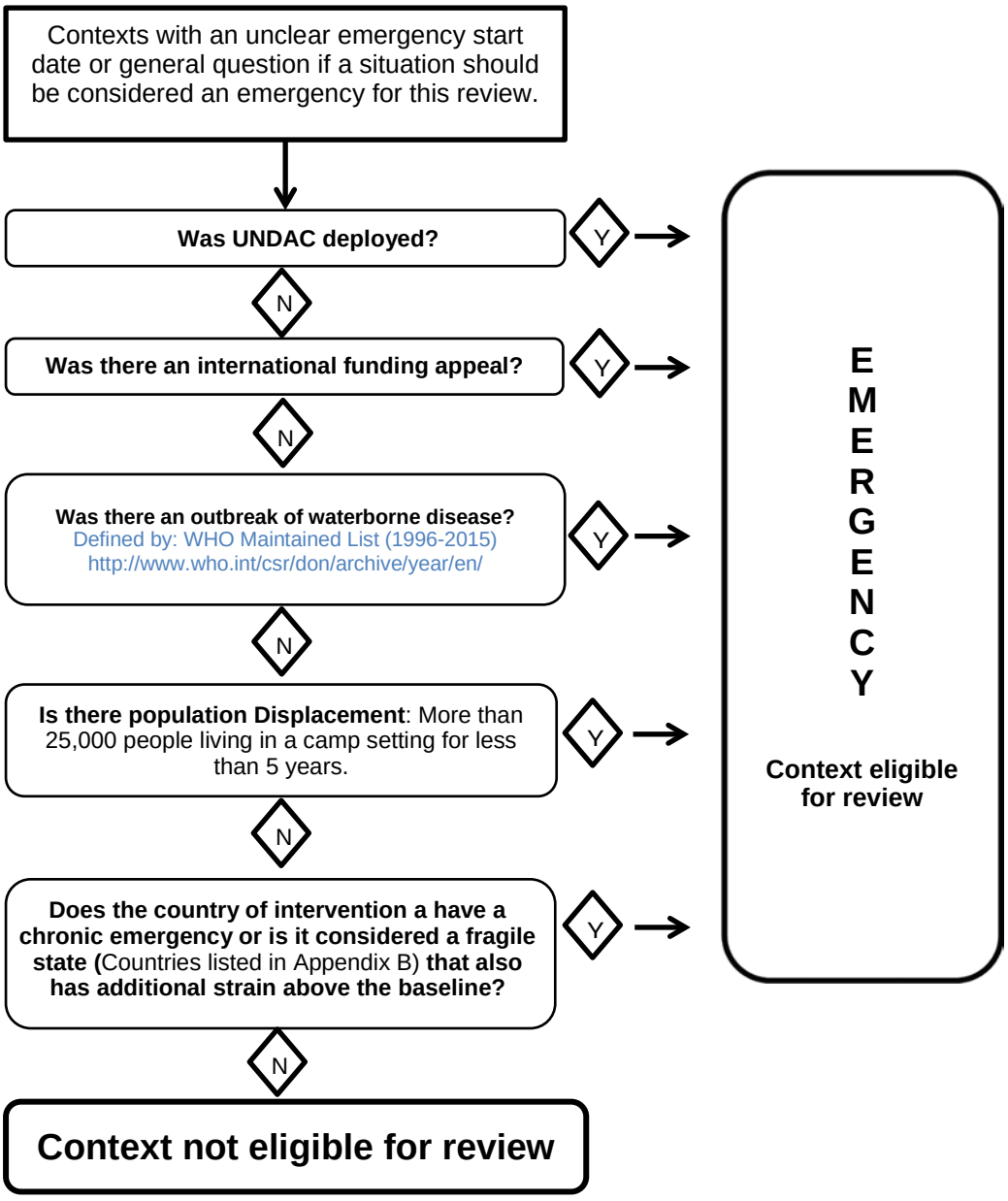
Defining a priori the Populations, Interventions, Comparisons, Outcomes, and Study Types (PICOS) increases the transparency as to how and why studies were selected. The PICOS variables for this review are described in detail below.

3.1.1 Populations

Populations considered in this review are persons in an emergency context that are also in a low-to-middle income country (LMIC) defined by the World Bank. All age, gender, and socio-economic demographics will be considered. For this analysis, an ‘emergency’ is defined as an event affecting a specific population that requires national or international assistance because local capacity is overwhelmed [32].

Identifying populations in an emergency can be straightforward, as in the case with an earthquake or tsunami, but can also be difficult to define considering a disease outbreak, or slow-onset emergencies like a drought that can take months or years to develop. Chronic and complex emergencies can also have several critical factors that make it difficult to define the type or timing of an emergency. To better identify populations in an emergency, a flow chart was developed to help classify emergency contexts (Figure B41). The flow chart is also intended to help define the onset of an emergency if the start date of an emergency is unclear.

Figure B41: Emergency decision tree



Source: Authors

3.1.2 Interventions

Inclusion for interventions fall into one of the eight interventions of interest: 1) hygiene promotion; 2) distribution of soap and/or hygiene kits; 3) environmental hygiene interventions; 4) source-based water treatment options; 5) distribution of household water treatment technologies;6) increasing water access; 7) installation of temporary or permanent latrines; and 8) distribution and management of latrine alternatives.

Only short-term hygiene interventions in emergency settings will be included. Short-term emergency interventions are defined as:

- Project length is less than 12 months; **AND**
- The intervention is within 12 months of a disaster.

The date of disaster for slow-onset, chronic, or complex emergencies without a clear start date is determined by the *most recent* event that defines the emergency in Figure B41. For example, a long established refugee camp in Kenya that would normally not eligible for review could have a sudden outbreak of Hepatitis E, which would then be eligible for review. Protracted emergencies are also not included in this review; however, the initial (12 months) or acute stage of a protracted emergency is eligible for review if it meets the other inclusion criteria.

Interventions designed as 'behavior change' will not be included in this review because it is outside the scope of emergency interventions. Behavior change is not an outcome that can be evaluated in less than one year. This is due to the significant period of time necessary to investigate the social, personal, and cultural constructs that lead users to change their behavior. Short-term adoption occurs when the project is ongoing, while behavior change implies a long-term shift in believe and action. A recent 3ie systematic review by Hulland et al. (2015) defines behavior change as:

> *"…sustained use [behavior change] is defined as the continued practice of a WASH behaviour and/or continued use of a WASH technology at least six months after the end of the project period."* [33]

This review is dedicated to the 'short-term' emergency response interventions that are antithetical to behavior change objectives. Alternatively, we focus on 'use of services' which evaluates the percent of the targeted population using the designed intervention during the emergency. Use of services highlighted in the causal chains and further explained in Section 3.4 below.

Given the wide variety of interventions, we will prioritize interventions more related to hygiene and use of services; this will include interventions #1, 2, 3, 4, and 5. Noting the interconnectedness and synergies of many interventions, we will include secondary interventions #6, 7, and 8 throughout our search and review to ensure thoroughness. If the information from the priority interventions is sparse, secondary interventions may be included in the final reporting.

3.1.3 Comparisons

As many relevant comparisons will be made to the best of ability of the data set. The eight interventions' impact and contextual factors will be compared with each other. Comparisons between intervention and control groups will be assessed for impact, as well as, comparisons between the three primary manuscript types (peer-review, agency papers, and grey literature). Timing of interventions, and other comparisons include factors such as: disaster type; geographical region; disasters

where people are displaced or not; grey literature compared to published literature; length of intervention; or complementary programing.

Cost-effectiveness comparisons will also be incorporated into the analysis. A full list of comparisons is found in Appendix B3: Anticipated comparisons; however, the available data will dictate the types of comparisons that can be made.

3.1.4 Outcomes

A study would be included in the review if it reported on at least one intermediate outcome or final impacts that corresponds to the three research questions in Section 2.

Intermediate Outcomes:

a) **Use of service:** Use of services is a general term that includes three specific definitions for: self-reported use, confirmed use, and effective use.

    a. Self-reported use is when a beneficiary reports the use of a product or event without additional verification. For example, self-reported use could be the recall of diarrhea episodes or daily use of a household treatment product. Self-reported use is often heavily biased.
    b. Confirmed use is when the evaluation tests, observes, or confirms in some way a product or service is used. For instance, testing free chlorine residual (FCR0 in household drinking water 'confirms' the use of a water treatment method regardless of what the beneficiary reports.
    c. Effective use is the percentage of households improving their environmental hygiene quality from contaminated to uncontaminated by using a particular intervention; it combines both methods of confirmed use (through FCR or microbiological testing) as well as self-reported the use of the intervention.

Final Impacts:

b) **Disease reduction:** Morbidity and mortality reductions are the ultimate impact of the interventions. Assessing both the intermediate and final outcomes of the interventions allows the research team to evaluate the critical gap on the casual chain between outcome and impact. Final outcome measures are likely limited to quantitative research with several potential measures that are often expressed as a comparison over time or with another group in the form of an odds ratio (OR) or risk ratio (RR). Prevalence is expressed as a percent (%) of the population with a particular disease, while incidence is a rate of new cases over a specified time period.

    a. Morbidity rates (OR, RR, or case rates);
    b. Mortality rates (OR, RR, or case rates);

c. Prevalence (%); or
d. Incidence rates (cases/time).

c) **Non-health outcomes:** The non-health related outcomes could be from qualitative or quantitative research. The subjectivity of thoughts or feelings through focus groups or household surveys may be assessed but difficult to verify or clearly express their true meaning. For instance, questions like, “Do you like the taste of your drinking water after using a certain treatment method?” or “Why do you wash your hands?” could be quantified through a percentage of households in a survey, but primarily serve as qualitative research valuable to understanding how or why some interventions could be better suited in some contexts over others.

a. Use of service (sustained difference in action by the population due to promotion, product input or context);
b. Quality of life and Psycho-social affects (i.e. populations felt safer, more time for other things, less discrimination);
c. User or agency preference of different interventions.

Contextual factors:

d) Contextual factors: Many factors can greatly influence the uptake and use of WASH interventions that are outside the typical outcomes and impacts. Geography, urban/rural/refugee setting, or presence of local NGO partners are examples of contextual factors that could greatly influence the design and impact of a WASH intervention. These will be assessed qualitatively and include:

a. World Bank regions
b. Use of local partners
c. Setting (urban/rural/camp)
d. Paying of community health worker
e. Timing of intervention (initial acute stage)

Economic Analysis:

e) Economic analysis: The outcomes collected for the economic analysis will be quantitative research and may include:

a. Cost-benefit analysis;
b. Cost-utility analysis;
c. Cost per beneficiary; or
d. Cost per DALY averted.

3.1.5 Study types

Due to the anticipated small amount of experimental evidence, all methodological designs are eligible for review (experimental, quasi-experimental, non-experimental, mixed-methods, and qualitative). Studies that include economic or cost analysis of emergency hygiene interventions will also be included. [34]

Economic or cost analysis data will be included as dedicated studies or if it is specified as a component of broader research. Economic analysis could be cost-benefit analysis, cost per beneficiary, or cost per DALY averted.

In lieu of the breadth of grey literature, we will specifically exclude: personal blogs, diaries, newspapers articles, magazine articles, and legal proceedings/court documents. Books and dissertations will not be specifically searched but may be included in the review. Also, systematic reviews that meet the inclusion criteria will not be included, but reference list will be collected for independent review.

Climate change may influence more frequent and severe weather, but the emergency response intervention remains focused the immediate flood, drought, or other disaster; thus climate change is outside the intended scope of review. We will record if studies identify climate change interventions in the context data collection, but it will not be a condition to include a study.

Research Question	**Includable study types**
a) What are the effects of short-term hygiene interventions on **use of service (e.g. use of soap, water treatment)** in emergency response situations? (quantitative analysis)	Experimental (RCT; Quasi-RCT), quasi-experimental (case control, cohort, regression discontinuity, difference-in-difference and propensity score matching) and non-experimental (cross-sectional, case reports, correlations, uncontrolled before-after) designs that allow for causal inference.
b) What are the effects of short-term hygiene interventions on **health-related outcomes** (i.e. morbidity and mortality) in emergency response situations? (quantitative analysis)	Experimental (RCT; Quasi-RCT), quasi-experimental (case control, cohort, regression discontinuity, difference-in-difference and propensity score matching) and non-experimental (cross-sectional, case reports, correlations, uncontrolled before-after) designs that allow for causal inference.
c) What are the effects of short-term hygiene interventions on **non-health related outcomes** (i.e. psycho-social, quality of life, behavior change) in emergency response situations? (quantitative analysis)	Experimental (RCT; Quasi-RCT), quasi-experimental (case control, cohort, regression discontinuity, difference-in-difference and propensity score matching) and non-experimental (cross-sectional, case reports, correlations, uncontrolled before-after) designs that allow for causal inference.
d) What contextual factors act as **barriers or facilitators** to implementation and uptake and the effectiveness of short-term hygiene interventions in emergency response situations? (qualitative analysis)	Any study (whether quantitative, qualitative or mixed-methods) will be eligible for inclusion regarding this question provided it contains relevant contextual data. However, We will exclude personal blogs, diaries, newspapers articles, magazine articles, and legal proceedings/court documents.
e) What is the **cost**-**effectiveness** of short-term hygiene interventions in emergency situations? (quantitative analysis)	Studies containing cost benefit, cost-effectiveness, cost per beneficiary or cost per DALY averted analysis.

3.2 Search methods for identification of studies

A comprehensive search strategy will identify published and electronic literature. Each intervention will have a unique search strategy. Sources will be searched using keywords appropriate to each intervention studied. For example, a keyword combination for household water treatment could be represented as: ('disaster*' or 'natural disaster*' or 'complex emergenc*' or 'emergenc*' or 'cholera' or 'outbreak') and ('household water treatment' or 'point of use' or 'point-of-use' or 'water treatment'). A complete list of keywords is included in Appendix B4: Keywords. Keywords will be searched in ten electronic databases, including:

- Cochrane Library
- Google Scholar
- IDEAS
- LILACs
- Ovid Medline (Pubmed)
- Web of Science
- Academic Search Premier (French)
- ARTFL-FRANTEXT (French)

ArticleFirst (French)We will work with Karen Vagts, a Tufts University librarian and information retrieval specialist, to finalize the search strings for the electronic databases. Additionally, the journals: Journal of Water and Health; Journal of Water, Sanitation, and Hygiene for Development; Disasters; Disaster Medicine and Public Health Preparedness; Prehospital and Disaster Medicine; and Waterlines will be manually searched for relevant manuscripts. For studies with a specified document date (e.g. date of publication), dates for inclusion will be 1995-2015, regardless of when the research took occurred. For example, a study carried out from 1993-1994 but only published in 1995 would be eligible for review. Searches will be conducted in the English, Spanish, and French; however, manuscripts in any language are eligible for review. Native speakers will be asked to volunteer their assistance in evaluating the eligible manuscripts not in English, Spanish, or French.

The identified limited number of quality peer-reviewed manuscripts increases the importance of unpublished grey literature. Grey data repositories, opengrey.org and greylit.org, will be searched in a manner similar to the peer-reviewed databases. A wide array of agencies will be approached through direct email solicitation and agency website searches (Appendix B5: List of websites and organizations for electronic searches), representative examples include:

- **UN Agencies / International Bodies:** Unicef, WHO, UNHCR, OCHA, ICRC, IOM
- **Government agencies/Donors:** CDC, USAid, OFDA, ECHO, DFID, HIF, LMIC websites related to emergency or disaster response
- **Development Banks:** World Bank, Asian Development Bank, African Development Bank
- **WASH Networks:** the WASH Cluster email list, the WASHPlus email list, WEDC

- **Private foundations:** The Bill and Melinda Gates Foundation, The Clinton Foundation
- **NGOs:** Action Against Hunger, Medecins Sans Frontieres, Oxfam, International Rescue Committee, Save the Children

Websites often have less search capabilities than electronic journals. To address this, we will work with the information retrieval specialist to customize the searches specifically for websites. Reference snowballing will also be completed, particularly in reaching out directly to authors of reports and authors in the reference list who might have additional unpublished information. Following the selection of studies (Section 3.3), references from the final included studies will be cross referenced and screened.

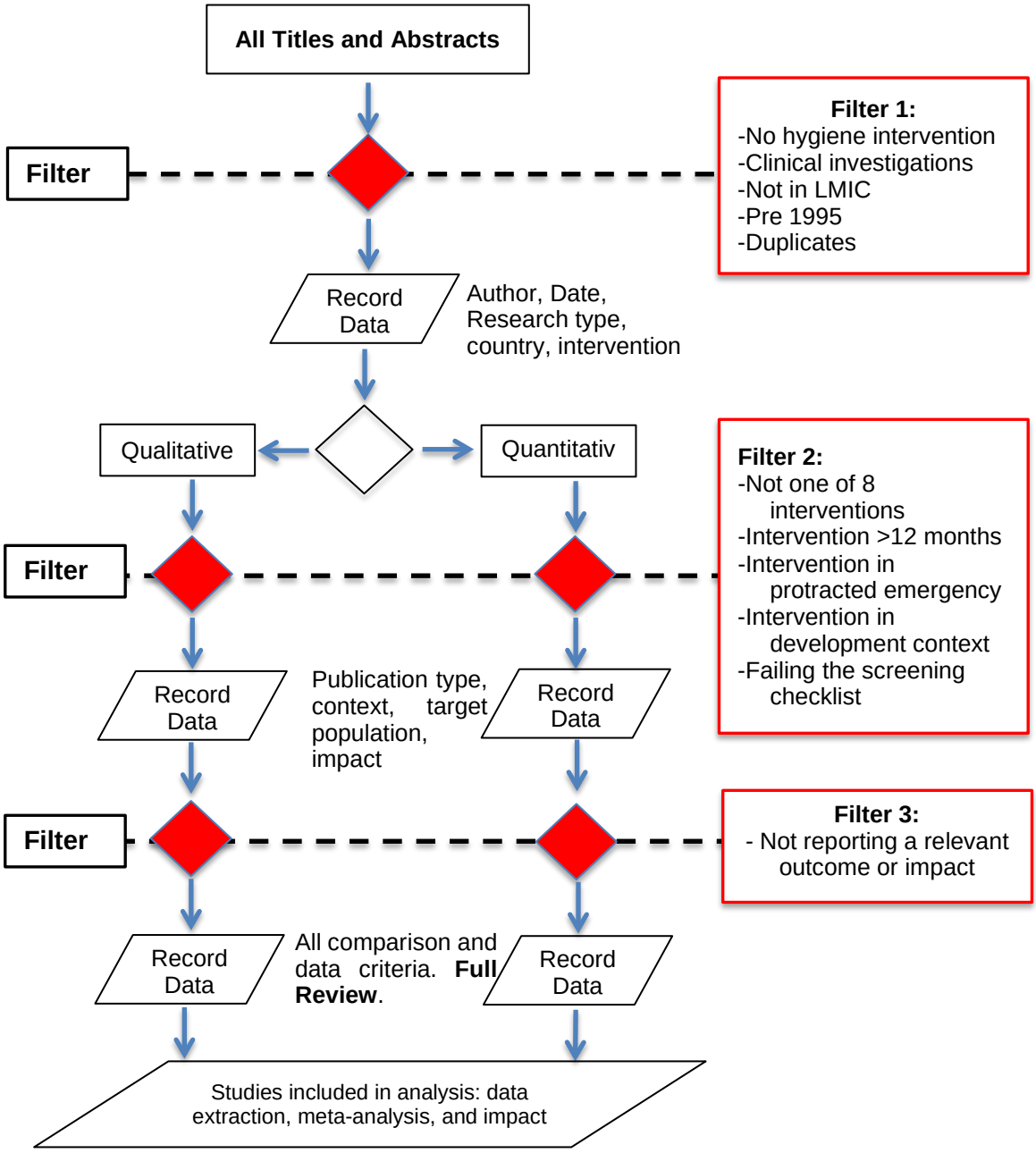
3.3 Selection of studies

The selection of studies will adhere to the principle standards of the Cochrane Intervention Reviews [35]. All gathered titles/abstracts will be numbered in sequence for identification to begin the three stage selection of studies. To achieve independent double screening after the initial title/abstract filter, two team members will review the manuscripts for stage 2 and 3 of the selection process. For stage 2, a research assistant and Mr. Yates will double screen the studies. On the final filter, one of the three hygiene experts will be the primary reviewer, with Mr. Yates acting as a secondary reviewer. A summary of the selection process is described in (Figure B42) with more detailed description of each stage below.

Filter 1: Filter 1 will exclude the following studies:

1) No water, sanitation, hygiene, environmental intervention (very liberal definition).
2) Clinical or hospital diagnoses will be eliminated because there is no intervention and non-communicable diseases will be eliminated because it is outside the scope.
3) Not implemented in a LMIC as defined by the World Bank. This will exclude studies in the United States of America, Canada, Western Europe and other developed nations.
4) Studies published before 1995.
5) Duplicates.

