Systematic review

What factors affect sustained adoption of safe water, hygiene and sanitation technologies?

A systematic review of literature

by Kristyna Hulland
Nina Martin
Robert Dreibelbis
Julia DeBruicker Valliant
Peter Winch

June 2015

UKaid from the British people
Johns Hopkins Bloomberg School of Public Health
Johns Hopkins Water Institute
3ie
EPPI Centre
UCL Institute of Education

This material has been funded by the Department for International Development. The views expressed do not necessarily reflect the views of the Department for International Development. The authors are part of the Department of International Health, The Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA; School of Civil Engineering and Environmental Science and Department of Anthropology, Oklahoma University, Norman, Oklahoma, USA; and were supported by the Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre).

The EPPI-Centre reference number for this report is 2303.

This report should be cited as:

Hulland K, Martin N, Dreibelbis R, DeBruicker Valliant J, Winch P (2015) *What factors affect sustained adoption of safe water, hygiene and sanitation technologies? A systematic review of literature*. London: EPPI-Centre, Social Science Research Unit, UCL Institute of Education, University College London.

ISBN: 978-1-907345-77-7

Contents

Tables

Figures

Abbreviations

3ie	International Initiative for Impact Evaluation
CDC	Centers for Disease Control
CHCs	Community health clubs
CLTS	Community-Led Total Sanitation
DfID	Department for International Development, UK
GHWP	Good handwashing practices
HMIC	Health Management Information Consortium (database, UK)
HW	Handwashing
HWS	Handwashing station
HWTS	Household water treatment and safe storage
IBM-WASH	Integrated Behavioural Model for Water, Sanitation and Hygiene Technologies
IBSS	International Bibliography of the Social Sciences
KAP	Knowledge, attitudes and practices
LMIC	Lower- and middle-income countries
MDG	Millennium Development Goal
MeSH	Medical Subject Headings (National Library of Medicine, USA)
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
POU	Point of Use
SES	Socio-economic status
SODIS	Solar disinfection
WASH	Water, sanitation and hygiene
WHO	World Health Organization
WSP	Water and Sanitation Programme (World Bank)

Executive summary

Background: the review question

Among the exciting advances in water, sanitation, and hygiene (WASH) programmes and policies, sustainability counts as a renewed and crucial area of focus for implementers, scientists, policy makers, and donors alike. To further our understanding of the barriers and facilitators to sustained adoption and use of water and sanitation technologies, we conducted a systematic review of studies concerning both initial and sustained adoption of WASH interventions at the individual, household and community levels in low- and middle-income countries. We built on previous reviews of handwashing and point-of-use water treatment, with a comprehensive review that is dramatically larger and broader in scope than previous studies. It is the only review we know of that includes a range of WASH interventions and factors associated with adoption. The review questions are:

> *Q1. What are the factors that influence the sustained adoption of clean water and sanitation technologies?*
>
> *Q2. What are the characteristics of interventions intended to improve adoption of clean water and sanitation technologies and how successful are these interventions at fostering both adoption and sustained adoption?*

In answering these questions, we examined the extent to which existing interventions addressed known barriers to and/or leverage known facilitators of the sustained adoption of water and sanitation technologies.

Important terminology

'Sustained use' 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'. By 'project period', we refer to any one of the following periods:

1. In a mass media behaviour change communication intervention, it is the period during which project-related material was being broadcast or disseminated through radio, television, newspapers or other mass channels of communication, or through mobile phone applications
2. In a community-based inter vention, it is the period during which there was external support to community groups, leaders and volunteers in the form of training, supervision and feedback, distribution of technology, or provision of communication materials
3. In a research project, it is the period during which the research team or the team's local partners were implementing the behaviour change intervention and/or WASH intervention being evaluated as part of the study.

This differs from 'maintenance', which refers to the continued practice of a WASH behaviour or use of a technology *during* the project period. While many behavioural models specify factors that motivate *initial* adoption of a WASH technology during a project, these may not be same factors that motivate the sustained practices of WASH behaviours into the extended future after the project ends.

Methods of the review

We searched commercial databases, hand-screened journals and web resources, and searched for peer-reviewed and grey literature to identify articles documenting water, sanitation, or hygiene interventions, incorporating behaviour change, uptake or sustainability, in lower- and middle-income countries. Citations were screened by title and

abstract. We identified 225 for full-text review, and 148 articles and reports were included in the mapping and keywording (identifying key words/themes of each included article) stage of our review. From these 148 articles, we extracted descriptive data that provided general information about the available literature documenting sustained adoption of water, sanitation and/or hygiene interventions. We identified 44 articles specifically reporting on long-term use or sustained adoption for in-depth review and further synthesis.

Results

Of the 148 articles and reports identified in our mapping and keywording phase, the literature was well distributed between interventions or programmes that addressed handwashing (n=55 studies), safe water (n=62) and sanitation (n=59). Forty-six percent of studies explicitly mentioned sustained adoption. After conducting an in-depth synthesis of the 44 studies explicitly reporting on sustained adoption, we found the following trends in that subset of articles, presented here in relation to our research questions.

- Research question 1 (in part): Measuring sustained adoption
    - Twenty-one (21/44) studies assessed WASH practices at least six months or more after the end of a study's project period. Due to the heterogeneity of outcome definitions, measurement methodologies, and comparisons made, WASH use trends over time appear variable.
    - Post-intervention sustainability is often measured by a combination of survey, interview and observation. There is no clear definition for sustained adoption employed in WASH literature, and sustained adoption is measured through self-report, observed practice, functionality and recalled knowledge.
- Research question 1 (in part): Behavioural factors that influence sustained adoption
    - *Psychosocial factors*: Perceived susceptibility and severity of disease and perceived benefits and barriers are common psychosocial factors identified as influences on sustained adoption. However, some other factors, such as injunctive and descriptive norms and nurturing, may be more predictive as motivators of continued use over time.
    - *Contextual factors*: These factors are often included in the study design. Age and gender are important factors that influence both who is able to practice the behaviour at the household level, and to determine roles in providing water, soap and child care.
    - *Technology factors*: Cost is an important factor regardless of the technology. Factors like durability, rate of water flow and maintenance are key in ensuring that technologies withstand frequent use over a long period of time.
- Research question 2: Programme characteristics influencing sustained adoption
    - Fourteen (14/44) articles assessing sustained adoption explicitly described programme or intervention tools and strategies utilised to promote WASH behaviour change.
    - Of the 14 articles reviewed, communication strategies were the most commonly described.
    - Evidence from this analysis suggests that the most influential programme factors associated with sustained adoption include frequent, personal contact with a health promoter over a period of time. Personal follow-up in conjunction with on-going communication and support through mass media

advertisements or group meetings may further contribute to sustained adoption.

Summary of findings from 44 articles assessing sustained WASH adoption

This table summarises the results of our in-depth analysis of 44 articles that stated an explicit purpose to assess sustained WASH adoption of an intervention. We also describe the relevance of our findings, and how these can be useful to our diverse audience.

Determinant category		Why this is important…	Key findings	How this can be used…
Understanding sustained adoption	Measuring outcomes	Well-defined indicators and measurements are essential to developing solid evaluation methodology Helps understand the abilities and limitations of current measurement metrics	'Sustained' adoption is interpreted in many ways by studies Studies employ a variety of measures, and rely heavily on verbal forms of participant report Observations of practice were not performed, beyond spot checks	Establish metrics that capture WASH practice over longer periods and account for habitual behaviours Build the evidence base for the effectiveness of WASH programming in promoting sustained adoption
Behavioural factors	Psychosocial	Psychosocial factors are the core of various behaviour change theories Provide the basis of the intervention design and rationale	Knowledge of the practice, self-efficacy, perceived benefits, and social norms all affect behaviour Pre-existing habits and perceived susceptibility or severity also contribute to sustained practice	Designing intervention content Developing effective communication strategies
	Technological	'Enabling technologies' Direct interface between user and behaviour practice Positive or negative aspects can alter behaviour adoption	Cost and durability are the most important factors across all three sectors	Designing intervention content Selecting an appropriate technology Implementation logistics

Determinant category		Why this is important…	Key findings	How this can be used…
	Contextual	Factors external to user or technology influence sustained adoption Form the environment in which behaviour change occurs	Socioeconomic status, level of education, age and gender all strongly tied to adoption Existing infrastructure and prior exposure to the interventions are also relevant 'Habit forming' environments are not emphasised	Programme planning and implementation Communicating results across different groups and settings
Programme characteristics	Communication strategies	Communication and education provide participants with ways to learn about and troubleshoot WASH technologies Can incorporate key behavioural factors (above)	Interpersonal communication was strongly linked to better recall and continued WASH practices Mass media events and group communication were also represented in the literature	Inform programme planning and intervention design Identify key communication channels to effect sustained behaviour change

Implications

Our review highlights the diversity of interventions and methodologies to promote and evaluate sustained WASH adoption, although inconsistent definitions of sustained behaviour change and inadequate measurement of behavioural outcomes and factors affecting behaviour are common. Individual psychosocial factors, such as perceived benefit, self-efficacy, and other factors derived from individual-level behavioural models, strongly dominate the WASH literature. Interpersonal factors such as social norms are also reported to strongly affect an individual's continued practice of WASH behaviours. The greater context around individuals, particularly concerning latrine use and handwashing, was found to be highly influential.

Given this situation, we developed a theory that identified the different points in the project cycle, and linked the project cycle to different factors. Most behaviour change models only describe or examine initial adoption, but do not consider the factors that influence sustained adoption, particularly beyond the end of behaviour change project activities. Taking into account two behavioural models identified through our review, we highlight the factors that enable and constrain behaviour practice throughout the various time periods of the behaviour practice. These timepoints begin prior to the start of interventions, and extend beyond the end of an intervention or behaviour change project. We also propose characteristics of an 'ideal' evaluation of sustained WASH behaviour

change, and advocate for a new generation of evaluations that incorporate these characteristics.