Figure B42: Summary flow diagram for study selection process



Filter 2: The downselected titles/abstracts will be coded only by type of most relevant hygiene intervention then reviewed by a research assistant and Mr. Yates for more stringent criteria. Studies will be excluded if any of the following are true:

1) Study not evaluating one of the eight types of hygiene interventions;
2) Interventions of more than 12 months.
3) Interventions in a protracted or chronic emergency.
4) Interventions in a development context.
5) Studies that fail the checklists in Appendix B5. Short checklists for various quantitative studies, as well as, qualitative and economic studies

will help identify weak studies without a full review. Each of these criteria will be coded in the master Excel spreadsheet.

Abstracts will be included in the full analysis if **one** or **both** reviewers support inclusion. Full studies will be downloaded then reviewed by Mr. Yates and one of the hygiene experts (Table B34).

Table B34: List of Reviewers for Each Hygiene Intervention (Filter 3)

Hygiene Intervention	First Reviewer	Second Reviewer
Well Rehabilitation	Dr. Lantagne	Mr. Yates
Source Based Water Treatment	Dr. Lantagne	
Household Water Treatment	Dr. Lantagne	
Hygiene Promotion	Ms. Vujcic	
Hygiene Kit Distribution	Ms. Vujcic	
Environmental Hygiene	Ms. Vujcic	
Latrine Installation	Dr. Joseph	
Latrine Alternatives	Dr. Joseph	

Filter 3: The two reviewers will evaluate the studies to independently assess the reported outcome, impact, or assessment that is relevant to a hygiene intervention OR qualitative information OR economic analysis.

During this process, the research team will assess potential for additional confounding factors, adherence to the scope of review, inconsistent outcomes or impact, unjustified conclusions and discuss any potential concerns with each other. Both reviewers must approve study for final inclusion. Any discrepancy will be determined by a third reviewer.

We do not expect an overwhelming amount of relevant studies that would be included in the review; however, given that possibility, we will remove manuscripts with the highest risk of bias score, Annex G.

If the revised number of relevant studies eligible for inclusion remains greater than 200, we will discuss possible options with 3ie and our advisory committee.

4. Data extraction and processing

Once the manuscripts have been down selected with consensus from all reviewers, data will be gathered for comparison and data extraction. A full list of criteria collected is listed in Annex A. The comprehensive list of criteria will establish the underpinnings for comparisons and appreciation of heterogeneity of the studies.

4.1 Coding

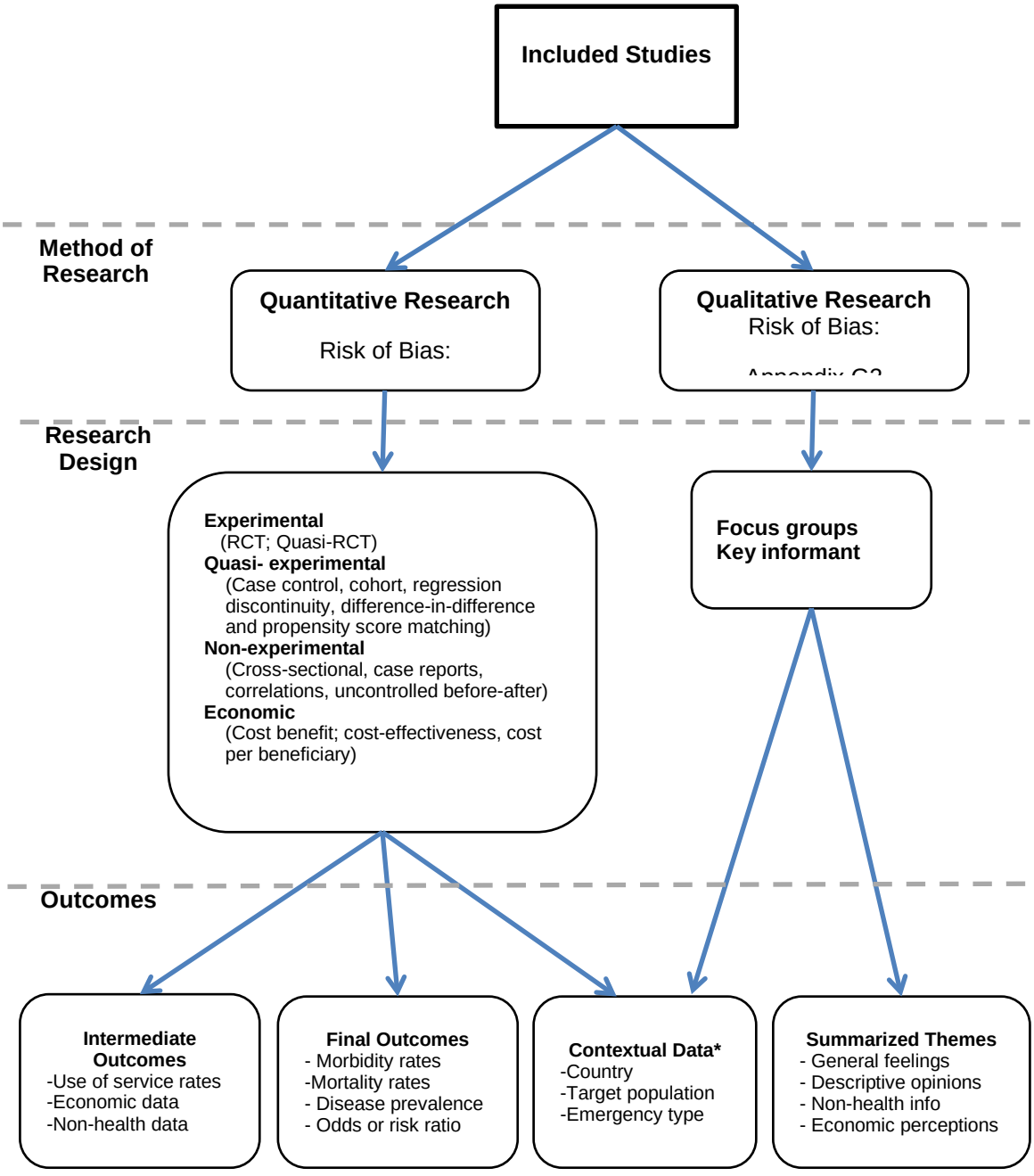
Research assistants and the review team will code studies included in the review. A team of two to three people will complete the coding. Initially, the research assistants and Mr. Yates will review and code at least 10 studies as a group to establish consistency. Then the research assistants and Mr. Yates will code the

remaining studies individually. Outcome measures will be double screened for accuracy by a member of the review team according to their expertise.

Information recorded from each manuscript is based on the Waddington et al. (2012) protocol and will describe: author and publication details, type of intervention, context of the intervention, study design, study quality, effect estimation, intermediate outcomes, qualitative information, economic outcomes, and final outcomes. Detailed criteria from all included studies (quantitative, qualitative, or economic) will be extracted into a master list in Microsoft Excel (2010).

From the initial screening, studies have been sorted into quantitative or qualitative research. Separating the studies by research method allows the data collection to address the differences in the types of research. Figure B43 is a descriptive flow chart of the types of studies expected in this review, with the different outcomes from the various study designs.

Figure B43: Source of Data Retrieval Flow Diagram



*Contextual data can originate from data from either qualitative or quantitative research designs

4.2 Quality appraisal

The risk of bias tools are also separated by research design: quantitative and qualitative. Each tool summarizes a study into ‘high risk,’ low risk,’ or ‘unclear.’ The assessment will be double screened by a member of the review team and a research assistant for quality assurance..

Quantitative appraisal

To determine the risk of bias in quantitative studies (experimental, quasi-experimental, and non-experimental), an assessment tool was developed, based on the Cochrane Handbook Risk of Bias Tool while also drawing heavily on the structuring and description by Baird et al (2013). We will assess the risk of bias through five categories: 1) selection and confounding; 2) spillover and contamination; 3) incomplete outcome; 4) selective reporting; and 5) other bias. Similarly described by Baird et al. [36]:

Selection and confounding: addresses the issue of program design. Allocations, selection of beneficiaries, targeting, and matching concerns are represented in this category.

Spillover and contamination: addresses the issue of spillovers from the treatment to the control group. Not controlling for outside factors or additional interventions in the area also have spillover effects.

Incomplete outcome: addresses the issue of whether analysis of all relevant outcomes was reported or whether there appears to be selection in reporting. Loss to follow-up or missing data can reduce the power of the research design as well as potentially introduce bias with unequal loss of sample between groups.

Selective reporting: authors utilize a credible analysis method and report on all intended outcomes. Some research is funded by manufacturers of products, which can lead to selective reporting of only favorable outcomes.

Other risks of bias: this category is to any number of other risks of bias present in the report. Self-reported data is of particular concern for our analysis. Also, retrospective baseline data, data using inappropriate methods, changing follow-up methods or procedures are examples of other potential biases. This is the most subjective of the five categories.

Each study will be scored across the five categories as ‘Low Risk,’ ‘High Risk,’ or ‘Unclear.’ The overall determination for the risk of bias for that study is assessed with the table below, summarizing the five categories into a single quality assessment for each qualitative study.

Table B35: Risk of Bias Summary

Risk of Bias	‘Low Risk’ Assessed in Categories
Low Risk	4-5 ‘Low Risk’ Scores
Medium Risk	3 ‘Low Risk’ Scores
High Risk	1-2 ‘Low Risk’ Scores

Qualitative appraisal

The qualitative assessment has been adapted from Spencer et al. 2003 “Quality in Qualitative Evaluation: A Framework for assessing research evidence” [37], [38]. The quality assessment is evaluated on four appraisal questions. There is no clearly objective rule for determining bias among qualitative studies. The guiding questions will be used by the research team to help establish core research questions that should be evaluated; however, professional judgment is necessary to make the assessment. Qualitative experts are on the research team and advisory board to ensure rigorous standards, consistency, and transparency.

Each study will be scored across the four appraisal questions categories: 1) design; 2) bias; 3) data collection; and clarity of finding as ‘Low Risk,’ ‘High Risk,’ or ‘Unclear.’ The overall determination for the risk of bias for that study is assessed with the table below.

> **Design:** The overall design of the research is considered, especially the targeting of the research population.
>
> **Bias:** How representative is the research population compared and are there obvious biases that affect the findings?
>
> **Data Collection:** How was the data collected, recorded (audio, video, transcribed)? Who collected the information?
>
> **Clarity of findings:** Do the conclusions match what could be achieved from the study design? Is there an inherent logic to the conclusions?

Table B36: Risk of Bias Summary

Risk of Bias	‘Low Risk’ Assessed in Categories
Low Risk	3 or more ‘Low Risk’ Score
Medium Risk	2 ‘Low Risk’ Scores
High Risk	1 or less ‘Low Risk’ Score

Economic appraisal

Economic assessments can be the primary purpose of the study or a component of a larger study. In either case, the economic review tool is a framework to assess the validity of economic information. The economic assessment tool (Appendix G3) is to be used in addition to the quantitative or qualitative tools found in Appendix G1 or G2. It was adapted from the CASP Economic Checklist [39]. Examples of economic studies could be cost-benefit or cost-effectiveness analysis. Simple cost statements or budget analyses will be recorded as contextual information, unless some formal economic evaluation was carried out.

4.3 Measures of treatment effect

Data will be collected from the selected studies including: sample size, 95% confidence intervals, and effect sizes. Where appropriate, the standardized mean difference will be determined for continuous variables, while odds ratios or risk ratios will be used for dichotomous variables. Impact will be described as a difference between groups (i.e. difference of means) or a ratio (i.e. risk ratio or odds ratio). Often reported in health studies, ratios less than 1.0 represent a protective effect, while ratios greater than 1.0 represent an increased risk. Length of follow-up will be extracted for all outcomes. Data transformations will be conducted as necessary according to the most appropriate methodology.

Studies with that have effect sizes with more precision will have more influence for the overall effect in the meta-analysis by using the 1/(standard error^2) for random effects variance. Additionally, small sample size correction and robust standard errors will be used when necessary as described by Baird et al [36].

4.4 Missing data

In the case of missing data, primary authors will be asked to supply missing information. Where no additional data can be retrieved, we will make use of response ratios as outlined by Waddington et al. (2012) and further described by Borenstein et al. (2009)[40], [41]. The response ratio measures the change between intervention and control groups by a simple proportion, similar to a risk ratio.

$$R = \frac{X_t}{X_c}$$

where R is the response ratio effect, X_t is the mean outcome of the intervention group, and X_c is the mean control group [41]. The response ratio described above may be used to compare different study designs with similar outputs. Waddington (2012) describes that due to the response ratio comparing effect only, difference-in-difference designs or propensity scoring designs can be compared side-by-side. Studies without control groups or a dataset where a response ratio cannot be used, the study may be excluded from analysis with consensus from the review team.

For qualitative research, we will also request the authors to provide primary data transcripts of the key informant interviews, focus group discussions, or other data collected. Qualitative studies must have clear study objectives related to outcomes listed in 3.1.4 and meet the timeframe and setting definitions described in section 3 before requesting additional information. Transcripts will only be searched for specified outcomes, serving as key words for thematic groupings. All reasonable attempts to include missing data will be made; however, given the timeframe allotted for analysis and reporting, this may not be possible. If missing data is thought to jeopardize the deliverables, the studies will be documented, but removed from analysis after discussion with the advisory board and 3ie.

4.5 Unit of analysis issues

Issues can arise when studies collect randomized information at an individual level (i.e. household) through geographic clusters (i.e. village). In situations where differences between the clusters are greater than differences within a cluster, the confidence intervals are incorrectly small (Waddington et al. 2012). This is a result from violating the assumption that comparisons within the cluster (village) are independent. Studies that do not fully control for this clustering effect have a unit analysis error that will be corrected. Standard error and confidence intervals will be adjusted with original data or an intra-cluster correlation coefficient of 0.02 will be used to make corrections.

4.6 Heterogeneity assessment

Heterogeneity will be assessed with up to three methods: Cochrane's Q, Tau^2 and I^2. Generally, more weight will be given to Tau^2 and $I^{2;}$ however, rationale for establishing or rejecting heterogeneous conclusions will be stated when tests contradict. In interventions with sufficient data, we will complete sub-group analysis, stratifying the data by different relevant groupings in accordance with the Cochrane Collaboration and Campbell Collaboration guidance and standards [35]. Example groupings could be by: disaster type; geographical region; disasters where people are displaced or not; grey literature compared to published literature; length of intervention; or complementary programing.

4.7 Subgroup analysis

Subgroup analysis will follow the PROGRESS-Plus criteria. These subgroups comprehensively differentiate subsets of the general population that are often vulnerable or discriminated against. A portion of the data collection variables are dedicated to PROGRESS-Plus categories; however, given the type of research carried out in emergencies, it is expected that only age and gender subgroups are expected for subgroup analysis. Contextual factors from qualitative data will be included to understand the variation in results, as research is clear that intermediate outcomes vary significantly between contexts. If additional subgroups become apparent, we will provide further analysis. We will clearly state which manuscripts are included in each stratification group.

4.8 Method of synthesis

We will synthesize outcomes across programs, considering contextual factors, timing of interventions, and training provided to recipient population. Stata statistical software will be used for data analysis.

Meta-analysis techniques (e.g. weighted average, pooled effect, forest plots, and funnel plots) for outcome assessments will be pursued if sufficient experimental design studies meet study inclusion criteria. Forest plots will be most useful to display the range of effect sizes across the findings [35], [42]. Difference in the timing of interventions could be a unique analysis regarding the time between the onset of a disaster and different interventions, with effect size presumably changing over time. We would also like to assess the length of time before a

particular outcome or impact is achieved; however, this is not expected to be possible with most interventions of interest. Improvements in water quality will likely be one area where significant synthesis can occur. Before synthesis, we will critically evaluate the quality of water quality testing in each of the studies to determine if *E. coli* or thermotolerant coliform data can be included in the calculations. Case-control data, particularly from cholera outbreaks, is another likely source of data that can be statistically analyzed.

The response ratio described above may be used to compare different study designs with similar outputs. Waddington (2012) describes that due to the response ratio comparing outcome effects only, some quasi-experimental designs can be compared side-by-side. We will also highlight outcome effect consistency to determine expected impact and relevance. Consensus among the review team with oversight from the Advisory Board will determine a level of confidence in each intervention as low/moderate/high to help guide policy and future research.

Qualitative Synthesis

We will combine related qualitative research material into file sets, and re-code data (if necessary) using qualitative analysis program Atlas.ti. We will review the codes to develop themes that reflect the gaps in the causal chain and then develop qualitative result summaries based on the themes. Direct quotations will be used to highlight key results. Qualitative research will be used to evaluate the gaps in the casual chains through factual analysis.

Economic Synthesis

Cost-effectiveness will be assessed using the range of 1-3 times the per capita income for the country of intervention [43]. Studies that have economic or cost-effectiveness outcomes, will be assessed with the CASP economic checklist and the WHO Manual for Economic Assessment of Drinking Water Interventions to help synthesize data [39], [44]. Results will be standardized to common metrics, such as $/DALY averted or cost per user, and compared across interventions. Costs will be normalized and converted to 2015 USD. Simple costs per beneficiary metrics will be considered high risk, unless there are clear descriptions about what is included in the analysis.

Integrated synthesis

This comprehensive review makes use of qualitative, quantitative, and contextual factors. By assessing all three data sources, an integrated synthesis of the causal chain can be evaluated. We will combine and contrast data from all three data sources to have a more robust understanding of the emergency hygiene interventions. This evaluation will shed new light on how the humanitarian response community views the emergency hygiene causal chain, potentially influencing how future programming is implemented or guiding future work in the sector.

4.9 Dependency of studies

The unit of observation for this review is on the intervention level, thus we will construct one effect size for each intervention in each study according to the outcomes of interest. There will likely be the case where multiple studies report on similar interventions, but from different NGOs in a particular emergency, or similar interventions by one NGO but in different emergencies in a single study; in either case, both studies will be assessed. In the situation where an NGO report is followed by a white paper or journal article, we will include only one study with the lowest risk of bias. Similarly, when dissertations and journal articles overlap in content, only one study will be included. If the risk of bias is the same, then inclusion will be made on if it was or to the level of being peer-reviewed.

Where possible, sub-groups will be analyzed by outcomes. it is likely that we will *synthesize* and *summarize* the same data set several times, following the methodology described by Baird et al. 2013 [36].

Baird et al. describes *synthetic effects* from non-independent data; studies that use the same populations with several different interventions or outcomes. Synthesis is simply the average effect size, with the correlation coefficient assumed to equal 1.0, representing the variance of the mean. *Summary effects* are when studies are independent and subgroup effect size is often reported. A random effects model will be used to combine effect size for independent studies. Forest plots will be utilized for graphic representation of the summary data. Replication of research with the same population will be included and analyzed independently.

Where the studies are assessed as independent with sufficient information, subgroup analysis for meta-analysis will be carried out. When individual studies report on multiple outcomes, we will attempt to summarize one outcome from the study according to each of our outcomes of interest. In situations where the same outcome is reported with multiple modes of data collection (e.g. self-reported diarrhea and scientific assessment) both measures will be collected. Where multiple interventions are carried out simultaneously and assessed together, secondary analysis will assess the difference in effect size of individual interventions, indicating potential synergies.

4.10 Sensitivity analysis

Sensitivity analysis will assess the risk of bias, study design type, treatment effect, and possible outliers. Sensitivity will be assessed by comparing conclusions with and without ‘high risk’ studies. Self-reported studies will also be stratified against confirmed use studies to assess the sensitivity of results with respect to reporting bias. Additional, hard cut offs for exclusion criteria are minimized, but if required, the researchers will discuss and agree upon an excepted level. Rational for inclusion or exclusion of a study will be recorded to facilitate the sensitivity analysis to ensure all appropriate studies are included in the analysis.

4.11 Summary of findings

The quality of evidence assessment for this review will be summarized with the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach. GRADE is outlined in the Cochrane Handbook in chapter 12 as a way to evaluate summary findings with respect to effect size, research design, and bias. A summary table for each of the interventions and subgroups will be created with expected effects and confidence in the results. Additionally, forest plots will be used to display effect sizes graphically, and funnel plots will display potential for publication bias.

5. Acknowledgements

We would like to thank 3ie for the opportunity and funding to conduct this research. In particular, we would like to thank Phillip Davies, Hugh Waddington, and John Eyers for their technical advice leading up to this protocol, as well as Daniel Phillips for coordinating our research.

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7. Review team

Name:	**Dr. Daniele Lantagne**
Title:	Assistant Professor
Affiliation:	Tufts University
Address:	Medford, MA, United States
Email:	daniele.lantagne@tufts.edu

Name:	**Travis Yates**
Title:	Research Assistant
Affiliation:	Tufts University
Address:	Medford, MA, United States
Email:	travis.yates@tufts.edu

Name:	**Dr. Myriam Leandre Joseph**
Title:	Physician / Consultant
Affiliation:	Independent
Address:	Port au Prince, Haiti
Email:	mimileandre@hotmail.com

Name:	**Jelena Vujcic**
Title:	Research Scientist / Consultant
Affiliation:	Independent
Address:	Surf City, NC United States
Email:	jelenavujcic@gmail.com

8. Declarations of interest

We are not aware of any conflicts of interest that would affect the methods or results presented herein. The research team is also carrying out another systematic review with the Humanitarian Evidence Program with similar methodology for WASH interventions in disease outbreaks, but will not influence the timeline or outputs of this review.

9. Roles and responsibilities

The development of the protocol was primarily carried out by Travis Yates with guidance from Daniele Lantagne and contributions from Myriam Leandre Joseph and Jelena Vujcic. Inclusion of manuscripts will be managed by Travis Yates with extensive collaboration by Daniele Lantagne, Myriam Leandre Joseph, and Jelena Vujcic. Data extraction and analysis will be done by Travis Yates and Daniele Lantagne. Final report writing will be led by Travis Yates with input from Daniele Lantagne, Myriam Leandre Joseph, and Jelena Vujcic.

10. Preliminary timeframe

Start date is 1 June, 2015

End date: 31 May, 2016

11. Plans for updating the review

The anticipated limited amount of published data indicates slow cycles of new data. Authors will remain up to date in newly published literature and maintain contacts established through this research for unpublished reports. On March 30, we will re-run electronic searches in peer-reviewed databases to ensure the most relevant data is included in our analysis.

Appendix B1: Data collection variables

General Information	
First Author	Surname
Year of Publication	(YYYY)
Publication Type	Journal Article Working Paper Book Unpublished Peer Reviewed Unpublished Non-peer Reviewed UN Report (Distributed) NGO Report (Distributed) Other Agency (Distributed) UN Report (non-Distributed) NGO Report (non-Distributed) Other Agency (non-Distributed)
Funder of Intervention	CDC USAid OFDA Unicef UNHCR WHO BMGF HIF DFID ECHO Private Funds Manufacturer Local Government Other Not Reported
Author Affiliation	Employee of intervening body Non-employee of intervening body Not Reported

Intervention Design	
Implementer (primary agency who received majority of original funds)	International NGO Local NGO UN agency / IFRC / ICRC / IOM Local government Military Other
Intervention Partner	Direct with no local partner Direct and with local partner Indirect with local partner
Target Group	Refugee IDP Men Women Children (<5)

	School age children (5-18 years) Elderly General Population Not Reported
PROGRESS-Plus	Place of Residence Ethnicity Occupation Gender Religion Education Social Capital Socio-economic position Age Disability Sexual orientation Other vulnerable groups
Intervention **(Multiple Answer)**	1) Hygiene promotion 2) Distribution of soap and/or hygiene kits 3) Environmental hygiene interventions 4) Source-based water treatment options 5) Distribution of household water treatment technologies 6) Increasing water access 7) Installation of temporary or permanent latrines 8) Distribution and management of latrine alternatives

Intervention Design (continued)		
Combination Intervention	Water and Hygiene Water and Sanitation Sanitation and Hygiene Water, Sanitation, and Hygiene	
Non-WASH Synergies	Nutrition and WASH Health and WASH Shelter and WASH Other sector and WASH	
Distribution Component	Yes / No / Unclear	
	if yes to above question **(Multiple Answer)**	Soap Bucket/jerrycan Personal hygiene items Household cleaning Water filter HWT items Cooking supplies Other NFI or CFI materials

Education (Promotion or Behavior change) Component	Yes / No / Unclear	
	if yes to above question **(Multiple Answer)**	Community Household School Radio Other Combination
Promoter Paid	Yes / No / Unclear	
Complementary Programs to Emergency Hygiene Intervention **(Multiple Answer)**	No Yes – Health Yes – Nutrition Yes – Shelter Yes - other	
Reference to climate change or climate adaptation	Yes / No / Unclear	

Context		
Global Assessment	Yes / No	
Multi-country	Yes / No	
Country	Specific country/countries N/A	
Region	Sub-Saharan Africa Middle East and North Africa Central Asia South Asia East Asia and Pacific Latin America Caribbean and South America non-LMIC	
Emergency	Flood Drought Outbreak Earthquake Tsunami Conflict Complex	
Disease Outbreak Risk	Yes / No / Not specified	
	if yes to above question **(Multiple Answer)**	Cholera Typhoid Other waterborne disease Other disease risk
Displacement	Yes / No / Unclear	
Camp Setting	Yes / No / Unclear	

Timing	
Intervention Period	(MM/YY – MM/YY)

Time from Onset of Disaster	# of months
Length of Intervention	# of months
Continuation of Intervention Beyond Initial Intervention	Yes / No / Unclear
Displacement	Yes / No / Unclear

Study Design				
Study Type **(Multiple Answer – economic or mixed methods)**	Quantitative RCT / quasi-RCT Case-control Cohort Cross-sectional Non-experimental	Mixed-Methods	Qualitative	Economic
Microbiological testing	Yes / No / Unclear			
Comparison Groups	Yes / No / Unclear			
Purpose of Manuscript	Baseline Intermediate Final Impact Rapid assessment Annual study Global assessment Unclear			
Method of Allocating Groups	Random / Systematic / None / Not Applicable			
Sample Size				
Sample Attrition	Yes / No / Minimal			
Contamination From other interventions	Yes / No / Minimal			

Quantitative Study Quality (Appendix B6)	
Selection Bias and Confounding	High Risk / Low Risk / Unclear
Spill-over and Contamination	High Risk / Low Risk / Unclear
Incomplete Outcome	High Risk / Low Risk / Unclear
Selective Reporting	High Risk / Low Risk / Unclear
Other Biases	High Risk / Low Risk / Unclear

Qualitative Study Quality (Appendix B6)	
Sample design/target selection of cases/documents?	High Risk / Low Risk / Unclear
Basis of evaluative appraisal?	High Risk / Low Risk / Unclear
How well was the data collection carried out?	High Risk / Low Risk / Unclear
Clarity in reporting and findings?	High Risk / Low Risk / Unclear

Outcomes and Impact		
	Effect Estimation	
	Unadjusted	Adjusted
Use of Service		
Economic Impact/Data		
Disease Impact (Morbidity, Mortality, Prevalence, Incidence)		
Non-Health Related Outcomes		
Environmental Impact (Climate Change)		
Additional Context Information Not Captured in Other Categories		

Appendix B2: Countries likely to have an emergency for review

The Fund for Peace Fragile States Index Peace was used to identify countries that have a low capacity to adequately respond to disasters[45]. Out of a possible indexed score of 120, the countries listed below scored above 90, corresponding to 'Alert,' 'High Alert,' or 'Very High Alert' status in either 2006, 2010, or 2014. Then, a list of countries with chronic emergencies, as defined by the UN Food and Agriculture Organization (FAO) [46], was overlaid to define priority 1 and priority 2 countries. *Priority 1* countries are on **both** the Fragility Index and chronic emergency list as a likely context for what we define as an 'emergency eligible of review.' Of the 22 countries on the FAO chronic emergency list, 20 (91%) were also on the Fragility Index. *Priority 2* countries may be less clear, but are likely to be considered an emergency with justification from the reviewer. This list is intended to help *identify* emergencies for the selection of studies, not list countries with emergencies.

Priority 1 Countries:

Countries listed on the Fragility Index **and** on the FAO chronic emergency list

Afghanistan	Iraq
Burundi	Kenya
Central African Republic	Liberia
Chad	North Korea
Congo (D.R.)	Sierra Leone
Cote d'Ivoire	Somalia
Eritrea	South Sudan
Ethiopia	Sudan
Guinea	Uganda
Haiti	Zimbabwe

Priority 2 Countries

Countries listed on the Fragility Index **or** on the FAO chronic emergency list

Angola	Myanmar
Bangladesh	Nepal
Burkina Faso	Niger
Cameroon	Nigeria
Colombia	Pakistan
Egypt	Rwanda
Georgia	Sri Lanka
Guinea Bissau	Syria
Iran	Tajikistan
Kyrgyzstan	Timor-Leste
Lebanon	Uzbekistan
Malawi	Yemen
Mauritania	

Appendix B3: Anticipated comparisons

Geography	LMIC Region
	Fragile States Index
	Continent
Population	Gender
	Age
	PROGRESS-Plus criteria
	Refugee/IDP/ local population
Context	Emergency type
	Complimentary programming
	Intervention type
	Disease type
	Cost-effectiveness
Program	Intervention type
	Hygiene promotion components
	Self-reported data
Timing	Time since onset of disaster
	Time to impact
	Length of intervention
	Continuation of intervention
Source	Journal/Agency/Grey
	Donor
	Agency type

Appendix B4: Keywords

General:
emergency
complex
crisis
humanitarian
aid
disaster
natural disaster
outbreak
emergency response
acute
non-acute
protracted
refugee
IDP
internally displaced
entrapped
low income country
middle income country
LMIC
diarrhea
diarrhoea
waterborne diseases
disease burden
cholera
disease risk
disease reduction
DALY
mortality
morbidity
prevalence
evidence
effectiveness
cost effectiveness
efficacy
WASH
water
water quality
water quantity
sanitation
hygiene
promotion
quality of life
physco-social
use of service

effective use

Water Access:
rehabilitation
cleaning
source
protected
unprotected
improved
unimproved
tankering

Source-based treatment:
chlorine
alum
Dispenser
HTH
well chlorination
bucket chlorination
pot chlorination

HWT:
PUR
aquatab
bottled water
SwS
safe water system
chlorine solution
HTH
sodis
filter
alum
flocculation
chlorine
water treatment
HWT

Handwashing promotion:
hygiene
handwashing
hand-washing
promotion
community health worker
health worker
promoter
MHM

menstruation health management
CLTS
Community led total sanitation
CATS
Community approach to total sanitation

Distribution of soap/hygiene kit:
soap
hygiene kit
distribution
NFI
non-food item
CRI
core relief item
Cash distribution

Environmental hygiene:
rubbish collection
refuse collection
trash collection
environmental
community plan
spraying

Appendix B5: List of websites and organizations for electronic searches

Agency reports and grey literature will be an important data source; thus, we have listed known agencies and websites that are likely to have manuscripts relevant for our review. In situations where websites do not have a searchable database or listed publications, direct solicitation of contacts from the organization will be made. Also, websites for countries listed in Appendix B2 will be searched for emergency response and disaster related content.

Type of Organization	Name	Website
UN Agencies	Unicef	http://data.unicef.org/
	WHO	http://www.who.int/gho/database/en/
	UNHCR	http://www.refworld.org/publisher,UNHCR,RESEARCH,,,0.html
	OCHA	https://www.humanitarianresponse.info/en/applications/tools/category/document-repository
International Bodies	International Committee of the Red Cross Red Crescent (ICRC)	https://www.icrc.org/eng/resources/library-research-service/
	International Federation of the Red Cross Red Crescent (IFRC)	http://www.ifrc.org/en/publications-and-reports/evaluations/
	International Organization for Migration (IOM)	http://publications.iom.int/bookstore/index.php?main_page=index&language=en
Development Banks	World Bank	http://data.worldbank.org/
	Asian Development Bank	http://www.adb.org/data/main
	African Development Bank	http://www.afdb.org/en/knowledge/statistics/data-portal/ and http://www.afdb.org/en/knowledge/statistics/open-data-for-africa/
Research Groups	Humanitarian Innovation Fund (HIF)	http://www.elrha.org/hif/innovation-resource-hub/
	EM-DAT The International Disaster Database	http://www.emdat.be/database
	ELRHA	http://www.elrha.org/
	3ie	http://www.3ieimpact.org/evidence/systematic-reviews/ and http://www.3ieimpact.org/en/evidence/impact-evaluations/impact-evaluation-repository/
	Cochrane Collaboration	http://community.cochrane.org/editorial-and-publishing-policy-resource/cochrane-database-systematic-reviews-cdsr

Type of Organization	Name	Website
Government Bodies	USAid	http://www.usaid.gov/data
	OFDA	See EM-DAT
	DFID	http://r4d.dfid.gov.uk/
	ECHO	https://euaidexplorer.ec.europa.eu/SearchPageAction.do
	CDC	http://www.cdc.gov/surveillancepractice/data.html
International Networks	WASH Cluster email list	Personally maintained list
	WASHPlus email list	Personally maintained list
	RedR	http://www.redr.org.uk/
	reliefweb	http://reliefweb.int/topics/wash
	Emergency Environmental Health Forum	Personally maintained list
	ODI	http://www.odi.org/search/site/data
	Humanitarian Practice Network	http://www.odihpn.org/hpn-resources
	Humanitarian Policy Group	Part of ODI
	CDAC Network	http://www.cdacnetwork.org/tools-and-resources/
	WEDC	http://wedc.lboro.ac.uk/knowledge/notes_emergencies.html
	Humanitarian Data Exchange	https://data.hdx.rwlabs.org/
NGO	Action Against Hunger (ACF)	http://www.actionagainsthunger.org/technical-surveys/list
	Care International	http://www.care.org/
	International Rescue Committee (IRC)	http://www.rescue.org/
	Oxfam	http://www.oxfam.org.uk/
	Doctors Without Borders (MSF)	http://www.msf.org/reports
	Save the Children	http://www.savethechildren.org/site/c.8rKLIXMGIpI4E/b.6153061/k.7E4A/Publications_and_Reports.htm
	Norwegian Refugee Council (NRC)	http://www.nrc.no/?aid=9137113
	Danish Refugee Council (DRC)	http://drc.dk/home/
	Samaritan's Purse	http://www.samaritanspurse.org/
	Medair	http://relief.medair.org/en/
	World Vision	http://www.worldvision.org/
	Catholic Relief Services	http://www.crs.org/publications/
	PATH	http://www.path.org/publications/list.php

Appendix B6: Screening checklists

Screening checklists are intended to help the reviewer identify key aspects of a study without a full review. Screening checklists are used at the second of three filters during the abstract assessment. Each of the key study designs has a screening checklist that is described below. The study is rejected if 'no' or 'unclear' is scored in both screening questions for any of the checklists. Full assessment criteria are in Appendix B7.

B6.1: Experimental screening checklist

Questions for the experimental screening questions were adapted from Waddington et al. (2012) protocol [40].

Experimental Study Design Questions	**Yes / No / Unclear**
1. Was the random allocation appropriate?	
2. Is the sample size adequate for comparisons?	

B6.2: Quasi-experimental screening checklist

The quasi-experimental questions were adapted by Cochrane and CASP evaluation tools for cohort and case-control studies[48], [49].

Quasi-experimental Study Design Questions	**Yes / No / Unclear**
1. Was the selection of participants clear and appropriate?	
2. Were populations matched or results adjusted for confounding factors?	

F3: Non-experimental screening checklist

The non-experimental study questions were adopted from Bhandari and Chan (2011) [50].

Non-experimental Study Design Questions	**Yes / No / Unclear**
1. Clear study objective/question?	
2. Explicit inclusion and exclusion criteria for study participants?	

B6.4: Qualitative screening checklist

The qualitative study screening questions were adapted from CASP "10 questions to help you make sense of qualitative research" and Spencer et al. 2003 "Quality in Qualitative Evaluation: A Framework for assessing research evidence" [37], [38].

Screening Questions	Yes / No / Unclear
1. Is a qualitative methodology appropriate to meet the objectives?	
2. Is the research design defensible?	

B6.5: Economic screening checklist

The screening questions were adopted from CASP 2013 Economic Evaluations Checklist and the Qualitative Research Checklist [38], [39]. This framework will identify economic manuscripts that are qualitative or quantitative.

Screening Questions	Yes / No / Unclear
1. Is the research design defensible with both costs and consequences considered?	
2. Is there a cost per unit or enough information given to calculate?	

Appendix B7: Quality appraisal checklists

The assessment of different study methodologies require appropriate frameworks unique to each design. The assessment tools listed below are intended to help the reviewer assess manuscripts for common biases and internal validity and are separated by quantitative (B7.1) and qualitative (B7.2) research methodologies.

B7.1: Quantitative appraisal

To determine the risk of bias in quantitative studies, an assessment tool was developed, drawing heavily from Baird et al (2013) which is based on the Cochrane Handbook Risk of Bias Tool[36], [51]. We will assess the risk of bias through five categories: 1) selection and confounding; 2) spillover and contamination; 3) incomplete outcome; 4) selective reporting; and 5) other bias. Each study will be scored across the five categories as 'Low Risk,' 'High Risk,' or 'Unclear.' The overall determination for the risk of bias for that study is assessed with the table below.

Table B37: Risk of Bias Summary

Risk of Bias	'Low Risk' Assessed in Categories
Low Risk	4-5 'Low Risk' Scores
Medium Risk	3 'Low Risk' Scores
High Risk	1-2 'Low Risk' Scores

B7.1.1.1: Selection bias and confounding

Bias Score	Criteria
Low Risk	• a. A random component in the sequence generation process is described (e.g. Referring to a random number table) and if the unit of allocation is based on a sufficiently large sample size. • b. The unit of allocation was by geographical/social unit, institution, team or professional and allocation was performed on all units at the start of the study; or if the unit of allocation was by beneficiary or group or episode of treatment and there was some form of centralized randomization scheme, an on-site computer system or sealed opaque envelopes were used. • c. If the outcomes are objectively measurable. • d. Baseline characteristics of the study and control/comparisons are reported and overall similar based on t-test or ANOVA for equality of means across groups. • e. if relevant (e.g. Cluster-rcts), authors control for external factors that might confound the impact of the programme (rain, infrastructure, community fixed effects, etc) through regression analysis or other techniques. • f. The attrition and noncompliance rate is below 15%, or the study assesses whether drop-outs are random draws from the sample

	(e.g. By examining correlation with determinants of outcomes, in both treatment and comparison groups)?
Unclear	• if a) or b) not specified in the paper, c) scores “no” or if d) scores “no” but the authors controlled for the relevant differences through regression analysis.
High Risk	• Otherwise

Quasi-experimental approaches (non-random allocation of the treatment): was the identification method free from any sources of bias or were sources of bias adequately corrected for with an appropriate method of analysis?

B7.1.1.2: Quasi-Experimental

Score	Criteria
I. Propensity score matching and combination of psm with panel models:	
Unclear	• a. The study matched on either (1) baseline characteristics, (2) time invariant characteristics or (3) endline variables not affected by participation in the programme. • b. The variables used to match are relevant (e.g. Demographic and socio-economic factors) to explain a) participation and b) the outcome and thus there are not evident differences across groups in variables that explain outcomes. • c. Except for kernel matching, the means of the individual covariates are equal for both the treatment and the control group after matching based on t-test for equality of means or ANOVA.
High Risk	• Otherwise

Quasi-experimental (continued)

Score	Criteria
II. Regression discontinuity design	
Low Risk	• a. Allocation is made based on a pre-determined discontinuity blinded to participants or if not blinded, individuals cannot amend the assignment variable. The sample size immediately at both sides of the cut-off point is sufficiently large. • b. The interval for selection of treatment and control group is reasonably small, or authors have weighted the matches on their distance to the cut-off point. • c. the mean of the covariates of the individuals immediately at both sides of the cut-off point (selected sample of participants and non-participants) are overall not statistically different based on t test or ANOVA for equality of means. • d. If relevant (e.g. Clustered studies) and although covariates are balanced, the authors include control for external factors through a regression analysis.