The findings of this review are limited by the scope of our search and only capture the literature reporting on WASH interventions and measures of adoption in lower- and middle-income countries. Many definitions of sustained adoption exist and measurement methodologies are diverse and poorly detailed, leading to difficulties in evaluating and replicating long-term WASH use.

We propose that the scope of WASH programme planning be widened to put in place conditions during the project period that favour sustained use of WASH technologies and sustained adoption of WASH practices after a project ends (see the summary of findings table). More emphasis needs to be placed on defining sustainability and translating this into metrics and programme elements that can be used to implement, evaluate, and further the discussion on sustained WASH adoption. Technologies, implementation strategies, funding mechanisms and evaluation designs should also be expanded to better support these definitions. We also propose that more resources be devoted to the evaluation of sustained use, and development of new methods for such evaluation. Finally, policy planning and funding should emphasise the importance of planning for sustained WASH adoption from the start, and support the right to safe water, hygiene and sanitation for all.

Our findings imply a need for direction and leadership in guiding the research agenda on sustained adoption of WASH technologies. In sections 5.6-5.9 of the main report, we discuss the steps necessary in supporting and evaluating sustained adoption, from the research to policy levels.

Intended audience

This review is relevant to development specialists, public health practitioners and environmental engineers. These findings will be relevant to efforts to decrease communicable disease and increase basic access to a safe, healthy living environment.

1. Background

Outline of chapter

In this chapter we introduce water, sanitation, and hygiene (WASH) as a dynamic discipline that seeks to extend health and environmental benefits of WASH in low- and middle-income countries. We discuss the importance of WASH in the context of health, recognising that the justification for implementing WASH programmes is shifting from an exclusive focus on diarrhoeal disease mortality and morbidity (the major motivator for water and sanitation interventions in the last few decades) towards a more nuanced view of human health in context. In addition to preventing diarrhoeal disease, clean water, adequate sanitation and proper hygiene may also significantly reduce the spread of pandemic influenza, and reduce environmental enteropathy and exposure to heavy metals. In addition, promotion of WASH technology and behaviours is also a critical component of climate change adaptation and promoting human rights.

The focus of this review is to examine sustained adoption of WASH technologies and behaviours. We discuss why sustained adoption is important, particularly considering that the practice of WASH behaviours must be repeated multiple times throughout the day over a long period, by all members of the community, in order to provide health and environmental benefits.

This chapter also provides background information on the status of policy and research for water, sanitation, and hygiene interventions. The Millennium Development Goals set a target for water and sanitation to reduce by half the proportion of the population without access to safe water and safe sanitation by 2015 over 1990 levels. Though this target has set the bar for research and policy, there is no clear evidence base for the factors that influence both initial and sustained adoption of WASH technologies.

Given this context, this review seeks to answer the following questions:

> *Q1. What are the factors that influence the sustained adoption of clean water and sanitation technologies?*
> *Q2. What are the characteristics of interventions intended to improve adoption of clean water and sanitation technologies and how successful are these interventions at fostering adoption and sustained adoption?*

We also examine how programmes address known barriers and facilitators to sustained adoption to promote successful interventions. We describe our research questions and sub-questions and briefly outline a format of the review in the last portion of this chapter. Lastly, we include a section for how readers may be able to use the findings presented in this report.

1.1 Water, sanitation and hygiene behaviours

1.1.1 Why water, sanitation and hygiene?

Progress on expanding access to improved water and sanitation has been unbalanced. According to 2012 estimates, approximately 89% of the global population had access to an improved water source (WHO/UNICEF, 2014). This represents an increase of 13% over 1990 levels and is above the Millennium Development Goal (MDG) target set for 2015. However, most of the countries in Sub-Saharan Africa are not on track to meet MDG targets. Only 64% of the world's population has access to improved sanitation – far below the MDG target of 75% by the year 2015. Progress against sanitation targets has been particularly slow in Sub-Saharan Africa and South Asia (WHO/UNICEF, 2014).

Water, sanitation and hygiene remain central in the post-2015 development agenda. Global diarrhoea-related mortality in children under five years of age remains a major justification for investment in WASH interventions, despite recent declines to an estimated 700,000 deaths in 2011 (Walker et al., 2013). Improvements in water quality, sanitation, and handwashing are associated with 15-40% reductions in the risk of diarrhoea among children under the age of five (Freeman et al., 2014; Wolf et al., 2014). The impacts of inadequate water and sanitation are particularly pronounced for women and girls. Inadequate sanitation facilities may expose women to the risk of violence, and finding adequate locations for open defecation can require significant time and energy resources (Pearson and McPhedran, 2008). Women and girls also bear the majority of the time and energy burden associated with fetching drinking water and this may potentially increase the risk of violence and injury (Sorenson et al., 2011).