Unclear	• if a) or b is) not specified in the paper or d) scores “no” but authors control for covariate differences across participants and control individuals.
High Risk	• Otherwise
III. Cross sectional regression studies using instrumental variables and Heckman procedures:	
Low Risk if all the following are true	• a. The instrumenting equation is significant at the level of F ≥ 10; if an F test is not reported, the author reports and assesses whether the Rsquared (goodness of fit) of the participation equation is sufficient for appropriate identification • b. For instrumental variables, the identifying instruments are individually significant ($p \leq 0.01$); for Heckman models, the identifiers are reported and significant ($p \leq 0.05$) • c. For generalised IV estimation, if at least two instruments are used, the study includes and reports an overidentifying test ($p \leq 0.05$ is required to reject the null hypothesis) • d. The study qualitatively assesses the exogeneity of the instrument/ identifier (both externally as well as why the variable should not enter by itself in the outcome equation); only score yes when the instrument is exogenously generated: e.g. natural experiment or random assignment of participants to the control and treatment groups. If instrument is the random assignment of the treatment, the systematic reviewer should assess the quality and success of the randomisation (e.g. see section on RCTs). • e. The study includes relevant control for confounding, and none of the controls is likely affected by participation.
Unclear	• if d) scores “no” and c) scores “yes”.
High Risk	• Otherwise

Quasi-experimental (continued)

Score	Criteria
IV. Cross sectional regression studies using OLS or maximum likelihood models including logit and probit models.	
Unclear if all the following are true	• The covariates distribution are balanced across groups • The authors control for a comprehensive set of confounders that may be correlated with both participation and explain outcomes (e.g. demographic and socio-economic factors at individual and community level) and thus, it is not evident the existence of unobservable characteristics that could be correlated with participation and affect the outcome. • The authors use proxies to control for the presence of unobservable confounders driving both participation and outcomes. • Participation does not have a causal impact in any of the controls.
High Risk	• Otherwise

V. Panel data models (controlled before-after, difference in difference multivariate regressions):	
Unclear if all the following are true	• The authors use a difference in difference multivariate estimation method or fixed effects models. • The author control for a comprehensive set of time-variant characteristics (e.g. the study includes adequate controls for confounding and thus, it is not evident the existence of time-variant unobservable characteristic that could be correlated with participation and affect the outcome) • The attrition and noncompliance rate is below 10%, or the study assesses whether drop-outs are random draws from the sample (e.g. by examining correlation with determinants of outcomes, in both treatment comparison group)?
High Risk	• Otherwise

B7.1.1.3: Non-Experimental

Score	Criteria
Non-experimental studies	
Unclear	• Mixed methods – individual components of mixed-methods research need to be assessed independently and scored. It is possible that quantitative data from a mixed method study scores a 'high bias' and qualitative scores a 'low bias' or vice versa.
High Risk	• Case reports • Case series • Uncontrolled before-after • Correlation research • Single variable research – no control or comparison group

B7.1.2 Spillovers and contamination

Score	Criteria
Was the study adequately protected against spillovers, cross-overs and contamination?	
Yes	• The intervention is unlikely to spillover to comparisons (e.g. Participants and non-participants are geographically and/or socially separated from one another and general equilibrium effects are not likely) and that the treatment and comparisons are isolated from other interventions which might explain changes in outcomes.
No	• Allocation was at the individual level and there are likely spillovers within households and communities which are not controlled for, or • Other interventions likely to affect outcomes operating at the same time in either group.
Unclear	• Spillovers and contamination are not addressed clearly

B7.1.3 Incomplete Outcome Data

Attrition bias due to amount, nature or handling of incomplete outcome data	
Score	**Criteria**
Low risk	• No missing outcome data; • Reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias); • Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups; • For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate; • For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size; • Missing data have been imputed using appropriate methods • Authors use 'common' methods of estimation (i.e. Credible analysis method to deal with attribution given the data available). Additionally, specific methods of analysis should answer positively the following questions: • For RCTs, if randomisation clearly described and achieved, e.g. Comparison of treatment and control on all appropriate observables prior to selection. • For PSM, if (a) for failure to match over 10% of participants, sensitivity analysis is used to re-estimate results using different matching methods (kernel matching techniques); (b) for matching with replacement, there is not any observation in the control group that is matched with a large number of observations in the treatment group; (c) authors report the results of rosenbaum test for hidden bias which suggest that the results are not sensitive to the existence of hidden bias. • For IV and Heckman models, if (a) the author tests and reports the results of a hausman test for exogeneity ($p \leqslant 0.05$ is required to reject the null hypothesis of exogeneity); (b) the study describes clearly and justifies the exogeneity of the instrumental variable(s)/identifier used (iv and heckman); (c) the value of the selectivity correction term (rho) is significantly different from 0 ($p<0.05$) (heckman approach). • d. For regression analysis, if authors carried out a hausmann test with a valid instrument and the authors cannot reject the null of exogeneity of the treatment variable at the 90% confidence.

Score	Criteria
High Risk	• Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups; • For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate; • For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size; • 'As-treated' analysis done with substantial departure of the intervention received from that assigned at randomization; • Potentially inappropriate application of simple imputation.
Unclear	• Insufficient reporting of attrition/exclusions to permit judgement of 'Low risk' or 'High risk' (e.g. number randomized not stated, no reasons for missing data provided); • The study did not address this outcome

B7.1.4 Selective Reporting

Reporting bias due to selective outcome reporting	
Score	**Criteria**
Low risk	• The study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way; • The study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon).
High Risk	• Not all of the study's pre-specified primary outcomes have been reported; • One or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. subscales) that were not pre-specified; • One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect); • One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; • The study report fails to include results for a key outcome that would be expected to have been reported for such a study.
Unclear	• Insufficient information to permit judgement of 'Low risk' or 'High risk'. **It is likely that the majority of studies will fall into this category.**

B7.1.5 Other Bias

Bias due to problems not covered elsewhere in the table.	
Score	**Criteria**
Low risk	The study appears to be free of other sources of bias.
High Risk	• **Data was collected by self-reporting from the beneficiary** • Blinding of the outcome may not have been controlled – lack of blinding. • Alternation or rotatation of enrolment, also concealment by date of birth or case number or any other explicitly unconcealed procedure. • Other potential threats to validity are present, and note these below (e.g. Coherence of results, data on the baseline collected retrospectively, information is collected using an inappropriate instrument or a different instrument/at different time/after different follow up period in the control and in the treatment group). • Had a potential source of bias related to the specific study design used; or • Has been claimed to have been fraudulent; or • Had some other problem.
Unclear	• Insufficient information to assess whether an important risk of bias exists; or • Insufficient rationale or evidence that an identified problem will introduce bias.

B7.2: Qualitative appraisal

The qualitative assessment has been adapted from Spencer et al. 2003 “Quality in Qualitative Evaluation: A Framework for assessing research evidence” [37], [38]. The quality assessment is evaluated on four appraisal questions. There is no clearly objective rule for determining bias among qualitative studies. The guiding questions will be used by the research team to help establish core research questions that should be evaluated; however, professional judgment is necessary to make the assessment. Qualitative experts are on the research team and advisory board to ensure rigorous standards, consistency, and transparency.

Each study will be scored across the four appraisal questions categories as ‘Low Risk,’ ‘High Risk,’ or ‘Unclear.’ The overall determination for the risk of bias for that study is assessed with the table below.

Table B38: Risk of Bias Summary

Risk of Bias	‘Low Risk’ Assessed in Categories
Low Risk	3 or more ‘Low Risk’ Score
Medium Risk	2 ‘Low Risk’ Scores
High Risk	1 or less ‘Low Risk’ Score

Appraisal Questions	Guiding Questions	Low Bias / High Bias / Unclear
1. How well defended is the sample design/ target selection of cases/documents ?	· Description of study locations/areas and how and why chosen · Description of population of interest and how sample selection relates to it (e.g. typical, extreme case, diverse constituencies etc.) · Rationale for basis of selection of target sample/settings/documents (e.g. characteristics/features of target sample/settings/documents, basis for inclusions and exclusions, discussion of sample size/number of cases/setting selected etc.)	
2. How clear is the basis of evaluative appraisal?	· Discussion of how assessments of effectiveness/evaluative judgments have been reached (i.e. whose judgments are they and on what basis have they been reached?) · Description of any formalized appraisal criteria used, when generated and how and by whom they have been applied · Discussion of any unintended consequences of intervention, their impact and why they arose	
3. How well was the data collection carried out?	· Who conducted data collection? · Were there procedures/documents used for collection/recording (Audio or video recording) · Examination of origins/influences on opposing or differing positions	
4. Is there clarity in reporting and findings?	· How clear and coherent is the reporting? · Demonstrates link to aims of study/research questions? · How clear are the assumptions/ theoretical perspectives/values/richness of data that have shaped the form and output of the evaluation?	

B7.3: Economic appraisal

The economic assessment has been adopted from CASP Economic Evaluation Checklist (2013) [39]. If two of the three questions are ‘high risk’ or ‘unclear’ the study is considered high risk overall. One ‘high risk’ from the three categories and the overall assessment is ‘medium risk,’ otherwise, ‘low risk.’

	High Risk / Low Risk / Unclear
1. Were all important and relevant resources required and health outcome costs for each alternative identified, measured in appropriate units and valued credibly? Consider how realistic are they and how they were derived?	
2. Were sensitivity and incremental analyses preformed? Consider changing the estimate of the variable does this change the result of the economic evaluation?	
3. Are results transferable to other contexts? Consider costs and program being translatable to other settings.	

Appendix C: Searching summary

Database		Date	Results
Scopus	WASH intervention string (9 sets) AND Context group AND LMIC country string AND 1995 – present	11-12 November 2015	666
Web of Science	WASH intervention string (9 sets) AND Context string AND 1995 – present (topic search)	16 November 2015	4,163
Ovid Medline Ovide Medline In-Process & Other Non-Index Citations; EBM Reviews Full Text – Cochrane DSR, ACP Journal Club and DARE	WASH intervention strings (9 sets) AND Context string AND 1995 – present (abstract, title)	23 November 2015	2,315
GoogleScholar	48 – 2 and 3 word searches: WASH intervention AND emergency or disaster; first 2 pages	25 November 2015	756
LILACS (Spanish/English)	WASH intervention strings (4 sets –water, sanitation, hygiene, WASH) AND Context string (abstract words)	25 November 2015	756
IDEAS	WASH intervention strings (4 sets –water, sanitation, hygiene, WASH) AND Context string (All record types; abstract, 1995-2015)	27 November 2015	328
Article First – Worldcat (French)	water/sanitation/hygiene AND context key words AND 1995-2015; kw	11 December 2015	83
Academic Search Premier	15 – 2 word searches; water/sanitation/hygiene; disaster/outbreak	11 December 2015	625
Academic Search Premier (French)	9 – 2 word searches; water/sanitation/hygiene; context	11 December 2015	634
		Total	**10,326**

Source	Description	Date	Results
Web Searching	NGO Websites UN (Unicef, WHO, UNHCR) Government agencies Information hubs (ALNAP, reliefweb) Development Banks Grey literature repositories	September 2014-March 2016	2,676
Direct Communication	Mass emails to WASH cluster Targeted (individual) emails Web postings Personal contacts Conference presentations	September 2015 – February 2016	2,024

Summary

Source	Results
Academic Databases	10,327
Internet Searching	2,676
Direct Communication	2,024
Total	**15,026**

Search Update

In September 2016, the search strings were re-run with to check for updated studies. Dates were restricted to 2015-2016. Additionally, local names for some products were searched to ensure searching was comprehensive. For example, ‘gadyen dlo’ is a Haitian word for WaterGuard or the Safe Water System that has been promoted in several countries.

Database		Date	Results
Scopus	WASH intervention string (9 sets) AND Context group AND LMIC country string AND 2015 – 2016	September 2016	58
Web of Science	WASH intervention string (9 sets) AND Context string AND 2015 – 2016 (topic search)	September 2016	2,180
Ovid Medline	WASH intervention strings (9 sets) AND Context string AND 2015 – 2016 (abstract, title)	September 2016	2,368
Cochrane	WASH intervention strings (9 sets) AND Context string AND 2015 – 2016 (abstract, title)	September 2016	610
GoogleScholar	48 – 2 and 3 word searches: WASH intervention AND emergency or disaster; first 2 pages	September 2016	480
LILACS (Spanish/English)	WASH intervention strings (4 sets –water, sanitation, hygiene, WASH) AND Context string (abstract words)	September 2016	99
IDEAS	WASH intervention strings (4 sets –water, sanitation, hygiene, WASH) AND Context string (All record types; abstract, 2015-2016)	September 2016	230
Article First – Worldcat (French)	water/sanitation/hygiene AND context key words AND 2015-2016; kw	September 2016	46
Academic Search Premier	15 – 2 word searches; water/sanitation/hygiene; disaster/outbreak; 2015-2016	September 2016	571
Academic Search Premier (French)	9 – 2 word searches; water/sanitation/hygiene; context; 2015-2016	September 2016	42
		Total	**6,684**

Example search string for databases

Keyword strings were used to search databases. Keyword strings for the eight WASH interventions (in addition to a 'WASH' intervention) were searched with other strings for emergency contexts, low and middle-income countries, outcomes, and included dates. Search strings were combined using the 'AND' operator, example strings are described below.

Keyword String	Keyword String
Intervention (example: water access)	("water access" OR "source rehabilitation" OR "source cleaning" OR "water source" OR "protected source" OR "unprotected source" OR "improved source" OR "unimproved source" OR "contaminated source" OR "water quality" OR "water quantity" OR "tanker*" OR "water truck*" OR "well rehabilitation" OR "well cleaning" OR "dug well" OR "tube well" OR "point source" OR "non-point source" OR river OR stream OR canal OR "drinking water")
Year	1995-Present
Context	(emergency OR emergencies OR crisis OR "emergency response" OR "complex emergenc*" OR disaster OR flood OR tsunami OR outbreak* OR earthquake OR drought* OR endemic OR pandemic OR hurricane OR typhoon OR "failed state" OR conflict OR war OR refugee OR "IDP" OR "internally displaced" OR entrapped or humanitarian)
Outcomes	(diarrhea OR diarrhoea OR outbreak OR "waterborne diseases" OR "disease burden" OR "disease risk" OR "disease reduction" OR "DALY" OR mortality OR morbidity OR prevalence OR evidence OR effectiveness OR "cost effectiveness" OR cost-effectiveness OR economic OR efficacy OR "quality of life" OR "QOL" OR psycosocial OR ebola OR cholera OR "hepatitis E" OR "hep e" OR "use of service" OR use-of-service OR "effective use" OR "sustained use" OR uptake OR up-take OR "up take" OR "EVD")
Low and Middle-Income Countries	("LMIC" OR "low and middle income countr*" OR "low-and-middle-income" OR "low income country" OR "low-income-country" OR "middle income country" OR "middle-income-country" OR afghanistan OR libya OR albania OR macedonia OR algeria OR madagascar OR "American Samoa" OR malawi OR angola OR malaysia OR armenia OR maldives OR azerbaijan OR mali OR bangladesh OR "Marshall Islands" OR belarus OR mauritania OR belize OR mauritius OR benin OR mexico OR bhutan OR micronesia OR bolivia OR moldova OR bosnia OR herzegovina OR mongolia OR botswana OR montenegro OR brazil OR morocco OR bulgaria OR mozambique OR "Burkina Faso" OR myanmar OR burundi OR namibia OR "Cabo Verde" OR nepal OR cambodia OR nicaragua OR cameroon OR niger OR "Central African Republic" OR "CAR" OR nigeria OR chad OR pakistan OR china OR palau OR colombia OR panama comoros OR "Papua New Guinea" OR congo OR paraguay OR congo OR peru OR "Costa Rica" OR philippines OR "Ivory

	Coast" OR "Cote d'Ivoire" OR romania OR cuba OR rwanda OR djibouti OR samoa OR dominica OR "Sao Tome" OR principe OR "Dominican Republic" OR senegal OR ecuador OR serbia OR egypt OR "Sierra Leone" OR "El Salvador" OR "Solomon Islands" OR eritrea OR somalia OR ethiopia OR "South Africa" OR fiji OR "South Sudan" OR gabon OR "Sri Lanka" OR gambia OR "St. Lucia" OR "Saint Lucia" OR georgia OR "St. Vincent" OR "Saint Vincent" OR grenadines OR ghana OR sudan OR grenada OR suriname OR guatemala OR swaziland OR guinea OR syrian OR syria OR guinea-bissau OR tajikistan OR guyana OR tanzania OR haiti OR thailand OR honduras OR timor-leste OR "Timor Leste" OR india OR togo OR indonesia OR tonga OR iran OR tunisia OR iraq OR turkey OR jamaica OR turkmenistan OR jordan OR tuvalu OR kazakhstan OR uganda OR kenya OR ukraine OR kiribati OR uzbekistan OR korea OR vanuatu OR kosovo OR vietnam OR "Kyrgyz Republic" OR kyrgyzstan OR "West Bank" OR gaza OR lao OR laos OR yemen OR lebanon OR zambia OR lesotho OR zimbabwe OR liberia OR "middle-east" OR "middle east" OR "Africa" OR "Sub-Saharan Africa" OR "Central America" OR "Latin America" OR "Caribbean" OR "South America" OR "Central Asia" OR "East Asia" OR pacific OR "South Asia" OR "Asia" OR "South-east Asia" OR "southeast Asia" OR "South east Asia")

Example weBSITE Searches WITH kEYWORDS

For websites that were not equipped to handle complex search strings, basic keywords within the scope of WASH were used in combination. Example keyword searches include:

- outbreak and water
- emergency and latrine
- cholera and hygiene

Websites Searched

Type of Organization	Name	Website
UN Agencies	Unicef	http://data.unicef.org/
	WHO	http://www.who.int/gho/database/en/
	UNHCR	http://www.refworld.org/publisher,UNHCR,RESEARCH,,,0.html
	PAHO	http://www.paho.org/hq/index.php?option=com_content&view=article&id=1245&Itemid=1497&lang=en
	OCHA	https://www.humanitarianresponse.info/en/applications/tools/category/document-repository
International Bodies	International Committee of the Red Cross Red Crescent (ICRC)	https://www.icrc.org/eng/resources/library-research-service/
	International Federation of the Red Cross Red Crescent (IFRC)	http://www.ifrc.org/en/publications-and-reports/evaluations/

	International Organization for Migration (IOM)	http://publications.iom.int/bookstore/index.php?main_page=index&language=en
Development Banks	World Bank	http://data.worldbank.org/
	Asian Development Bank	http://www.adb.org/data/main
	African Development Bank	http://www.afdb.org/en/knowledge/statistics/data-portal/ and http://www.afdb.org/en/knowledge/statistics/open-data-for-africa/
Research Groups	Humanitarian Innovation Fund (HIF)	http://www.elrha.org/hif/innovation-resource-hub/
	EM-DAT The International Disaster Database	http://www.emdat.be/database
	ELRHA	http://www.elrha.org/
	Evidence Aid	http://www.evidenceaid.org/resources/
	3ie	http://www.3ieimpact.org/evidence/systematic-reviews/ and http://www.3ieimpact.org/en/evidence/impact-evaluations/impact-evaluation-repository/
	Grey Lit	http://www.greylit.org
	IRC WASH	http://www.ircwash.org/resources
	Open Grey	http://www.opengrey.org
	Cochrane Collaboration	http://community.cochrane.org/editorial-and-publishing-policy-resource/cochrane-database-systematic-reviews-cdsr

Type of Organization	**Name**	**Website**
Government Bodies	USAid	http://www.usaid.gov/data
	OFDA	See EM-DAT
	DFID	http://r4d.dfid.gov.uk/
	ECHO	https://euaidexplorer.ec.europa.eu/SearchPageAction.do
	CDC	http://www.cdc.gov/surveillancepractice/data.html
International Networks	WASH Cluster email list	Personally maintained list
	WASHPlus email list	Personally maintained list
	RedR	http://www.redr.org.uk/
	Reliefweb	http://reliefweb.int/topics/wash
	Emergency Environmental Health Forum	Personally maintained list
	ODI	http://www.odi.org/search/site/data
	Humanitarian Practice Network	http://www.odihpn.org/hpn-resources
	Humanitarian Policy Group	Part of ODI
	CDAC Network	http://www.cdacnetwork.org/tools-and-resources/
	WEDC	http://wedc.lboro.ac.uk/knowledge/notes_emergencies.html
	Humanitarian Data Exchange	https://data.hdx.rwlabs.org/
NGO	Action Against Hunger (ACF)	http://www.actionagainsthunger.org/technical-surveys/list
	Care International	http://www.care.org/
	International Rescue Committee (IRC)	http://www.rescue.org/
	Oxfam	http://www.oxfam.org.uk/
	Doctors Without Borders (MSF)	http://www.msf.org/reports

	Save the Children	http://www.savethechildren.org/site/c.8rKLIXMGIpI4E/b.6153061/k.7E4A/Publications_and_Reports.htm
	Norwegian Refugee Council (NRC)	http://www.nrc.no/?aid=9137113
	Danish Refugee Council (DRC)	http://drc.dk/home/
	J-PAL	https://www.povertyactionlab.org/evaluations
	IPA	http://www.poverty-action.org/research
	Samaritan's Purse	http://www.samaritanspurse.org/
	Medair	http://relief.medair.org/en/
	Global Communities	http://www.globalcommunities.org/resourcelibrary%20
	World Vision	http://www.worldvision.org/
	Catholic Relief Services	http://www.crs.org/publications/
	PATH	http://www.path.org/publications/list.php

Local Government Websites	**Country**	**Website**
	Afghanistan	http://www.saarc-sadkn.org/countries/afganistan/partner.aspx
		http://www.andma.gov.af/news/allnews
		http://president.gov.af/en/documents
		http://www.unocha.org/afghanistan
	Burundi	http://www.burundi.gov.bi/#
		http://www.burundi-gov.bi
		http://presidence.gov.bi
	Central African Republic	http://www.unocha.org/car
	Chad	http://www.unocha.org/tchad/
		http://www.gouvernementdutchad.org/fr/
		https://translate.googleusercontent.com/translate_c?depth=1&hl=en&prev=search&rurl=translate.google.com&sl=fr&u=http://www.uggstchad.blogspot.com/&usg=ALkJrhio74pG-lUL-tlClx5HObs9UuK1yg
		https://translate.googleusercontent.com/translate_c?depth=1&hl=en&prev=search&rurl=translate.google.com&sl=fr&u=http://www.onrtv.td/fr/%3Fbr%3D103%26p%3D2013%26cat%3D2013&usg=ALkJrhi7s4DaGqyB1nZFn2khkfuogwsSeg
	Congo (D.R.)	https://translate.googleusercontent.com/translate_c?depth=1&hl=en&prev=search&rurl=translate.google.com&sl=fr&u=http://www.sante-tchad.org/Delegations-Sanitaires-Regionales_r29.html&usg=ALkJrhiaI_D8vJxq7SpAj3ZeJXQlTabwkg
	Cote d'Ivoire	http://www.presidentrdc.cd
	Eritrea	http://www.unocha.org/drc
		http://www.gouv.ci/Main.php
	Ethiopia	http://www.eritrea.be/old/eritrea-health.htm
		http://www.shabait.com/component/search/?searchword=emergency&ordering=&searchphrase=all
		http://www.unocha.org/eastern-africa/about-us/about-ocha-eastern-africa/eritrea
		http://www.moh.gov.et/hehp

Guinea	http://www.dppc.gov.et
Haiti	http://www.ethiopia.gov.et/government
	http://www.mowr.gov.et
	https://www.humanitarianresponse.info/operations/ethiopia
Iraq	http://www.guineaecuatorialpress.com/noticia.php?id=982&lang=en
Kenya	https://www.humanitarianresponse.info/operations/haiti
	http://mspp.gouv.ht/newsite/
	http://primature.gouv.ht//
	http://www.unocha.org/iraq
	http://www.president.go.ke/projects/
Liberia	http://presidency.go.ke/index.php/health
	http://presidency.go.ke/index.php/environment-water-natural-resources
	http://www.mygov.go.ke/?page_id=431
	http://presidency.go.ke
	http://www.emansion.gov.lr
	http://www.micatliberia.com
	http://www.mohsw.gov.lr
North Korea	http://legislature.gov.lr
Sierra Leone	http://wash-liberia.org
	http://www.mia.gov.lr/doc/Web%201%20National%20Disaster%20Risk%20Management%20Policy-clean-12102012.pdf
	http://www.mia.gov.lr
	http://www.korea-dpr.com
	http://www.statehouse.gov.sl
	http://www.statehouse-sl.org
	http://health.gov.sl
Somalia	http://ogi.gov.sl/gosl-portal
	http://www.parliament.gov.sl
	http://www.washlearningsl.org/document-library/
South Sudan	http://www.somaligovernment.org
	http://www.somalia.gov.so/?AspxAutoDetectCookieSupport=1
	http://www.unocha.org/somalia
	http://www.unocha.org/south-sudan/
	http://www.goss.org
	http://www.goss.org/index.php/ministries/health
	http://www.goss.org/index.php/ministries/interior
Sudan	http://www.goss.org/index.php/commissions/relief-rehabilitation
	http://www.goss.org/index.php/commissions/reconstruction-fund
Uganda	http://www.mojss.org
	http://www.unocha.org/sudan/
	http://gov.ug
	http://www.statehouse.go.ug

	https://molg.go.ug
	http://www.opm.go.ug
	http://www.parliament.go.ug/new/
	http://www.health.go.ug
	http://www.mwe.go.ug
	http://www.budget.go.ug
	http://www.mia.go.ug
Zimbabwe	http://www.mglsd.go.ug/programmes/index.html http://opm.go.ug/departments/department-of-disaster-preparedness-management-refugees/department-of-relief-disaster-preparedness-and-management.html
	http://www.zim.gov.zw
	http://www.environment.gov.zw
	http://www.mohcc.gov.zw
	http://www.parlzim.gov.zw/about-parliament/publications
	http://www.archives.gov.zw/sample-sites-2
	http://www.zinwa.co.zw
	http://www.ncuwash.org
Angola	http://www.governo.gov.ao
Bangladesh	http://www.bangladesh.gov.bd
	http://www.mohfw.gov.bd
	http://www.sid.gov.bd
	http://www.ictd.gov.bd
	http://www.modmr.gov.bd
	http://www.lged.gov.bd/GovtWebsites.aspx
	http://www.moi.gov.bd
	http://www.dpp.gov.bd/bgpress/
	http://www.minlaw.gov.bd
	http://www.mopa.gov.bd/en
	http://www.pmo.gov.bd
	http://www.parliament.gov.bd
	http://www.mof.gov.bd/en/
	http://www.mowr.gov.bd/
	http://www.dphe.gov.bd/index.phpoption=com_content&view=article&id=71&Itemid=80
Burkina Faso	http://www.unocha.org/rowca/about-us/about-ocha-rowca/burkina-faso
	http://presidence.bf
	http://www.gouvernement.gov.bf
Cameroon	http://www.spm.gov.cm/en/government.html
	https://www.prc.cm/en/the-president
Colombia	http://wp.presidencia.gov.co/Paginas/presidencia.aspx
Egypt	http://www.sis.gov.eg/En/
Georgia	http://gov.ge/index.php?lang_id=ENG

	http://moe.gov.ge/index.php?sec_id=42&lang_id=ENG
Guinea Bissau	http://www.guinebissaurepublic.com
Iran	http://www.president.ir/en/
	http://en.iwpco.ir/default.aspx
Kyrgyzstan	http://www.gov.kg
	http://water.nature.gov.kg/index.php/en/
	http://www.mes.kg/en/
Lebanon	http://www.presidency.gov.lb/english/Pages/default.aspx
	http://www.pcm.gov.lb/arabic/index.aspx?pageid=5
	http://energyandwater.gov.lb
	http://www.moph.gov.lb/Pages/Home.aspx
	http://nna-leb.gov.lb/en
Malawi	http://www.malawi.gov.mw
	http://www.finance.gov.mw
	http://www.parliament.gov.mw
Mauritania	http://www.mauritania.mr/fr/
Myanmar	http://www.unocha.org/myanmar
	http://www.president-office.gov.mm/en/
	http://www.moh.gov.mm
	http://www.moi.gov.mm
	http://www.dmh.gov.mm
Nepal	http://www.unocha.org/nepal
	http://www.nepal.gov.np/portal/npgea/home?l=en&rn=1447506123350
	http://drrportal.gov.np http://www.mohp.gov.np/index.php/latest-news-scroller/38-welcome-to-nepal-governme health-and-population-website
	http://www.seiu.gov.np
	http://newah.org.np
	http://un.org.np
	http://www.moud.gov.np
	http://www.dwidp.gov.np
	http://www.enviro-nepal.gov.np/ContentPages/view/54
	http://nitc.gov.np/eq/
	http://neoc.gov.np/en/
Niger	http://www.moha.gov.np/home
	http://www.gouv.ne
	http://www.presidence.ne
	http://www.nigerstate.gov.ng
Nigeria	http://www.unocha.org/niger
	http://www.statehouse.gov.ng
	http://www.unocha.org/nigeria
	http://www.health.gov.ng

	http://osun.gov.ng/government/executive/ministries/environment-and-sanitation/
	http://nema.gov.ng
Pakistan	http://www.unocha.org/pakistan/
	http://www.pakistan.gov.pk
	http://www.ndma.gov.pk/new/
	http://www.wapda.gov.pk
	http://www.pcrwr.gov.pk
	http://www.pdma.gov.pk
	http://www.nidm.gov.pk
Rwanda	www.moh.gov.rw
	www.mininfra.gov.rw
	www.midimar.gov.rw
	www.rdb.gov.rw
	http://www.gov.rw/home/
	http://www.mhc.gov.rw
Sri Lanka	http://www.unocha.org/asia-and-pacific/country-profiles/sri-lanka
	https://www.gov.lk/welcome.html
	http://www.mwsd.gov.lk/index_e.html http://www.waterboard.lk/web/index.php?option=com_content&view=article&id=59:sanit development-goals-in-sri-lanka&catid=29:sewerage&Itemid=174&lang=en
	http://www.dmc.gov.lk/index_english.htm
Syria	http://www.health.gov.lk/en/
	http://www.unocha.org/syria
Tajikistan	http://www.egov.sy/page/en/132/0/HOME.html#&panel1-1
Timor-Leste	http://www.prezident.tj/en
	http://timor-leste.gov.tl/?lang=en
	http://www.transparency.gov.tl/english.html
	http://www.mj.gov.tl
	http://www.moh.gov.tl
Uzbekistan	http://www.statistics.gov.tl
	http://www.gov.uz/en
	http://www.agro.uz/uz/
	https://www.minzdrav.uz
	http://www.mvd.uz
	http://www.fvv.uz
Yemen	http://www.stat.uz
	http://www.unocha.org/yemen
	http://www.yemen.gov.ye

Appendix D: Data extraction template

Information from included studies was entered into a spread sheet in Microsoft Excel (2010) using dropdown menus where possible. Data was double screened for accuracy by two research assistants.

General Information	
First Author Surname	
Year of Publication	(YYYY)
Publication Type	Journal Article Book chapter or book Local government UN Report NGO Report CDC USaid or OFDA DFID Unpublished or pre-published work Other Agency
Primary Emergency	Flood Earthquake Tsunami Typhoon Outbreak Pop displacement - natural disaster Pop displacement - conflict Pop spike in existing camp setting Conflict Nutrition General 'emergency' Multiple emergencies No emergency - development Disease outside scope Other
Secondary Emergency	None Flood Earthquake Tsunami Typhoon Outbreak Pop displacement - natural disaster Pop displacement - conflict Pop spike in existing camp setting Conflict Nutrition General 'emergency' Multiple emergencies No emergency - development Disease outside scope Other
Funder of Intervention	CDC

	USAid OFDA Unicef UNHCR WHO BMGF HIF DFID ECHO Private Funds Manufacturer Local Government Other Not Reported
Outbreak Type (if any)	Cholera Disease (general) Ebola Hep E Typhoid Dysentery Diarrhea Hep A Dysentery Diarrhea Other Hepatitis 'not specified' Disease but not of interest None
Secondary Outbreak Type (if any)	Cholera Disease (general) Ebola Hep E Typhoid Dysentery Diarrhea Hep A Dysentery Diarrhea Other Hepatitis 'not specified' Disease but not of interest None
Outbreak Defined	Not an Outbreak Disease new to area Endemic Priority Disease 2x baseline Spike in cases Unsure or not clear
Outbreak a Global Emergency	1 0

	99 -NA
Date of Emergency	MM/YYYY
Country 1	
Country 2	
Country 3	
Country (other)	4 or more specific countries General/global analysis Regional Other
Comment on Country or Context	
Research Design	Cross-sectional Cluster (cross-sectional) Staged (cross-sectional) Before/After (cross-sectional) Before/After (cluster) Before/After (other) Case study Multiple case studies Case control RCT Mixed methods Qualitative Agency Lessons Learned Personal Observation Summary of several agencies lessons learned Not specified Other
Research Design Description	

Implementation	
Implementer of Project	
Author Affiliation	Employee of Implementing Agency External Consultant Academic Gov't Agency (CDC/Usaid) Other
Local Partner	0 1
Funder of Project (if stated)	
Purpose of Manuscript	Impact / End of project Baseline Intermediate Lessons Learned Technology/Academic Research Annual study Global assessment Pilot (small trial) Other

Comments	
Previous Work in the Area or with Same Group of People	1 0 99 -unclear but likely
Length of Time Working in the Area	<6 months <1 year <2 years >2 years More than 2 years
Description of Previous Work	
Project Start	MM/YYYY
Project End	MM/YYYY
Length of Project	# of months
Evaluation Start	MM/YYYY
Evaluation End	MM/YYYY
Comment on Timing or Dates	
Target Groups (1)	Emergency affected Refugee IDP Men Women Young Children (<5) School age (6-17) Elderly (60+) General population Not reported Other
Target Groups (2)	Emergency affected Refugee IDP Men Women Young Children (<5) School age (6-17) Elderly (60+) General population Not reported Other
Target Groups (3)	Emergency affected Refugee IDP Men Women Young Children (<5) School age (6-17) Elderly (60+) General population Not reported

	Other
Target Population	#
People/Households	People Households
Location of Intervention	Refugee camp IDP camp Urban Rural Peri-urban Not specified Urban and rural (large area with presumably both) Other
Comment on Target Population	

Evaluation	
Households Evaluated	0 1
Method of Allocating Groups / Selection	Random Systematic Cluster None (cross sectional) Not Applicable
Sample Size	#
People / Households	People Households
Description (if necessary)	
Focus Group Discussion	0 1
Sample Size	#
People / Groups	People Groups Other
Description (if necessary / Total People)	
Key Informants	0 1
Sample Size	#
Informant Description	People Organizations Other
Description (if necessary)	
Other Method of Data Collection	0 1
Number	#
Of What	
Description (if necessary)	

Intervention	
Primary Intervention	Water Access (Rehabilitation of water points / tankering or bladders) NFI Distribution Source-based water treatment HWTS Hygiene/handwashing promotion CLTS/CATS Sanitation - latrines Sanitation - latrine alternatives Environmental Hygiene WASH Package (no primary focus)
Secondary Intervention	None Water Access (Rehabilitation of water points / tankering or bladders) NFI Distribution Source-based water treatment HWTS Hygiene/handwashing promotion CLTS/CATS Sanitation - latrines Sanitation - latrine alternatives Environmental Hygiene Remaining WASH Package
Intervention Description	
Intervention Goal	Prevention Control Prevention AND Control Other
Rehabilitation of Water Sources	0 1
Description	
Tankering or Bladders	0 1
Description	
Source-based Water Treatment	0 1
Description	
HWT	0 1
Description	
Hygiene Promotion	0 1
Description	
Soap or NFI Kit Distribution	0 1
Description	
Environmental Hygiene	0 1
Description	

Latrines	0 1
Description	
CLTS/CATS	0 1
Description	
Latrine Alternatives	0 1
Description	
Additional Sectors of Response	None Health Nutrition Shelter Other
Description	

Distribution of Items	
Hygiene Kits Distributed	0 1
Number	#
Soap	0 1
Description	
Bucket/Jerry Can	0 1
Description	
Cleaning Supplies	0 1
Description	
Personal Hygiene Materials (not soap)	0 1
Description	
HWT	0 1
Description	
Cooking Items	0 1
Description	
Mattress/Bedding	0 1
Description	
Food	0 1
Description	
Other HH Items	0 1
Description	

Promotion

Hygiene Promotion	Promotion described Promotion mentioned, but not described Promotion strategies / approach described only Promotion NOT mentioned
Description	
Community Meetings	0 1
Description	
Household Visit	0 1
Description	
School	0 1
Description	
Radio	0 1
Description	
Megaphone	0 1
Description	
Skit / Play / Theater	0 1
Description	
Printed Material (Poster/ Flyer)	0 1
Description	
Other	0 1
Description	
Comments	
Promoters Paid	1 0 88 - Not stated 99 - N/A
Description	

Messaging	
Were Hygiene Messages Described	0 1
If yes, continue	
Handwashing at Critical Times	0 1
Description	
Water Risk	0 1
Description	
Encouraging Sanitation	0 1
Description	

Safe Food / Environment	0 1
Description	
Use of a Product	0 1
Description	
Other Messages	0 1
Description	

Project Approach	
Was the Community Involved in the Project Design	0 1
Description	
Community required to contribute (time or materials?)	0 1
Description	
Project 'acceptable' culturally	0 1
Description	
Plan for Continuation of Intervention	0 1
Description	
Climate Change Strategy	0 1
Description	
Risk of Bias – Quantitative	
Selection Bias and Confounding	High risk Low risk Unclear
Spill-over and Contamination	High risk Low risk Unclear
Incomplete Outcome	High risk Low risk Unclear
Selective Reporting	High risk Low risk Unclear
Other Biases	High risk Low risk Unclear
Comments	
Overall Study Quality	Low Risk Medium Risk High Risk

Risk of Bias – Qualitative	
Sample Design / Target Selection	High risk Low risk Unclear
Basis of Appraisal	High risk Low risk Unclear
Proper Collection Procedures	High risk Low risk Unclear
Clarity in Reporting and Findings	High risk Low risk Unclear
Comments	
Overall Study Quality	Low Risk Medium Risk High Risk

Outcomes	
Morbidity Measured	0 1
Morbidity Impact (OR, RR, prevalence)	
Reported / Confirmed	Reported (beneficiary) Confirmed - clinic test Confirmed - field test Confirmed - observation Confirmed - several methods Reported and confirmed
Recall Time	<2x per week <1 week 1 week 2 weeks >2 weeks
Mortality Measured	0 1
Mortality Impact (OR, RR, prevalence)	
Reported / Confirmed	Reported (beneficiary) Confirmed - clinic test Confirmed - field test Confirmed - observation Confirmed - several methods Reported and confirmed
Recall Time	<2x per week <1 week 1 week 2 weeks >2 weeks
Morbidity or Mortality Comments (non-specific)	
Reported Use	0

	1
Description	
Confirmed Use	0 1
Description	
Effective Use	0 1
Description	
Economic Info	0 1
Description	
Non-Health Related Outcomes	0 1
Description	
Knowledge or Behavior Change	0 1
Description	
Coverage	0 1
Description	

Water Testing	
Microbiological Testing (*E.coli*, CFU/100 mL)	0 1
Description	
Chlorine Residual (FCR, mg/L)	0 1
Description	
Turbidity (NTU)	0 1
Description	
Barriers and Facilitators	
Barriers to Project (Difficulties Identified in Manuscript)	
Facilitators (Positive Things that Helped the Project)	
Identified Limitations or Restrictions for the Evaluation of the Project	
Recommendations Identified in the Manuscript	
Other Information Not Described Elsewhere	

Appendix E: Risk of bias detail for included studies

Included studies were assessed for the risk of bias and outlined in the Protocol in Appendix B. Quantitative and qualitative studies were assessed with slightly different tools but both tools assessed study design, data collection, and reporting.