WASH interventions, such as handwashing with soap, can play a key role in the response to epidemics of cholera and dysentery in urban slums (Dunkle et al., 2011; Tappero and Tauxe, 2011) and refugee camps (Mahamud et al., 2012), reduction in neonatal infections (Edmond and Zaidi, 2010; Vergnano et al., 2005) and maternal infections (van Dillen et al., 2010), and control of pandemic influenza (Aledort et al., 2007).

More recently, researchers have highlighted the importance of environmental enteropathy: chronic inflammation of the gut walls as a result of continuous exposure to faecal pathogens in the environment. Environmental enteropathy has been identified as a mechanism through which faecal contamination of the environment has impacts on stunting and growth faltering, anaemia and delayed mental development in young children (Korpe and Petri, 2012; Lin et al., 2013; Ngure et al., 2014). Keusch et al. (2013) report on detailed clinical observations and suggest that the stresses of environmental enteropathy can lead to long-term stunting, poor health outcomes and increased mortality. WASH interventions potentially reduce the harmful effects of environmental enteropathy, and community trials are underway to examine this potential (Arnold et al., 2013; Ngure et al., 2014).

Water treatment interventions such as ceramic filters can reduce exposure not only to faecal pathogens, but also to heavy metals such as arsenic, iron and fluoride (Ngai et al., 2007; Shafiquzzaman et al., 2011). Climate scientists are predicting increased variability of precipitation everywhere (Dore, 2005), which in many areas will take the form of longer dry periods (droughts) punctuated by episodes of extreme precipitation (floods) (Dore, 2005; Taylor et al., 2013). This may make it necessary for people to rely increasingly on groundwater instead of surface water during dry periods, and to filter this water to remove heavy metals (Scanlon et al., 2006). Construction of wells-to-tap groundwater and promotion of water filters thus may be a key component of climate change adaptation plans in many settings (Wilby and Dessai, 2010).

Finally, a number of authors have suggested that access to clean water and sanitation should be considered a human right (Gleick, 1998; Hunt, 2006), independent of the effects of WASH interventions on health, due to the large influence that clean water and sanitation have on quality of life and human dignity.

1.1.2 Promotion of water, sanitation and hygiene behaviours

WASH interventions typically promote both a technology (hardware) and regular use of the technology in the correct way (key behaviours). Thus a water treatment intervention might distribute or sell a technology (ceramic water filter) to remove faecal pathogens and heavy metals from drinking water, and promote related behaviours (regular use and periodic cleaning of the filter). In this review, our focus is the behaviours and the effectiveness of their promotion, rather than the effectiveness of technologies alone.

Examples of household-level technologies include: handwashing stations to encourage handwashing with soap (Watt, 1988); chlorine dispensers or chlorine tablets for point-of-

use treatment of water from wells or standpipes (Arnold and Colford, 2007; Clasen et al., 2007); and household-based water treatment with filters or chemical additives, and improved latrines (Clasen et al., 2010). Other systematic reviews and studies in the WASH literature (e.g. Clasen, 2006; Fewtrell et al., 2005; Wolf et al., 2014) have documented associations between WASH technologies such as point-of-use water treatment and health behaviours such as handwashing with soap and a range of health outcomes. For the purposes of this review, we assume that continued use of WASH technologies and continued practice of WASH behaviours is necessary for the observed health benefits to be maintained. It is beyond the scope of this review to formally test this hypothesis; however it is an assumption that we made before initiating the review.

We examine sustained adoption of WASH behaviours. The principal behaviours that we examine in this review are:

- **Water**: Filtering, boiling and chlorinating drinking water, solar disinfection of drinking water
- **Sanitation**: Building, using and maintaining latrines and toilets
- **Hygiene**: Handwashing with soap at key times – before eating, before food preparation and after visiting the toilet.

These behaviours can be promoted across a wide range of settings, including schools, hospitals and restaurants. While handwashing with soap may be promoted before and after patient contact in clinics and hospitals, before food preparation in restaurants and before eating and after visiting the toilet in schools, we do not examine the adoption of WASH behaviours in schools, hospitals, restaurants and other institutional settings. Rather, we focus on the promotion of these behaviours primarily at the household and community levels.

Household-level promotion of WASH behaviours commonly takes the form of household visits by paid or voluntary health promoters. The promoter might help to set up the technology, demonstrate how to use and maintain it or demonstrate the target behaviour using various promotional strategies. Examples include: stating the benefits of the behaviour, such as reduced risk of cholera and dysentery or avoidance of the toxic effects of heavy metals; stating that others in the community are adopting the behaviour (social norms); or leveraging disgust surrounding faeces.