Quantitative Studies

Author	Title	Year	Selection & Confoun-ding	Spillover & Contamin-ation	Incomp-lete Outcomes	Selective Reporting	Other Bias	Overall Risk of Bias
ACF	Household NFI monitoring Report (PDM) May 2009	2009	High risk	High risk	High risk	High risk	High risk	High Risk
ACF	Non Food Items and Emergency Shelter Post Distribution Monitoring Report, Yobe State, Nigeria	2015	High risk	Low risk	High risk	High risk	High risk	High Risk
ACF	HYGIENE KITS POST DISTRIBUTION MONITORING REPORT	2014	High risk	High risk	High risk	High risk	Unclear	High Risk
ACF	DRM and WASH Post Distribution Monitoring Report KPK, Pakistan-November 2014	2014	High risk	Unclear	High risk	High risk	High risk	High Risk
ACF	Projet pilote de l'approche de marché pour la promotion du chlore liquide	2014	High risk	High risk	Low risk	High risk	Low risk	High Risk
Bonnaud	Typhoon Haiyan- Post Distribution Monitoring Report	2014	High risk	High risk	High risk	High risk	High risk	High Risk
Care International	Preventing Diarrhea Following a Flood Emergency: Home Based Chlorination"	2004	High risk	High risk	Unclear	Unclear	High risk	High Risk
Cavallaro	Evaluation of pot-chlorination of wells during a cholera outbreak, Bissau, Guinea-Bissau, 2008	2011	High risk	Low risk	Low risk	Low risk	Low risk	Low Risk
Clasen	Household-Based Ceramic Water Filters for the Treatment of Drinking Water in Disaster Response: An Assessment of a Pilot Programme in the Dominican Republic	2006	High risk	Unclear	Unclear	Unclear	High risk	High Risk
Clasen	Cross-sectional within: Household-Based Ceramic Water Filters for the Treatment of Drinking Water in Disaster Response: An	2006	High risk	Unclear	High risk	Unclear	High risk	High Risk

	Assessment of a Pilot Programme in the Dominican Republic							
Colindres	After the flood: an evaluation of in-home drinking water treatment with combined flocculent-disinfectant following Tropical Storm Jeanne — Gonaives, Haiti, 2004	2007	Low risk	High risk	Unclear	Unclear	High risk	High Risk
Contzen, Mosler	Impact of different promotional channels on handwashing behaviour in an emergency context: Haiti post-earthquake public health promotions and cholera response	2013	High risk	Low risk	Low risk	Unclear	High risk	High Risk
de Lange, Rink	Keeping it simple: a gender-specific sanitation tool for emergencies	2014	High risk	Low risk	High risk	High risk	High risk	High Risk
Doocy, S.	Point-of-use water treatment and diarrhoea reduction in the emergency context: an effectiveness trial in Liberia	2006	Low risk	Low risk	Unclear	Low risk	Low risk	Low Risk
Dunoyer	Rapport de capitalisation au sujet de l'épidémie de choléra au Tchad, 2010	2011	High risk	High risk	High risk	High risk	Low risk	High Risk
Dunston, Chris	Collaboration, cholera, and cyclones: A project to improve point-of-use water quality in Madagascar	2001	High risk	High risk	Low risk	High risk	High risk	High Risk
Einarsdbttir, J	Health Education and Cholera in Rural Guinea-Bissau	2001	High risk	High risk	High risk	High risk	High risk	High Risk
Ensink	Assessment of a membrane drinking water filter in an emergency setting	2015	Unclear	Unclear	Unclear	Unclear	High risk	High Risk
Gartley, M.	Uptake of household disinfection kits as an additional measure in response to a cholera outbreak in urban areas of Haiti	2013	High risk	High risk	Unclear	High risk	High risk	High Risk
Grayel	Programme d'intervention pour limiter et prévenir la propagation de l'épidémie de choléra en République Démocratique du Congo	2014	High risk	High risk	High risk	Low risk	Low risk	High Risk
Gupta, S	Factors associated with E. coli contamination of household drinking water among tsunami and earthquake survivors, Indonesia	2007	High risk	Low risk	Low risk	High risk	Unclear	Medium Risk

Gupta, S	Inadequate drinking water quality from tanker trucks following a tsunami disaster, Aceh, Indonesia, June 2005	2006	High risk	High risk	High risk	Low risk	High risk	High Risk
Husain, F	A pilot study of a portable hand washing station for recently displaced refugees during an acute emergency in Benishangul-Gumuz Regional State, Ethiopia	2015	High risk	Low risk	Low risk	Low risk	Unclear	Medium Risk
Imanishi, M	Household Water Treatment Uptake during a Public Health Response to a Large Typhoid Fever Outbreak in Harare, Zimbabwe	2014	High risk	Low risk	Low risk	Unclear	High risk	Medium Risk
Lantagne, D	"Case Study 2- Indonesia: Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Results from Nepal, Indonesia, Kenya, and Haiti"	2012	High risk	Low risk	Low risk	Low risk	Low risk	Low Risk
Lantagne, D	"Case Study 3 - Kenya: Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Results from Nepal, Indonesia, Kenya, and Haiti"	2012	High risk	Low risk	Low risk	Low risk	Low risk	Low Risk
Lantagne, D	Case Study 4 - Haiti: Use of Household Water Treatment and Safe Storage Methods in Acute Emergency Response: Case Study Results from Nepal, Indonesia, Kenya, and Haiti	2012	High risk	Low risk	Low risk	Unclear	Low Risk	Medium Risk
Lantagne, D	Case Study 1 - DSI Aquatabs/Safe storage container distribution: Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake	2013	High risk	Low risk	Low risk	Unclear	Low Risk	Medium Risk
Lantagne, D	Case Study 2- NFI Aquatabs: Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake	2013	Low risk	Low risk	Low risk	Unclear	Unclear	Medium Risk

Lantagne, D	Case Study 3 - Ceramic FilterPure: Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake	2013	High risk	Unclear	Low risk	Low risk	Low risk	Medium Risk
Lantagne, D	Case Study 4- Biosand: Effective Use of Household Water Treatment and Safe Storage in Response to the 2010 Haiti Earthquake	2013	High risk	Unclear	Low risk	Low risk	Low risk	Medium Risk
Lin, Li-Feng	Rapid evaluation on the risk of vector and emergency vector control after the earthquake	2008	High risk	Unclear	Unclear	Unclear	Unclear	High Risk
Luby, S	Chlorine spot treatment of flooded tube wells, an efficacy trial	2006	Low risk	Unclear	Low risk	Low risk	Low risk	Low Risk
Lytton, L	Deep impact: why post-tsunami wells need a measured approach	2008	High risk	High risk	Low risk	Low risk	High risk	High Risk
Macgregor-Skinner, G	Preventing diarrhea following water emergencies: An evaluation of home-based chlorination in West Timor, Indonesia, 2004	2005	High risk	Unclear	Low risk	High risk	Low risk	High Risk
MEDAIR	Post-Distribution Assessment Report for Point of Use Water Filter Distribution in Palei	2015	High risk	Low risk	Low risk	High risk	Low risk	Medium Risk
Meyer Capps, Jean	Open Defecation Status, Community-Led Total Sanitation and Ebola Virus Disease (EVD) in Voinjama and Kolahun Health Districts, Lofa County, Liberia (2014)	2015	High risk	Unclear	High risk	High risk	Unclear	High Risk
Mong, Kaiser, Ibrahim, Rasoatiana, Razafimbololona, Quick	Impact of Safe Water System on Water Quality in Cyclone-Affected Communities in Madagascar	2001	High risk	Low risk	High risk	High risk	High risk	High Risk
Mountfield	SMS Survey	2011	High risk	Unclear	Low risk	Low risk	High risk	High Risk
Patel, D	Excreta disposal in emergencies: Bag and Peepoo trials with internally displaced people in Port-au-Prince	2011	High risk	High risk	High risk	High risk	High risk	High Risk

Plan International	Emergency Assistance to Typhoon Usagi-Affected Populations in Central Luzon	2013	High risk	High risk	High risk	High risk	High risk	High Risk
Roberts	Keeping clean water clean in a Malawi refugee camp: a randomized intervention trial	2001	Low risk	Low risk	Low risk	Low risk	Low risk	Low Risk
Ruiz-Roman, Elena	Evaluation of the blanket distribution of non-food items as part of the cholera response in Zimbabwe	2009	High risk	Low risk	Unclear	High risk	High risk	High Risk
Siriajul Islam, M	Faecal contamination of drinking water sources of Dhaka city during the 2004 flood in Bangladesh and use of disinfectants for water treatment	2007	High risk	High risk	Unclear	High risk	High risk	High Risk
Topklo	Projet de reprise communautaire de la lutte contre le choléra et les maladies hydriques dans les zones de santé de Minova (Sud Kivu) et de Kirotshe (Nord Kivu), R.D. Congo	2015	High risk	High risk	Low risk	High risk	Low risk	High Risk
Villholth, K. G.	Tsunami impacts on groundwater and water supply in eastern Sri Lanka	2007	High risk	Low risk	High risk	Unclear	Low risk	High Risk
Yates	Case Study 2 - Sierra Leone: Effectiveness of chlorine dispensers in emergencies: case study results from Haiti, Sierra Leone, Democratic Republic of Congo, and Senegal	2015	High risk	Unclear	Low risk	Low risk	Low risk	Medium Risk
Yates	Case Study 3 - Haiti: Effectiveness of chlorine dispensers in emergencies: case study results from Haiti, Sierra Leone, Democratic Republic of Congo, and Senegal	2015	High risk	Unclear	Low risk	Low risk	Low risk	Medium Risk
Yates	Case Study 4 - Senegal: Effectiveness of chlorine dispensers in emergencies: case study results from Haiti, Sierra Leone, Democratic Republic of Congo, and Senegal	2015	High risk	Unclear	Low risk	Low risk	Low risk	Medium Risk

Qualitative and Field Commentary Studies

Author	Title	Year	Sample Design and Target Selection	Bias of Appraisal	Data Collection	Clarity in Reporting and Findings	Overall Risk of Bias
ACF	Community Led Ebola Management and Eradication Approach (CLEME) REVIEW REPORT	2015	High risk	High risk	Unclear	High risk	High Risk
ACF	Feasibility study and piloting of a Decentralized safe water access solution dedicated to emergency and natural catastrophes through a pre-trained community based Emergency Response Team (ERT) "Aquasure"	2014	High risk	High risk	Unclear	High risk	High Risk
ACF	Projet d'urgence d'amélioration des conditions d'accès à l'eau, hygiène et assainissement dans les camps de déplacés de Bangui - Document de capitalisation	2014	High risk	High risk	High risk	High risk	High risk
ACF	Le choléra au Tchad en 2011 et les stratégies d'intervention associées	2012	High risk	High risk	High risk	High risk	High risk
ACF	Bilan des actions d'urgence mises en place sur le départment du Nord-Ouest et plus particulièrement sur Port-de-Paix suite au passage des cyclones Ike et Hanna	2008	High risk	High risk	High risk	High risk	High risk
Alem, G	Evaluation of Emergency Water Supply and Sanitation	2004	High risk	Low risk	High risk	Unclear	High Risk
Baker, J	Final Evaluation Oxfam’s North Kivu Emergency Response	2009	High risk	High risk	Unclear	High risk	High Risk
Bastable, Andy	Innovative designs and approaches in sanitation when responding to challenging and complex humanitarian contexts in urban areas	2012	High risk	High risk	Unclear	High risk	High Risk
Cabezas, C	Efectividad del uso de alcohol glicerinado para la descontaminación de manos en una población sin aceso al agua potable posterremoto en Pisco, Perú	2008	High risk	High risk	High risk	High risk	High Risk

Clasen, T	The drinking water response to the Indian Ocean tsunami, including the role of household water treatment	2006	High risk	Unclear	High risk	Unclear	High Risk
Coloni, Francesca	Biodegradable bags as emergency sanitation in urban settings: the field experience	2012	High risk	High risk	Unclear	High risk	High Risk
Condor, J	Evaluation of the International Organization for Migration's Ongoing Activities on Support to the Flash Appeal for the Haiti Earthquake and Cholera Outbreak (Sida/IOM Agreement January 2010 – May 2011)	2011	High risk	High risk	Unclear	High risk	High Risk
DeGabriele, J.	An emergency response to humanitarian WASH-related emergencies in Zimbabwe	2009	High risk	High risk	Unclear	Low risk	High Risk
Dorea, C.	Up-flow Clarifier for emergency water treatment	2009	High risk	High risk	High risk	Unclear	High Risk
El-Mahmid, Ibrahim	Zimbabwe Emergency Response 01/05/2008 – 30/06/2009 Capitalization Report	2009	High risk	High risk	High risk	High risk	High Risk
Eyrard, J.	Portable toilets in emergencies: lessons learned from Port-au-Prince, Haiti	2011	High risk	High risk	High risk	High risk	High Risk
Flachenberg, F.	Hygiene promotion in emergencies: A fortuitous comparison The case of Bentiu IDP Camps, Unity state, South Sudan	2014	High risk	High risk	High risk	High risk	High Risk
Fortune, V.	British Red Cross – Mass Sanitation Module 2010 Haiti Earthquake Response Post Deployment Learning Evaluation	2010	High risk	Low risk	Unclear	Unclear	High Risk
Garandeau, R	Chlorination of hand-dug wells in Monrovia	2006	High risk	Low risk	High risk	Unclear	High Risk
Gauthier, J	2014 ACF: A REAL-TIME EVALUATION OF ACF'S RESPONSE TO CHOLERA EMERGENCY IN JUBA, SOUTH SUDAN	2014	High risk	High risk	Unclear	Low risk	High Risk
Global Communities	Stopping Ebola in its Tracks: A Community-Led Response	2015	High risk	Unclear	High risk	Low risk	High Risk
Grayel	Evaluation externe - Réponse d'urgence à l'épidémie de choléra en Haïti	2011	High risk	High risk	High risk	High risk	High Risk
Greaves, F	Case Study 1 - Haiti: Learning and recommendations on the use of CLTS in	2010	High risk	High risk	Unclear	Unclear	High Risk

	emergency and postconflict/post-emergency situations						
Greaves, F WV - Khan	Case Study 2 - Pakistan: Learning and recommendations on the use of CLTS in emergency and postconflict/post-emergency situations	2012	High risk	High risk	Unclear	Unclear	High Risk
Guévart	Diffuseur artisanal de chlore pour désinfecter les puits lors de l'épidémie de choléra de Douala (2004)	2008	High risk	High risk	High risk	High risk	High risk
Howard, Jim	Rethinking the unthinkable—effective excreta disposal in emergency situations	1996	High risk	High risk	Unclear	High risk	High Risk
Khan, F	Assessment of hygiene communication plan in the aftermath of the 2005 earthquake in Pakistan	2008	High risk	Unclear	Low risk	Low risk	Medium Risk
Kinstedt, K	The Application of Ecological Sanitation for Excreta Disposal in Disaster Relief	2012	High risk	High risk	High risk	High risk	High Risk
Martin	Rapport final - Water trucking DINEPA-ACF, Zone métropolitaine de Port-au-Prince, mai 2010 - 15 mai 2011	2011	High risk	High risk	High risk	High risk	High risk
Matemo	Use of H2S Tests to Monitor Water Quality in Insecure Environment	2014	Unclear	High risk	Unclear	High risk	High Risk
Mattson, Kay	Technical Review of Water , Sanitation and Hygiene Promotion Activities for T-Shelter Beneficiaries	2013	Unclear	Low risk	Low risk	Low risk	Low Risk
Miziniak, J	Sustainable Relief Programming for dispersed communities Case Study: Zambia Floods 2007	No Date	High risk	High risk	Unclear	High risk	High Risk
Moyenga, David	Sanitation solutions for a refugee camp: Field trial of sanitation for the vulnerable	2011	Low risk	Unclear	High risk	High risk	High Risk
Mwase, H.	The Potential of Ecosan to Provide Sustainable Sanitation in Emergency Situations and to achieve “quick wins” in MDGs	2006	High risk	High risk	Unclear	High risk	High Risk
Neseni, N	Evaluation of the WASH Response to the 2008-2009 Zimbabwe Cholera Epidemic and Preparedness Planning for Future Outbreaks	2009	Unclear	Unclear	Unclear	Low risk	High Risk

Parsa, N.	Human waste management in first phase response, protecting groundwater and human health: case study from Haiyan 2013	2014	High risk	High risk	Unclear	High risk	High Risk
Patinet	Evaluation externe de la réponse d'Action Contre la Faim en eau, assainissement et hygiène à l'urgence post-séisme du 12/01/2010 en Haïti	2010	High risk	High risk	Low risk	Low risk	Medium Risk
Pennacchia, Victoria	Bridging the Gap: Providing Water and Sanitation and Non-Food Item Assistance to Returnees, IDPs and Host Communities in North Kivu	2011	High risk	High risk	Unclear	High risk	High Risk
Pinera, JF	Restoring sanitation services after an earthquake: Field experience in Bam, Iran	2005	High risk	High risk	Unclear	High risk	High Risk
Pinera, JF	Water and sanitation in camps on the Andaman Islands	2006	High risk	High risk	Unclear	High risk	High Risk
Plan	Building Back Batter in Tacloban : Post-Haiyan Community Rehabilitation	2014	High risk	High risk	High risk	High risk	High Risk
Puddifoot, J.	Pit latrines in Nepal - the refugee dimension	1995	High risk	High risk	High risk	High risk	High Risk
Rees-Gildea, P.	Sierra Leone Cholera ERU Operation Review	2013	Unclear	Low risk	High risk	High risk	High Risk
Rowe, A	Chlorinating well water with liquid bleach was not an effective water disinfection strategy in Guinea-Bissau	2010	High risk	Low risk	High risk	High risk	High Risk
Saltori, R	Challenges of tsunami and conflict affected rural water supply in Sri Lanka	2006	Low risk	Low risk	Unclear	Low risk	Low Risk
Simpson, R	Real Time Evaluation of the Cholera Response in Zimbabwe 09 February – 19 February 2009	2009	Unclear	Unclear	High risk	High risk	High Risk
Singh, C.B.	Evaluation Report “Sustaining the lives and dignity of IDPs in Purnea district – Bihar”	2009	High risk	High risk	High risk	High risk	High Risk
Singh, Pankaj	Note from the field: The Pakistan floods: Success of the household trench latrine	2012	High risk	High risk	Unclear	High risk	High Risk
Steele, Andre	Impact of jerry can disinfection in a camp environment - experiences in an IDP camp in Northern Uganda	2008	High risk	High risk	High risk	High risk	High Risk
van der Wijk, J	Evaluation of the DEC-funded CAFOD Health and WASH Project in the DRC	2010	High risk	Unclear	High risk	Low risk	High Risk

Varampath, A	South Asia floods; WASH interventions/capacity review Focusing on key WASH interventions and capacity of agencies to deliver these	2008	High risk	High risk	High risk	Unclear	High Risk
Visser, Marco	WaSH Provision in Bahn Refugee Camp in Nimba, Liberia	2012	High risk	Unclear	High risk	Low risk	High Risk
Vithanage, M.	Effect of well cleaning and pumping on groundwater quality of a tsunami-affected coastal aquifer in eastern Sri Lanka	2009	High risk	Low risk	Low risk	Low risk	Low Risk
Wall	Ann Kite Yo Pale (let them speak) Best Practice and Lessons Learned in Communication with Disaster Affected Communities: Haiti 2010	2010	Low risk	Low risk	Unclear	Unclear	Medium Risk
Wango, Kamwati	SRCS/IFRC RESPONSE TO THE 2010/11 SOMALIA DROUGHT	2011	High risk	High risk	High risk	High risk	High Risk
Waterkeyn, J.	Rapid sanitation uptake in the internally displaced people camps of northern Uganda through community health clubs	2005	Low risk	High risk	High risk	High risk	High Risk
WHO	CASE STUDY 2 (20) - Zimbabwe within: Guidance on communication with respect to safe drinking water and household hygiene Literature review, interviews and case studies	No Date	High risk	High risk	Unclear	Unclear	High Risk
Williams, Gaines, Patrick, Berendes, Fitter, Handzel	Perceptions of health Communication, Water Treatment and Sanitation in Artibonite Department, Haiti, March-April 2012	2015	Low risk	Low risk	Unclear	Unclear	Medium Risk

Appendix F: Summary of evidence procedure

To establish the summary of evidence from multiple studies of varying qualities and study designs, a protocol was developed to clearly communicate the overall evidence for outcomes and interventions. The summary of evidence protocol is based on GRADE assessment of evidence outlined in Cochrane Review; however, some modifications were made so there would be a less emphasis on randomized control trials (RCT), which are rarely carried out in humanitarian research. The summary of evidence is described through four categories to give the reader levels of confidence in the quality for the outcomes and interventions. The four hierarchal categories are taken directly from GRADE and Cochrane:

- *High* **–** Further research is very unlikely to change our confidence in the estimate of effect or accuracy.
- *Moderate* – Further research is likely to have an important impact on our confidence in the estimate of effect or accuracy and may change the estimate.
- *Low* – Further research is very likely to have an important impact on our confidence in the estimate of effect or accuracy and is likely to change the estimate.
- *Very low* – Any estimate of effect or accuracy is very uncertain.

A three-step evaluation process is used to determine the level of evidence with transparency. Each outcome (health, use, and barrier/facilitator) is assessed individually. The baseline of evidence (Step 1) is determined by the study designs. Steps 2 and 3 downgrade or upgrade the baseline evidence considering biases, effect size, consistency, and generalizability (Table F39). Definitions for upgrading and downgrading are below the figure.

The overall evidence for the intervention is then balanced between the outcomes assessed. Outcomes with the most studies are weighted heavier; however, judgement and group discussions should be used to appreciate the definitions of ‘high,’ ‘moderate,’ ‘low,’ and ‘very low’ defined above.

Table F39: Level of evidence assessment

Step 1: Evidence Baseline Established from Study Design

Study Design		Summary of Evidence
RCT	→	4 - High
Control Groups	→	3 - Moderate
Cross-sectional, Observation, Qualitative	→	2 - Low
Field Observation	→	1 - Very Low

Step 2: Factors that Reduce the Evidence Baseline (1 step per point if applicable)

- High bias in ½ or more of the studies included in the outcome
- Unexplained heterogeneity
- Imprecision - small sample sizes

Step 3: Factors that Increase the Evidence Baseline (1 step per point if applicable, maximum 2 step increase)

- Large magnitude of effect
- Evidence of dose-response relationship
- Confidence in effect (confidence intervals)
- Generalizability (multiple studies across different contexts with consistent results)

Step 1: Start with the study design evaluating the outcome. In situations with a mixture of research designs, the most frequent study design controls. When the same number of studies is in each category, start with 'Low.'

Step 2: The quality of studies is downgraded. One step down for each of the criteria identified. Level 1 is the lowest possible.

- **High Bias**: ½ or more of the studies are high bias. Confidence in the results and conclusions lessens with high bias evaluations and can be a major limitation to the intervention effect.
- **Inconsistency of results**: Studies have a wide range of effects or estimates. Contradictory conclusions or factors that do not explain variation/heterogeneity.
- **Imprecision of results**: Studies have limited samples so application and implication of conclusions are doubted.

Step 3: Factors that upgrade studies include:

- **Large magnitude of effect:** Studies with low and medium bias that conclude a 'large affect size' (e.g. RR > 2 or RR < 0.5) that is in agreement with other studies.
- **Dose-response:** Evidence that outcomes change with a dose-response relationship.
- **Confidence in Effect:** Narrow range of rates or calculated effect size and confidence intervals. Consistency of impact and factors.
- **Generalizability:** Multiple studies across different contexts with consistent results.