Community-level promotion of WASH behaviours may involve convening a community group to assess the situation and make recommendations, the sale and distribution of WASH technologies by community groups or individual entrepreneurs, community-wide events such as meetings and festivals where the technologies and behaviours are promoted, or organising a community-level system to maintain WASH technologies such as well or latrines maintenance, ordering replacement parts, making repairs and performing routine maintenance. Other factors influencing sustained adoption, such as the design, durability and continued functioning of various WASH technologies, are mentioned in this review in the context of how they influence behaviour.

1.1.3 Sustainability in water, sanitation and hygiene interventions

Sustainability is a concern across many sectors in global development. Depending on the sector, the term's meaning can vary considerably. In the agricultural sector, sustainability may refer to balancing groundwater withdrawal with rates of recharge, soil erosion reduction and making efficient use of non-renewable resources such as fossil fuels.

However, depending on the context, the meaning of sustainability in WASH behaviour change interventions is very diverse. The Millennium Development Goal for drinking water calls for halving the proportion of people without sustainable access to safe water from 1990 to 2015. The Millennium Task Force on WASH stated that sustainability must

encompass 'social, economic, and environmental perspectives' (Lenton et al., 2005). WASH behaviours must be performed regularly and repeatedly, over a long term, if their potential impacts on health, nutrition and child development outcomes are to be realised. For example, handwashing with soap just once, before one meal, will not have a detectable health impact. The health impact comes from handwashing repeatedly, every day, before every meal.

Psychologists term behaviours that are practised repeatedly, and incorporated into daily routines, as *habitual behaviours* or *habits*. Andrews was one of the first to define habit in the literature (1908: 121): 'A habit, from the standpoint of psychology, is a more or less fixed way of thinking, willing, or feeling acquired through previous repetition of a mental experience.'

Wood et al. (2002) note that habits over time exhibit a high degree of automaticity: they are increasingly performed subconsciously, without the person making conscious decisions about when, where and how to perform the behaviour. This can make it challenging to accurately measure behaviours such as handwashing through questions on household surveys. If handwashing comes to be performed subconsciously, the survey respondent may not be in a position to report accurately on how many times she or he washed hands on that day, and when she or he washed hands with soap most recently.

For the purposes of this review, 'sustained use' 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.

By project period, we refer to any one of the following periods:

1. In a mass media behaviour change communication intervention, it is the period during which project-related material was being broadcast or disseminated through radio, television, newspapers or other mass channels of communication, or through mobile phone applications
2. In a community-based intervention, it is the period during which there was external support to community groups, leaders and volunteers in the form of training, supervision and feedback, distribution of technology or provision of communication materials
3. In a research project, it is the period during which the research team or the team's local partners were implementing the behaviour change intervention and/or WASH intervention being evaluated as part of the study.

Habitual WASH behaviours that are repeated multiple times per day include handwashing, treatment of drinking water and use of the latrine. At the same time, some WASH behaviours cannot become habitual, because they are performed infrequently or at irregular intervals. Such behaviours include cleaning and maintenance of technologies such as pumps, water filters, latrines and toilets.

Finally, we note that, while summarising the evidence base on sustained adoption of WASH behaviours is the subject of this review, methodologies for the measurement of sustained adoption are not well developed. However, it is our hope that one result of this review will be to stimulate further efforts to develop such methodologies.

1.2 Definitional and conceptual issues

1.2.1 Water, sanitation, and hygiene technologies

WASH technologies refer to the specific technologies, hardware, tools or devices that support consumption of safe drinking water, effective containment and/or deactivation of human faeces, or improved handwashing practices. Specific examples include (WHO/UNICEF, 2014):

- Household water treatment and storage (Centers for Disease Control, 2014), including: filter technologies, point-of-use water treatment with chemicals additives (for example sodium hypochlorite-based water treatment systems), ultra-violet filtration devices, solar disinfection, boiling, and modified or improved water storage containers
- Sanitation, including: improved latrine/toilet designs, ecological sanitation technologies, child potties, sani-pads (for infant faeces disposal)
- Handwashing hardware, including: handwashing stations that include soap and water, hand sanitisers, and soapy water
- Water supply, including: specific hand pump technologies, small-scale treatment and distribution systems, rainwater harvesting interventions, protected and/or improved wells, and other technologies specifically designed to improve water availability or distribution at the community or household level.

1.2.2 Behavioural determinants

Behavioural determinants are the constellation of psychological, social, environmental, demographic or technological factors that shape individual-level behaviours or clusters of behaviours. For the purposes of this review, these factors have been classified into three main categories (Dreibelbis et al., 2013):

- **Contextual factors**: Background characteristics of the individual, setting or location that can influence behavioural outcomes
- **Psychosocial factors**: Psychological, social, or cultural factors that can influence behavioural outcomes
- **Technological factors**: Characteristics of a specific technology or device that influence its use and sustained use over time, such as cost, size and ease of use.