Note: the maximum upgrade is 2 and should be justified.

Appendix G: Description of excluded studies from full reivew

Studies that were not eligible from the full text review are presented below. The primary reason for not including the study was separated into 10 categories. Only one reason category is presented despite the possibility of a study not meeting the inclusion criteria for multiple reasons.

Note: Only first authors or organizations are displayed.

Table G40: Categories of Exclusion

Category	Count
Development Context	16
Instruction Manual	2
No Clear WASH Intervention	84
No Outcome or Impact of Relevance	43
Outside Scope	36
Policy Document	13
Protracted Emergency	28
Repeated Research	1
Review Documents	37
Timing (13+ Months from Disaster)	14
Total	**274**

Lists of each category are presented below in order of Table 1.

Development Context

Studies included WASH interventions within the scope of the review, but were carried out in a development setting. The context was often rural and intending to improve WASH conditions rather than respond to an emergency.

Author	Title	Year
Christensen, G	Pilot Cluster Randomized Controlled Trials to Evaluate Adoption of Water, Sanitation, and Hygiene Interventions and Their Combination in Rural Western Kenya	2015
Das, R.	Communication Strategy on Water, Sanitation & Hygiene for Diarrhoea & Cholera Prevention Liberia 2012	2012
Demberere, T	An analysis of the effectiveness of WASH interventions in relation to diarrhoeal diseases in Chipinge district, Zimbabwe	2011
Haupt, F.	Depend or survive-sanitation and hygiene promotion in the Aral Sea disaster zone	1999
Huq, A.,	Simple sari cloth filtration of water is sustainable and continues to protect villagers from cholera in Matlab, Bangladesh	2010
Meddings, D	Cost effectiveness of a latrine revision programme in Kabul, Afghanistan	2004

Mengistie, B. and N. Baraki	Community based assessment on household management of waste and hygiene practices in Kersa Woreda, Eastern Ethiopia	2010
Mercedes, B.	Integrating WaSH and Nutrition sectors, based on a field review of ACF International missions	2013
Nzengya, D. M.	The impact of a school-based hygiene education intervention on student knowledge in Kenya	2015
Sanchez, I	A review of Oxfam GB's COMMUNITY LED TOTAL SANITATION (CLTS) initiative in Kitgum/Lamwo districts, northern Uganda, between July 2009 and July 2010 Part I	2011
Sanou, D., H. Turgeon-O'Brien and T. Desrosiers	Impact of an integrated nutrition intervention on nutrient intakes, morbidity and growth of rural Burkinabe preschool children	2011
Spears, D	The power of WASH: Why sanitation matters for nutrition	2015
Talaat, M	Effects of Hand Hygiene Campaigns on Incidence of Laboratory-confirmed Influenza and Absenteeism in Schoolchildren, Cairo, Egypt	2011
Vortmann, M	Water, Sanitation, and Hygiene at the World's Largest Mass Gathering	2015
Wenlong, G	Oral rehydration salt use and its correlates in low-level care of diarrhea among children under 36 months old in rural Western China	2013
No Author	Estimating report of survey on hand hygiene	2015

Instruction Manuals

Documents that described 'how to' respond or instructions for interventions were beyond the scope of review.

Author	Title	Year
Bigot, A	Refugee health: an approach to emergency situations	1997
Wildman, T.	Technical Guidelines On Water Trucking in Drought Emergencies	No Date

No Clear WASH Intervention

Documents may mention WASH themes or considerations, but do not actually describe a WASH intervention. A clear WASH intervention was necessary for inclusion. Discussions around disasters and outbreaks could also be mentioned without an intervention. Studies that mention WASH activities as a possible solution but not evaluating them could also be included in this category.

Author	Title	Year
Adams, J.	Visit to Sierra Leone 19 September to 24 October 2012	2012
Adams, J.	More than navel-gazing—guidelines for emergency sanitation and water-supply programmes	1996
Ahmed, S	The 2008 Cholera Epidemic in Zimbabwe: Experience of the icddr,b Team in the Field	2011
Aibana, O	Cholera Vaccination Campaign Contributes to Improved Knowledge Regarding Cholera and Improved Practice Relevant to Waterborne Disease in Rural Haiti	2013
Atuyambe, L. M.,	Land slide disaster in eastern Uganda: rapid assessment of water, sanitation and hygiene situation in Bulucheke camp, Bududa district	2011
Barzaga, B	Hepatitis A shifting epidemiology in South-East Asia and China	2000
Bechen, R.,	Cholera in Goma, July 1994	1996
Bergeri, I.	OCG response to cholera in Haiti, October 2010 – March 2011	2011
Beau De Rochars, V. E.,	Knowledge, attitudes, and practices related to treatment and prevention of cholera, Haiti, 2010	2011
Borchert, M., I.	Ebola haemorrhagic fever outbreak in Masindi District, Uganda: outbreak description and lessons learned	2011
Briñez A, Karol J.	The quality of water for human consumption in the Tolima department, Colombia.	2012
Brito, G	Pathophysiology and impact of enteric bacterial and protozoal infections: new approaches to therapy	2005
Bruck, C	Child Morbidity and Camp Decongestion in Post-war Uganda	2010
Carter, R	Rapid assessment of groundwater opportunities for displaced and refugee populations	2007
Cascioli Sharp, R.	REAL-TIME LEARNING REPORT ON WORLD VISION'S RESPONSE TO THE EBOLA VIRUS IN SIERRA LEONE	2014
Chanda Shimi, A.,	Impact and adaptation to flood: A focus on water supply, sanitation and health problems of rural community in Bangladesh	2010
Chen, Y	Waning of anti-HAV immunity in Shijiazhuang prefecture, Hebei province, China: a comparison of seroprevalence between 1992 and 2011	2014
Chirisa, I.,	The 2008/2009 cholera outbreak in Harare, Zimbabwe: case of failure in urban environmental health and planning	2015
Consortium, F. W. and L. W. Consortium	Prioritising Water, Sanitation and Hygiene in Ebola Recovery: For health, life and dignity	2015
Contzen, N. and H.-J. Mosler	Identifying the psychological determinants of handwashing: Results from two cross-sectional questionnaire studies in Haiti and Ethiopia	2015
Cronin, A	Quantifying the burden of disease associated with inadequate provision of water and sanitation in selected sub-Saharan refugee camps	2009
de Vreede, E	Children's hygiene and sanitation training in Somalia	2005

Dorea, C. C.	Coagulant-based emergency water treatment	2009
Duncalf, J.	Coordinated Humanitarian Assistance to the populations most affected by tropical storm WASHI	2013
Dyer, O.	Health risks emerge as ceasefire allows some humanitarian relief	2006
Emina, J	Accounting for recent trends in the prevalence of diarrhoea in the Democratic Republic of Congo (DRC): results from consecutive cross-sectional surveys	2012
Etienne, F.	Technical WASH Review in Gonaïves	2009
Ford, T	Emerging issues in water and health research	2005
Forsberg, B	Diarrhoea case management in low- and middle-income countries -- an unfinished agenda.	2007
Galada, H	Attitudes toward post-earthquake water and sanitation management and payment options in Leogane, Haiti	2013
Giardina, D., F. Prandini and S. Sorlini	Integrated Assessment of the Water, Sanitation and Hygiene Situation in Haitian Schools in the Time of Emergency	2013
Hamai, L.	Integrated Assessment of Syrian Refugees in Host Communities Emergency Food Security and Livelihoods; Water, Sanitation and Hygiene; Protection	2013
Hayden, T.	Menstrual hygiene management in emergencies: Taking stock of support from UNICEF and partners	2012
Howard, M	Infectious disease emergencies in disasters	1996
Kang, Z.-Y.,	Rural Drinking Water Problems and Countermeasures after the Earthquake Disaster	2009
Korkoyah Jr., D. T., and F. F. Wreh	EBOLA IMPACT REVEALED An Assessment of the Differing Impact of the Outbreak on Women and Men in Liberia	2015
Lamond, E. and J. Kinyanjui	CHOLERA OUTBREAK GUIDELINES PREPAREDNESS, PREVENTION AND CONTROL	2012
Lee, V	Disaster relief and initial response to the earthquake and tsunami in Meulaboh, Indonesia	2005
Leidner, A. J. and N. C. Adusumilli	Estimating effects of improved drinking water and sanitation on cholera	2013
Levy, B.,	Ebola infection control in Sierra Leonean health clinics: A large cross-agency cooperative project	2015
Lilje, J., H. Kessely and H.-J. Mosler	Factors Determining Water Treatment Behavior for the Prevention of Cholera in Chad	2015
Lothe, P.	EVALUATION OF ECHO'S 1999 TO 2002 FUNDED ACTIONS IN SUDAN WATER AND SANITATION, FOOD SECURITY AND NON FOOD ITEMS DISTRIBUTIONS	2003
Madzingamiri, D. M. A. C. Schouten and M. Blokland	Water, sanitation and hygiene partners collaborating to combat severe cholera outbreaks during the State of Emergency in Zimbabwe	2015
Manga, N. M.,	Cholera in Senegal from 2004 to 2006: lessons learned from successive outbreaks	2008
Marks, P	Use of hygiene advice and active immunisation to control an outbreak of hepatitis A	2001

Martin, A	Mortality Rates above Emergency Threshold in Population Affected by Conflict in North Kivu, Democratic Republic of Congo, July 2012-April 2013.	2014
McDonald, C. E.	Improving WASH response by reinforcing sector preparedness and coordination	2013
McDonald, K. D.	Grandmothers wheeled in barrows	2001
Nandy, S	Floods in India–Disaster and Management	2005
Okware, S. I. F.	An outbreak of Ebola in Uganda	2002
Osti, R.	Forms of community participation and agencies' role for the implementation of water-induced disaster management: protecting and enhancing the poor	2004
Oxfam	Turning the tide on Ebola: Scaling up public health campaigns before it's too late	2014
Rab, M. A.,	Water-borne hepatitis E virus epidemic in Islamabad, Pakistan: a common source outbreak traced to the malfunction of a modern water treatment plant	1997
Rahman, M. M. and M. K. Bux	Post disaster situation of water supply and sanitation	1995
Rajabali, A	Communicable disease among displaced Afghans: refuge without shelter	2009
Schaetti, C., N	Comparing sociocultural features of cholera in three endemic African settings	2013
Schulz Fisher, M.	Responding to the Cholera Epidemic in Haiti	2014
Scott, R	Sustainable WASH interventions as populations transition from relief to development.	2013
Sivakumar, B.	Water crisis: From conflict to cooperation-an overview	2011
Tambe, M. P.	Investigation of an Outbreak of Hepatitis'E' in a Rural Area of Dhule District in Maharashtra	2015
Thormar, S. B.	Evaluation of Ebola response – Uganda	2013
Usman, A.	Recurrent cholera outbreaks in Kano - Norther Nigeria	2005
Watkins, R	Gastrointestinal infections in the setting of natural disasters	2012
Watson, J	Epidemics after natural disasters	2007
Weiss, W	A comparison of the medium-term impact and recovery of the pakistan floods and the haiti earthquake: Objective and subjective measures	2014
No Author	Combating Ebola Outbreak in Guinea through Intensified Social Mobilization and Improved Contact Tracing	2015
No Author	Working with Children in Humanitarian WASH Programmes	No Date
No Author	Emergency Cash-based Interventions in Urban Areas: Tropical Storm Washi in the Philippines	2012
No Author	Comprehensive Child Focused Assessment Al Za'atari Refugee Camp – Mafraq Governorate, Jordan	2015

No Author	DFID's Humanitarian Emergency Response in the Horn of Africa	2012
No Author	Ebola Outbreak in West Africa Lessons Learned from Quarantine – Sierra Leone and Liberia	2015
No Author	HEALTH: West Africa	2012
No Author	Hepatitis E , Sudan - update	2004
No Author	Hepatitis E, Chad - update	2004
No Author	Public health impact of Rwandan refugee crisis: what happened in Goma, Zaire, in July, 1994? Goma Epidemiology Group	1995
No Author	Pushed to the Limit and Beyond A year into the largest ever Ebola outbreak	2015
No Author	Summary of WASH Cluster Cholera Response Lessons learnt	2009
No Author	THE IMPACT OF U.S. WATER PROGRAMS ON GLOBAL HEALTH	2013
No Author	WASH Approaches in the Relief-to-Development Continuum	2016
No Author	WASH in Guinea, Liberia, and Sierra Leone The Impact of Ebola	2015
No Author	WASH IN SCHOOLS Liberia's first step to recovery from Ebola	2015
No Author	WASH Working Group S. Syria - Amman WASH Response Strategy May 2015	2015
No Author	Water and sanitation in health emergencies: the role of WHO in the response to the earthquake in Haiti, 12 January 2010	2010
No Author	Water, sanitation, and hygiene: the Dominican Republic's plan to control outbreaks	2011

No Outcome or Impact of Relevance

Studies did not clearly present an outcome or impact within the review.

Author	Title	Year
ACF	Bilan des actions d'urgence mises en place sur le départment du Nord-Ouest et plus particulièrement sur Port-de-Paix suite au passage des cyclones Ike et Hanna	2008
Adams, J.	Managing water supply and sanitation in emergencies	1999
Amin, M. T. and M. Y. Han	Water environmental and sanitation status in disaster relief of Pakistan's 2005 earthquake	2009
Condor, J.	Evaluation of the International Organization for Migration's Ongoing Activities on Support to the Flash Appeal for the Haiti Earthquake and Cholera Outbreak (Sida/IOM Agreement January 2010 – May 2011)	2011
DuBois, A. E., M. Sinkala, P. Kalluri, M. Makasa-	Epidemic cholera in urban Zambia: hand soap and dried fish as protective factors	2006

Chikoya and R. E. Quick		
ELHRA	High-science in low-tech emergency settings: a foreseeable horizon or height of folly	2011
Enzley, S. and F. Barros	A Global Review of Diarrhoeal Disease Control	1997
Fernando, W. B. G., A. H. Gunapala and W. A. Jayantha	Water supply and sanitation needs in a disaster–Lessons learned through the tsunami disaster in Sri Lanka	2009
Gormley, M.	After the Tsunami: water supply and sanitation, from emergency response to rehabilitation	2005
Guthmann, J.-P.,	A Large Outbreak of Hepatitis E among a Displaced Population in Darfur, Sudan, 2004: The Role of Water Treatment Methods	2006
Joseph, F.	In need of a better WASH: Water, sanitation, and hygiene policy issues in post-earthquake Haiti	2011
Kessler, R	Hidden benefits: linking relief and development in Kabul	1998
Kramer, S.,	Thermophilic composting of human wastes in uncertain urban environments: a case study from Haiti	2013
Larose, L	Hygiene is not cleanliness. For a new definition of hygiene promotion in emergency humanitarian aid	2001
Le Masson	Intégrer le genre dans les projets d'urgence dans le secteur de l'eau, l'assainissement et l'hygiène	2014
Luby, S. P.,	Field trial of a low cost method to evaluate hand cleanliness	2007
Martin	Rapport final - Water trucking DINEPA-ACF, Zone métropolitaine de Port-au-Prince, mai 2010 - 15 mai 2011	2011
Mahamud, A.,	EPIDEMIC CHOLERA IN KAKUMA REFUGEE CAMP, KENYA: THE IMPORTANCE OF SANITATION AND SOAP	2010
MSF	Cholera Outbreak OCG E-Cell response in Haiti, 2010-2011	
MSF	Cholera Outbreak in Zimbabwe OCA, OCB, OCBA, 2008-2009	
Ockelford, J.	Review of the WASH Cluster in Bangladesh SIDR Response	2008
Poon, K.	International Federation of Red Cross Red Crescent Societies & Democratic People's Republic of Korea Red Cross Society	2012
Rahman, M. M. and M. K. Bux	Post disaster situation of water supply and sanitation	1995
Randall, J. J	Environmental stewardship and the humanitarian aid water and sanitation sector: Lessons from the 2004 tsunami disaster response	2009
Randall, J. J.	Environmental stewardship and the humanitarian aid water and sanitation sector: Lessons from the 2004 tsunami disaster response	2009
Samaritan's Purse	Mozambique Flood Response	2013

Samaritan's Purse	Liberia Ebola Interim Report	2014
Samaritan's Purse	Malawi Flood Response	2015
Sarkar, M	Assessing the efforts of NGOs in cyclone disaster management in Bangladesh	2009
Schuller, M. and T. Levey	Kabrit ki gen twÃ²p mÃ¨t: understanding gaps in WASH services in Haiti's IDP camps	2014
Shaikh, M. G., and V. S. Majumdar	CHLORINATIONAL LEVEL OF WATER AND PREVALENCE OF VIRAL HEPATITIS IN FLOOD AFFECTED AREAS OF VADODARA CITY, INDIA	2011
Shekhar, A., S.	Ensuring safe water and sanitation during floods in rural communities of Bihar State, India	2010
Sherlock, P.	Water and Sanitation for refugees and internally displaced people	2006
Walden, VM	Major concerns facing water, sanitation and community hygiene promotion responses in emergencies	No Date
Wiles, Peter	THE 2004 INDIAN OCEAN TSUNAMI DISASTER EVALUATION OF UNICEF'S RESPONSE (EMERGENCY AND INITIAL RECOVERY PHASE) SYNTHESIS REPORT	2006
Wijeyaratne, P.	Prevention of water borne diseases in the tsunami affected Thotagamuwa-Hikkaduwa area of southern Sri Lanka	2006
No Author	Sanitation without Landmines and Explosive Remnants of War	2016
No Author	Findings of the WASH Assessments of Syrian Households in Za'atari Refugee Camp Mafraq Governorate	2013
No Author	Global WASH Cluster Evaluation of the Support Provided to National Coordination Platforms	2014
No Author	Key Findings of REACH's Survey of WASH Facilities in Za'atari	2013
No Author	SOMALIA EMERGENCY RESPONSE - INTERIM REPORT	2012
No Author	EMERGENCY INTERVENTION RESPONSE	No Date

Outside Scope of Review

Studies may have activities that could be considered WASH in some respects, but were primarily described within the scope of nutrition, health, or another sector.

Author	Title	Year
Barbiche, J	2014 ACF Burkina Faso Case Studies GB	2014
Chamberlain, P.	Mid-Term Review: BRC/PRC Typhoon Haiyan - Iloilo Recovery Programme	2015
Desmyter, D.,	Monitoring and Evaluation of 1,000 Households receiving Ceramic Pot (Kosim) Filters after an Emergency Flood Mass Distribution in Northern Ghana	2009
Di Bella, V.	Challenges for the SWM sector in post-natural disaster and post-conflict scenarios: a comparison	2011
Dorea, C	The potential of a semi-decentralised bulk water treatment approach for emergency relief	2014

Ernst, S.,	Cholera management and prevention at Hopital Albert Schweitzer, Haiti	2011
Flachenberg, F.	Hygiene promotion in Ebola: embedding best practices for safe and dignified burials, the case of Freetown, Sierra Leone	2015
Fox, P	Caring for Myanmar refugees in Thailand	1996
Fuster Callaba, C. A.	DescripciÃ³n de las experiencias de las brigadas de control de vectores durante la epidemia de cÃ³lera en HaitÃ-	2013
GOAL	EBOLA RESPONSE LESSONS LEARNED SERIES: SUPPORT TO QUARANTINED HOMES	No Date
GOAL	EBOLA RESPONSE LESSONS LEARNED SERIES: SOCIAL MOBILISATION ACTION CONSORTIUM	No Date
Heaselgrave, W.	The efficacy of simulated solar disinfection (SODIS) against coxsackievirus, poliovirus and hepatitis A virus	2012
Jeuland, M	Cost-benefit comparisons of investments in improved water supply and cholera vaccination programs	2009
Kuitems, J.	Review of the WASH Cluster in Union of Myanmar, following the cyclone Nargis response	2009
Lamb, J.	Working with markets and the local Government whilst responding to the WaSH needs of the Syrian crisis	2015
Miller, S., L.	Development of an intervention to reduce transmission of respiratory infections and pandemic flu: measuring and predicting hand-washing intentions	2012
Murray, J	Cost-effectiveness of oral cholera vaccine in a stable refugee population at risk for epidemic cholera and in a population with endemic cholera	1998
OCHA	South Sudan: Cholera cases decline as aid agencies join forces to contain the outbreak	2015
OCHA	Haiti: Improved sanitation to combat cholera	2012
OCHA	DRC: Fighting cholera with chlorinated water	2012
OCHA	DRC: Doctors and engineers team up against cholera in South Kivu	2013
Pietzsch, S.	The effects of using P&G Purifier of Water during the treatment of severe acute malnutrition	2014
Rebmann, T	Lessons Public Health Professionals Learned From Past Disasters	2008
Rijsdijk, A.	Evaluation of ECHO´s Gobal Plan 2000 - Angola Sector: Water and Sanitation	2001
Sardar, T	An optimal cost effectiveness study on Zimbabwe cholera seasonal data from 2008-2011	2013
Unicef	Children in Haiti - One Year After the Earthquake	2011
Unicef	INDEPENDENT REVIEW OF UNICEF'S OPERATIONAL RESPONSE TO THE JANUARY 2010 EARTHQUAKE IN HAITI	2011
USAid	Pre-Crisis Market Mapping and Analysis: Strengthening Emergency Water, Sanitation, and Hygiene (WASH) Response in Urban Settings	2015

Vandevelde	L'alimentation en eau des populations civiles lors de situations de sortie de crise et de post-conflit: exemple de la ville de Mitrovica (Kosovo) en 1999-2000	2002
Visser, M	Ebola response in the Republic of Congo	2005
WHO	Ebola Response in Action	2014
WHO	EVALUATING HOUSEHOLD WATER TREATMENT OPTIONS: Health-based targets and microbiological performance specifications	2011
Wild, L. and N. Mason	Examining the role of WASH services within peace- and state- building processes Findings from Tearfund programmes in the Democratic Republic of Congo and the Republic of South Sudan	2012
No Author	WATER TRUCKING IN HAITI: FROM EMMERGENCY RESPONSE TO EXIT STRATEGY	2012
No Author	Tropical Storm Sendong (WASHI)	2012
No Author	Tropical Storm Washi/Sendong Action Review Report	2012

Policy Document

Studies that could be bordering on reviews or technical instructions, but intended to influence future interventions/research rather than evaluate a project.