1.2.3 WASH interventions

We differentiate specific technologies from the associated messaging and/or intervention activities pursued to promote their use and adoption. Interventions or behaviour change communication strategies can focus on specific technologies (such as social marketing of point-of-use water treatment methods) or specific behavioural outcomes (i.e. community-led total sanitation as a means to increase latrine construction). Interventions may target specific psychosocial factors (such as increasing knowledge regarding disease risk), contextual factors (such as financing or microcredit loans for water supply improvements) or technological factors (such as increasing local manufacturing capacity for sanitation components).

1.3 Policy and practice background

The Millennium Development Goal no. 7 (ensure environmental sustainability) specifies targets for water and sanitation access – to reduce by half the proportion of the population without access to safe water and safe sanitation by 2015 over 1990 levels. Concerns about climate change and its effect on the availability of water have reinforced the importance of water and sanitation in the eyes of some policy makers and donors. The health targets, and emerging environmental targets, have provided an overarching framework for policy, international and national investment, and donor priorities over the last decade.

According to recent estimates from the WHO/UNICEF Joint Monitoring Programme for Drinking Water and Sanitation, only 56% of the population in LMICs has access to improved sanitation and 86% lack access to an improved water supply (2014). Information on water supply coverage, in particular, may overrepresent the percentage of people with access to

safe drinking water (Bain et al., 2012). Over 40% of lower- and middle-income country populations rely on 'other improved' sources – water sources such as stand pipes, public taps or protected wells that protect the point-of-origin from contamination, but still require household storage and transport (WHO/UNICEF, 2014). Emerging evidence suggests that these 'other improved' sources are still associated with significant declines in water quality and poorer health outcomes when compared to households with on-site connections to protected water sources.

Improving access to safe drinking water and effective sanitation can be accomplished in two ways: 1) expanding access to large-scale infrastructure projects (such as water distribution systems or sewerage systems), or 2) improving access to smaller-scale community or household-level technologies. Large-scale infrastructure projects serve greater numbers of people; however, their costs are often prohibitive. This high price typically limits the involvement and investment in large-scale systems to national governments, multilateral and bilateral donors and development banks. These projects accounted for over 60% of sanitation and drinking water aid provided by OECD countries in 2008. Small-scale systems include: hand pumps, non-networked water treatment kiosks, on-plot or community-based sanitation systems, or household water treatment technologies. Small-scale systems and technologies, together with hygiene education programmes accounted for only 17% of foreign aid during the same year. These figures, however, do not reflect the significant contributions of small public sector institutions, including international and local non-governmental organisations that are actively involved in the distribution and promotion of such small-scale technologies. While costing much less than large-scale systems, these small systems and technologies have a much greater reliance on individual- and community-level behaviour change to support both initial adoption and sustained use.

Evidence on both adoption and sustained use of small-scale water and sanitation systems and technologies is unclear, particularly with respect to household water treatment products. Recent approaches to expanding access to sanitation have relied on a two-pronged approach: supply-side improvements matched with demand creation activities at the local level, such as community-led total sanitation or the 'hygiene club' model employed in southern Africa. Demand-creation activities shift the financial responsibility for sanitation improvements away from large-scale investors (municipalities, development banks, national governments, etc.) to communities and/or individual beneficiaries. Demand-creation activities that have gained traction in recent years (Community-Led Total Sanitation, 'Hygiene Clubs') explicitly focus on psychosocial factors, such as social norms, social support and self-efficacy, while traditional public health messages about disease aetiology play only a minimal role in formal activities to change behaviours. In contrast, water supply and treatment promotional efforts remain grounded in intervention models that emphasise health benefits as the rationale for adoption of the key behaviours. There is a dearth of systematic information on the nuanced social, behavioural, technological and contextual factors that influence both initial and sustained adoption of small-scale and household technologies.

This review is intended to help inform policy in the following ways:

- To influence intervention design and development to more effectively address the factors that promote or inhibit the sustained adoption of small-scale water and sanitation technologies
- To influence policy discourse around the viability of small-scale technologies to improve access to safe drinking water and sanitation
- To identify information and knowledge gaps that can influence other researchers to contribute to the body of knowledge about the factors that influence initial and sustained adoption of water and sanitation technologies.

1.4 Research background

1.4.1 The water, sanitation and hygiene landscape

The majority of systematic reviews and meta-analyses related to water and sanitation technologies have focused on impact and health gains related to water, sanitation, or hygiene improvements (Arnold and Colford, 2007; Cairncross et al., 2010; Clasen et al., 2007; Engel and Lim, 2013; Esrey et al., 1991; Fewtrell et al., 2005; Waddington et al., 2009; Wolf et al., 2014) and typically support the conclusion that these improvements are effective at reducing the risk of diarrhoea in children under the age of five. In addition to systematically documenting evidence of health impact, several of these studies provide compelling evidence for the need to further understand factors that determine the use and adoption of improved water and sanitation technologies. Clasen et al. (2007), Arnold and Colford (2007), and Waddington et al. (2009) all note that intervention trials with longer follow-up periods show smaller effects, and compliance rates decline significantly over time. Recent analyses by Enger et al. (2012, 2013) and Brown and Clasen (2012) demonstrate that compliance is a key factor in achieving the health benefits from WASH interventions: decreases in compliance of 5-10% drastically reduced the reduction in diarrhoea observed with perfect compliance. These findings highlight the fact that the impact of water and sanitation interventions on diarrhoea is probably tied to behaviour change and adoption among the intended beneficiaries. Arnold and Colford (2007) and Waddington et al. (2009) also note an inverse relationship between study duration and impact on diarrhoea, suggesting either an attenuation of health benefits or lack of sustained adoption and use of household technologies over time. Hunter (2009) also cites duration of study follow-up as being associated with continued use; however, these conclusions are based on modelled data, and may not accurately represent the long-term trend in sustained WASH adoption.

Of the systematic reviews of health outcomes, few have examined the sustainability of associated behaviours as closely as Waddington et al. (2009). Examining the long-term sustainability and/or diffusion of behavioural outcomes that are necessary components of WASH interventions, the authors identify only five studies that evaluated behavioural outcomes and/or proxy measures of behaviour more than one year after interventions were completed. Within the context of a diffusion-of-innovation framework, the authors highlight the important need to further understand the causal pathway between intervention activities and sustained adoption of intervention behaviours in order to ensure lasting impact.

We identified only two systematic reviews of studies explicitly assessing behavioural outcomes and/or behaviour change interventions. Parker et al. (2012) systematically review behaviour change research on point-of-use water treatment interventions in LMICs, identifying a total of 26 studies that met their inclusion criteria. Of those, only five studies (19%) fully described the components of the behavioural interventions, and only seven (27%) presented a theory of change or behavioural theory utilised in the development of the intervention or impact assessment. Adequate control or comparison groups were included in only 10 (38%) reported studies. Seven (27%) studies reported utilisation rates of point-of-use water treatment >50% at follow-up, but only five of these studies evaluated this using behavioural outcome measures. The authors posit three possible explanations for the overall modest uptake rates: 1) the lack of systematic behavioural research available to inform intervention strategies; 2) the lack of intervention details and/or process evaluations that would enable replication or full interpretation of the intervention results; and 3) the reliance on research designs that are inadequate for investigating the factors that motivate or inhibit behaviour change.

Vindigni et al. (2011) completed a systematic review of handwashing interventions with a focus on outcome measures and sustained behaviour change in LMICs. The authors

identified 27 unique studies with varying lengths of follow-up time, but only four studies which evaluated sustained behaviour change more than six months after the intervention period: four evaluated sustained behaviours one to three years after, and one study had a follow-up period of up to nine years. The authors conclude that more studies with longer post-intervention follow-up periods are required in order to fully understand the sustainability of handwashing behaviour change interventions.

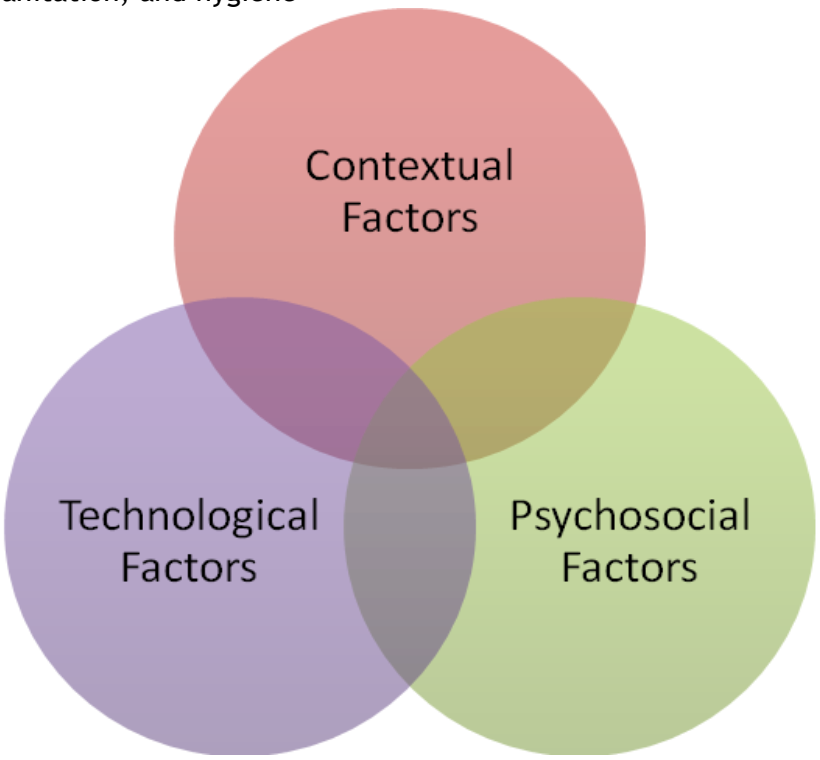
Alternatively, there were a number of non-systematic reviews that addressed behavioural outcomes or technologies. Sobsey at al. (2008) provide a direct comparison of the higher rates of ceramic and biosand filter use post-intervention when compared to household chlorination or solar disinfection (SODIS) interventions. Meierhofer and Landolt (2009) found in a review of global SODIS intervention programmes that availability of necessary hardware, exposure to more than one behaviour change information session, incorporation of motivated promoters and government institutions, higher levels of education, and social pressures for providing clean drinking water were all associated with sustained use of SODIS technologies at the household level.