Author	Title	Year
Ali, S. I.	WASH in Emergencies Problem Exploration Report Water Treatment	2016
Bastable, A	Water, sanitation and hygiene services beyond 2015: improving access and sustainability Promoting Sustainability in Refugee & IDP responses	2015
Brun, D.	Demystifying Gender LESSONS LEARNED FROM THE IMPLEMENTATION OF MINIMUM COMMITMENTS FOR GENDER PROGRAMMING IN EMERGENCY WASH RESPONSE. A CASE STUDY FROM THE DRC	No Date
Bryant, J.	Urban WASH in Emergencies	2014
Cohen, M	Urban Disaster Response and Recovery: Gender-sensitive WASH Programming in Post-earthquake Haiti	2014
Luff, R	Bulk water treatment unit performance: For the cameras or the community?	2012
Parker, A. H	Menstrual management: A neglected aspect of hygiene interventions	2014
Polanski, P	Evaluating humanitarian response to disasters in the WASH sector	2014
Ramos, M.	WASH in Emergencies Problem Exploration Report Handwashing	2016
Reed, B.	WASH in Emergencies Problem Exploration Report Solid Waste Management	2016
Richardson, J.	UNICEF Tsunami Communications Evaluation	2005

Sommer, M.	Menstrual hygiene management in humanitarian emergencies: Gaps and recommendations	2012
No Author	URBAN DISASTER RESPONSE AND RECOVERY Gender-sensitive WASH programming in post- earthquake Haiti	2014

Protracted Emergency

Studies that describe interventions that were responding to contexts for extended periods of time were not included. The scope of the review was 'short-term emergencies' defined as within 12 months of an emergency; thus, long established refugee camps or chronic emergencies were not included.

Author	Title	Year
ADB	War, Conflict and Water in Eastern Sri Lanka	2013
Alem, G.	Evaluation of Emergency Water Supply and Sanitation	2004
Balfour, N.,	CLTS in Fragile and Insecure Contexts: Experience from Somalia and South Sudan	2014
Brocklehurst, C	Engineering in the time of cholera: overcoming institutional and political challenges to rebuild Zimbabwe's water and sanitation infrastructure in the aftermath of the 2008 cholera epidemic	2013
Cherian, D.	ZIMBABWE EMERGENCY WATER AND SANITATION PROJECT	2006
Colwell, R. R	Reduction of cholera in Bangladeshi villages by simple filtration	2003
DeGabriele, J.	Water & Sanitation and Nutrition Projects in South Central Somalia	2008
Dost, Q.	Southern Afghanistan community and child focused services, water and sanitation programme	2008
Egbuta, John O.	2014 ACF Emergency Nutrition Program Implementation in Northern Nigeria	2014
House, S.	Humanitarian support to vulnerable households in the most water and sanitation scarce and cold regions of Afghanistan	2011
Hubbard, B	Development of Haiti's rural water, sanitation and hygiene workforce	2014
IRC	UNDERSTANDING HAND WASHING BEHAVIOR RESULTS OF FORMATIVE RESEARCH ON HAND WASHING IN REFUGEE CAMP POPULATIONS IN THAILAND, KENYA AND ETHIOPIA SUMMARY OF FINDINGS	2011
Klaassen, W.	Emergency Nutrition, Health and WASH interventions for conflict-affected population in South Central Somalia	2011
Kumamaru, K	Improving access to safe water for internally displaced persons (IDPs) in a fragile state, Somalia	2013
Mensah, A.	People and their waste in an emergency context: The case of Monrovia, Liberia	2006

Mol, A.	The success of household sand filtration	2001
Morris-Iveson, L.	WASH and DRR integration during a flood response in Cordoba province, Colombia	No Date
Opryszko, M. C.,	Water and hygiene interventions to reduce diarrhoea in rural Afghanistan: a randomized controlled study	2010
Patrick, M., D.	Access to Safe Water in Rural Artibonite, Haiti 16 Months after the Onset of the Cholera Epidemic	2013
Peterson, E. A.	The effect of soap distribution on diarrhoea: Nyamithuthu Refugee Camp	1998
Pezon, C. , K.	Costing water services in refugee camps Camp Bambasi, Ethiopia, and Camp Kounoungou, Chad	2015
Pinera, J. F.	Urban armed conflicts and water services	2012
Savel, M	WATER QUALITY, WATER CONSERVATION, AND WASTEWATER DISPOSAL HABITS IN 10 GATHERINGS OF SOUTH LEBANON	2009
Sisson, A	An assessment of long-term biosand filter use and sustainability in the Artibonite Valley near Deschapelles, Haiti	2013
Shantz	An assessment of the use and performance of Ceramic Water Filters (CWFs) in the emergency context of Rakhine State, Myanmar	2016
van de Rijdt, M.	External Evaluation of the NCA WASH Programme in Darfur With Special Focus on IDP Camps in Zalingei	2010
No Author	UNDERSTANDING HAND WASHING BEHAVIOR RESULTS OF FORMATIVE RESEARCH ON HAND WASHING IN REFUGEE CAMP POPULATIONS IN THAILAND, KENYA AND ETHIOPIA SUMMARY OF FINDINGS	2011
No Author	WASH Cash Transfer Programming in Gaza – challenges and opportunities	No Date

Repeated Research

Studies that were reported and/or published by different people within the same group of authors on the same project or research.

Author	Title	Year
Yardley, S.	How WASH can contribute to peace- and state-building	2011

Review Documents

Documents that summarized other studies or evaluations as the primary focus were considered review documents. They were not included, but references were screened and evaluated against our inclusion criteria.

Author	Title	Year
Aoyagi, K.,	Quality of drinking water and sanitation after the Sumatra-Andaman Earthquake and the Indian Ocean Tsunami in southern Sri Lanka	2006
Blake, S.,	Potable water issues during disaster response and recovery: Lessons learned from recent coastal disasters	2011
Branz, Ariel	Chlorination of Water in Emergencies: Review of Knowledge, Recommendations for Implementation, and Research Needed	2016
Brown, D.	Urban Crises and Humanitarian Responses: A Literature Review	2015
Brown, J	Water, sanitation and hygiene in emergencies: summary review and recommendations for further research	2012
Bryant, J	Urban WASH in Emergencies	2014
Cairncross, S.	Evaluation of the WASH activities undertaken to prevent and control cholera outbreaks in Guinea- Conakry & Guinea-Bissau : systematic literature review	2009
Campuzano Cuadrado, P.	[Epidemic cholera in complex emergencies]	2014
Clasen, T. F	Interventions to improve disposal of human excreta for preventing diarrhoea (review)	2010
Clasen, T., L.	The drinking water response to the Indian Ocean tsunami, including the role of household water treatment	2006
Cronin, A. A.,	A review of water and sanitation provision in refugee camps in association with selected health and nutrition indicators--the need for integrated service provision	2008
Ferron, S.	Emergency WASH for Children, scoping study	2014
Fewtrell, L	Water, sanitation and hygiene in developing countries: interventions and diarrhoea - a review.	2005
Gonzalez-Hernandez, A. and L. Boughen	Meta-Evaluation Report ACF Programme Evaluations 2008	2009
Hunter, P. R.	Household Water Treatment in Developing Countries: Comparing Different Intervention Types Using Meta-Regression	2009
Kooy, M	Doing Things Differently: Can Water Supply, Sanitation, and Hygiene Services Support Peace- and State-Building Processes?	2015
Leonardi, E.	Emergency Preparedness and Response Evaluations 2003-2008 SUMMARY REVIEW	2008
Li, H	Control effects of water improvements and sanitation interventions on diarrhea incidences in China: a meta-analysis	2014
Loevinsohn, M	The cost of a knowledge silo: a systematic re-review of water, sanitation and hygiene interventions	2015
No Author	Guidance on communication with respect to safe drinking water and household hygiene Literature review , interviews and case studies	No Date

Murugaiah, C.	The burden of cholera	2011
Mwaniki, P.	Lessons learned in WASH response during rural flood emergencies	2009
Onsurbe, J	"2014 ACF IMPACT OF WATER, SANITATION AND HYGIENE INTERVENTIONS ON HEALTH AND NUTRITION"	2014
Parkinson, J	A Review of the Evidence Base for WASH interventions in Emergency Responses	2009
Pavanello, S. and J. Darcy	Improving the provision of basic services for the poor in fragile environments International Literature Review	2008
Ramesh, A.,	Evidence on the Effectiveness of Water, Sanitation, and Hygiene (WASH) Interventions on Health Outcomes in Humanitarian Crises: A Systematic Review	2015
Rush, H. and N. Marshall	Case Study : Innovation in Water , Sanitation and Hygiene	2015
Seguin, M	Non-clinical interventions for acute respiratory infections and diarrhoeal diseases among young children in developing countries	2015
Shah, D	Promoting appropriate management of diarrhea: A systematic review of literature for advocacy and action: UNICEF-PHFI series on newborn and child health, India	2012
Smith, M.	Lessons learned in WASH Response during Urban Flood Emergencies	2009
Taylor, D. L.,	The Impact of Water, Sanitation and Hygiene Interventions to Control Cholera: A Systematic Review	2015
Waddington, H. and B. Snilstveit	Effectiveness and sustainability of water, sanitation, and hygiene interventions in combating diarrhoea	2009
Waddington, H., B. Snilstveit, H.	Water, sanitation and hygiene interventions to combat childhood diarrhoea in developing countries	2009
Welle, K.	Improving the provision of basic services for the poor in fragile environments Water Supply, Sanitation and Hygiene International Literature Review	2008
No Author	Programme d'amélioration des conditions de vie des populations hôtes, retournées et déplacées dans les territoires de Masisi, Kalehe et Kabare	2012
No Author	Programme Wash pour l'Amélioration des conditions de vie des populations hôtes, déplacées et retournées dans le Sud et le Nord Kivu	2009

Timing: 13 or more months from Disaster

Studies that describe interventions that in some ways could be considered an emergency but are more than 12 months from the 'emergency event.' This is similar to the protracted emergency, but could be more clearly meet the 13+ month definition in some cases.

Author	Title	Year
Ali, S. I., S.	Effectiveness of emergency water treatment practices in refugee camps in South Sudan	2015
Apiyo, R. J.	FINAL EVALUATION REPORT REGIONAL SUPPLY HUB MECHANISM AS A STRATEGY FOR WASH EMERGENCY RESPONSE IN SOMALIA	2014
Bean, J.	EVALUATION REPORT KISANGANI INTEGRATED WATER, SANITATION AND MALARIA CONTROL PROGRAMME, EASTERN DRC	2003
Boot, N.	Delivering sustainable water supply in fragile and conflict affected states: experiences from Syria	2015
Casanova, L	Ceramic pot filter user satisfaction and water quantity production in tsunami-affected Sri Lankan communities	2012
DeVillez, P.	Evaluation of DG ECHO's Action in the Water and Sanitation/Public Health Sector in Zimbabwe	2011
Domercant, J. W.,	Update on progress in selected public health programs after the 2010 earthquake and cholera epidemic--Haiti, 2014	2015
Gelting, R.	Evaluation of the Health Impact of the American Red Cross- Sponsored Water and Sanitation Infrastructure Reconstruction Program in Communities Affected by Hurricane Mitch Honduras , Nicaragua , El Salvador , and Guatemala	2002
McKenzie, S	Oxfam in Goma - a public-health learning experience	1996
Moll, D.,	Health impact of water and sanitation infrastructure reconstruction programmes in eight Central American communities affected by Hurricane Mitch	2007
Ngegba, S.	Water and Sanitation Programme February-December 2002 Jaluahun Chiefdom, Kailahun District Eastern Province, Sierra Leone	2002
Polo Torres, M.,	Combining Hygiene Behavior Change with Water & Sanitation: A Pilot Project in Hato Mayor, Dominican Republic	2004
Sabogal, R. I.,	Sustainability of water, sanitation and hygiene interventions in Central America	2014
No Author	DFID's Water, Sanitation and Hygiene Programming in Sudan	2013

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ACF. 2007. UNOCHA Emergency Funding Water and Sanitation Program in Kebri Dehar District, Somali Region. Action Contre La Faim - France.

ACF. 2009. Household NFI monitoring Report (PDM) May 2009. Action Contre La Faim - Zimbabwe.

ACF. 2014a. DRM and WASH Post Distribution Monitoring Report KPK, Pakistan- November 2014. Action Against Hunger - International.

ACF. 2014b. Feasibility study and piloting of a Decentralized safe water access solution dedicated to emergency and natural catastrophes through a pre-trained community based Emergency Response Team (ERT) "Aquasure". Action Contre la Faim.

ACF. 2014c. Hygiene Kits Post Distribution Monitoring Report Action Contre La Faim - South Sudan.

ACF. 2014d. Projet pilote de l'approche de marché pour la promotion du chlore liquide. Action Contre La Faim.

ACF. 2015a. Community Led Ebola Management and Eradication (CLEME) Trigger Behavioral Change to strengthen community's resilience to Ebola Outbreaks. Action Contre La Faim.

ACF. 2015b. Non Food Items and Emergency Shelter Post Distribution Monitoring Report, Yobe State, Nigeria. Action Contre la Faim.

Alem, Getschew. 2004. Evaluation of Emergency Water Supply and Sanitation. Oxfam GB.

Baker, Jock , and Ephrem Mbogha. 2009. Final Evaluation Oxfam's North Kivu Emergency Response. Oxfam.

Bastable, Andy, and Jenny Lamb. 2012. "Innovative designs and approaches in sanitation when responding to challenging and complex humanitarian contexts in urban areas." *Waterlines* 31 (1-2):67-82.

Beau De Rochars, V. E., J. Tipret, M. Patrick, L. Jacobson, K. E. Barbour, D. Berendes, D. Bensyl, C. Frazier, J. W. Domercant, R. Archer, T. Roels, J. W. Tappero, and T. Handzel. 2011. "Knowledge, attitudes, and practices related to treatment and prevention of cholera, Haiti, 2010." *Emerging Infectious Diseases* 17 (11):2158-61.

Cabezas, César, Beatriz Álvares, Elizabeth Salazar, Víctor Sánchez-Paredes, and Juan José Quispe. 2008. "Efectividad del uso de alcohol glicerinado para la descontaminación de manos en una población sin aceso al agua potable

posterremoto en Pisco, Perú." *Revista Peruana de Medicina Experimental y Salud Publica* 25 (4):391-393.

Cavallaro, Elizabeth C., Julie R. Harris, Mauricio Serafim da Goia, Jean Carlos dos Santos Barrado, Aglaer Alves da Nobrega, Inacio Carvalho de Alvarenga Junior, Augusto Paulo Silva, Jeremy Sobel, and Eric Mintz. 2011. "Evaluation of pot-chlorination of wells during a cholera outbreak, Bissau, Guinea-Bissau, 2008." *Journal of Water and Health* 9 (2):394-402. doi: 10.2166/wh.2011.122.

Clasen, T. , Lucy Smith, Jeff Albert, Andrew Bastable, and Jean-Francois Fesselet. 2006. "The drinking water response to the Indian Ocean tsunami, including the role of household water treatment." *Disaster Prevention and Management* 15 (1):190-201.

Clasen, T., and S. Boisson. 2006. "Household-based ceramic water filters for the treatment of drinking water in disaster response: An assessment of a pilot programme in the Dominican Republic." *Water Practice & Technology* 1 (02).

Colindres, Romulo E., Seema Jain, Anna Bowen, Polyana Domond, and Eric Mintz. 2007. "After the flood: an evaluation of in-home drinking water treatment with combined flocculent-disinfectant following Tropical Storm Jeanne - Gonaives, Haiti, 2004." *Journal of Water and Health* 5 (3):367-374. doi: 10.2166/wh.2007.032.

Coloni, Francesca, Rafael Van den Bergh, Federico Sittaro, Stephanie Giandonato, Geneviève Loots, and Peter Maes. 2012. "Biodegradable bags as emergency sanitation in urban settings: the field experience." *Waterlines* 31 (1-2):122-132.

Colwell, R. R., A. Huq, M. S. Islam, K. M. Aziz, M. Yunus, N. H. Khan, A. Mahmud, R. B. Sack, G. B. Nair, J. Chakraborty, D. A. Sack, and E. Russek-Cohen. 2003. "Reduction of cholera in Bangladeshi villages by simple filtration." *Proc Natl Acad Sci U S A* 100 (3):1051-5. doi: 10.1073/pnas.0237386100.

Condor, Jeremy , and Raj Rana. 2011. Evaluation of the International Organization for Migration's Ongoing Activities on Support to the Flash Appeal for the Haiti Earthquake and Cholera Outbreak IOM International Organization for Migration

Conroy, Ronán M., M. E. Meegan, Tina Joyce, Kevin McGuigan, and Joseph Barnes. 2001. "Solar disinfection of drinking water protects against cholera in children under 6 years of age." *Archives of disease in childhood* 85 (4):293-295.

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Date, Kashmira, Bobbie Person, Benjamin Nygren, Vincent Were, Steve Kola, Tracy Ayers, and Robert Quick. 2013. "Evaluation of a Rapid Cholera Response Activity-Nyanza Province, Kenya, 2008." *Journal of Infectious Diseases* 208:S62-S68. doi: 10.1093/infdis/jit198.

de Lange, Rink, Annick Lenglet, Jean Francois Fesselet, Martha Gartley, Azat Altyev, Julie Fisher, and Leslie Shanks. 2014. "Keeping it simple: a gender-specific sanitation tool for emergencies." *Waterlines* 33 (1):45-54.

DeGabriele, Joseph 2008. Water & Sanitation and Nutrition Projects in South Central Somalia. Action Contre la Faim - Somalia.

DeGabriele, Joseph , and Alima Musa. 2009. An emergency response to humanitarian WASH- related emergencies in Zimbabwe. Action Contre la Faim & Welthungerhilfe Zimbabwe.

Dinku, Siseraw 2011. Emergency Water, Sanitation, and Hygiene Interventions for AWD and Drough Affected Pastorial Communities in Borana Zone, Ethiopia. Action Contre La Faim - International (ACF - IN).

Doocy, S., and G. Burnham. 2006. "Point-of-use water treatment and diarrhoea reduction in the emergency context: an effectiveness trial in Liberia." *Tropical Medicine & International Health* 11 (10):1542-52.

Dorea, Caetano Chang, Richard Luff, Andy Bastable, and Brian Adrian Clarke. 2009. "Up-flow Clarifier for emergency water treatment." *Water and Environment Journal* 23 (4):293-299. doi: 10.1111/j.1747-6593.2008.00142.x.

Dunoyer, Jessica , and Bertrand Sudre. 2012. Le choléra au Tchad en 2011 et les stratégies d'intervention associées. Action Contre la Faim - France.

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Ensink, Jeroen H. J., Andy Bastable, and Sandy Cairncross. 2015. "Assessment of a membrane drinking water filter in an emergency setting." *Journal of Water and Health* 13 (2):362-370. doi: 10.2166/wh.2014.025.

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International Initiative for Impact Evaluation
London International Development Centre
36 Gordon Square
London WC1H 0PD
United Kingdom

3ieuk@3ieimpact.org
Tel: +44 207 958 8351/8350

www.3ieimpact.org