1.4.2 Theoretical grounding for review

This systematic review employs the Integrated Behavioural Model for Water, Sanitation, and Hygiene (IBM-WASH) to provide theoretical grounding for our research questions as well as to guide our analysis and characterisation of factors that may influence the adoption and sustained adoption of water and sanitation technologies (Dreibelbis et al., 2013). The IBM-WASH framework incorporates the models of Curtis et al. (2009), Mosler (2012), Figueroa and Kinkaid (2010), and Coombes and Devine (Coombes and Devine, 2010; Devine, 2009) and key behaviour change theories such as the Health Belief Model (Becker et al., 1977; Janz and Becker, 1984), the Theory of Reasoned Action and Theory of Planned Behaviour (Ajzen, 1991; Fishbein and Ajzen, 1975), Social Cognitive Theory (Bandura, 1989), and Diffusion of Innovation Theory (Rogers, 2003).

The framework has three large, overlapping dimensions that mutually influence one another, as defined in Section 1.2.2 (specific examples are given in Table 1).

Figure 1: The interacting dimensions of the integrated behavioural model for water, sanitation, and hygiene



These three interacting dimensions (Figure 1) not only encompass our understanding of WASH-related practices, but are also consistent with the idea of reciprocal determinism in Social Cognitive Theory, which describes mutual interactions between the individual, the behaviour and the environment in which the behaviour is practised (Bandura, 1989). The individual factors of the IBM-WASH are listed in Table 1.

Table 1: The integrated behavioural model for water, sanitation, and hygiene

Levels	**Contextual factors**	**Psychosocial factors**	**Technology factors**
Societal/ structural	Policy and regulations, climate and geography	Leadership/ advocacy, cultural identity	Manufacturing, financing and distribution of the product; current and past national policies and promotion of products
Community	Access to markets, access to resources, built and physical environment	Shared values, collective efficacy, social integration, stigma	Location, access, availability, individual versus collective ownership/access, and maintenance of the product
Interpersonal/ household	Roles and responsibilities, household structure, division of labour, available space	Injunctive norms, descriptive norms, aspirations, shame, nurture	Sharing of access to the product, modelling/ demonstration of use of the product
Individual	Wealth, age, education, gender, livelihoods/employment	Self-efficacy, knowledge, disgust, perceived threat	Perceived cost, value, convenience and other strengths and weaknesses of the product
Habitual	Favourable environment for habit formation, opportunity for and barriers to repetition of the behaviour	Existing water and sanitation habits, outcome expectations	Ease/effectiveness of routine use of the product

1.5 Research questions

The primary research question for our systematic review is:

Q1. What are the factors that influence the sustained adoption of clean water and sanitation technologies?

We then divided this question into the following sub categories:

Q1a How is sustained adoption defined and measured?

Using the IBM-WASH as a theoretical guide for this research, each of the three main dimensions of the framework constitutes a specific sub-question within our systematic review:

Q1b What are the contextual factors that result in the adoption of water and sanitation technologies (i.e. what are the key environmental, political, and demographic factors influencing behaviour)?

Q1c What are the psychosocial factors that result in the adoption of water and sanitation technologies?

Q1d What are the technological factors that result in the adoption of water and sanitation technologies (i.e. what aspects of WASH technologies facilitate behaviour change)?

Our understanding of the factors that influence the adoption and sustained adoption of these factors are drawn primarily from 'views' studies – qualitative or mixed-method studies in which individuals provide information on the knowledge, attitudes, and opinions that influence current water and sanitation practices or the adoption of specific technologies or behaviours. It is also drawn from observational studies that investigate associations between specific or reported population characteristics and behavioural outcomes.

Understanding the barriers to and facilitators of adoption and sustained adoption of WASH technologies alone is not sufficient to inform policy and practice. Rather, it is also necessary to understand the extent to which current intervention strategies address these barriers and facilitators. The second stage of our review addressed the question:

Q2. What are the characteristics of interventions intended to improve the adoption of clean water and sanitation technologies and how successful are these interventions at fostering both adoption and sustained adoption?

This stage considered evaluations in which behavioural outcomes were analysed, process evaluations of health impact trials, and other studies that documented characteristics of interventions intended to improve initial and/or sustained adoption.

We also examined the extent to which existing interventions addressed known barriers to and/or leverage known facilitators in crafting effective interventions.

Chapter 2 describes the methods used in identifying the studies for mapping and synthesis and provides details of the data extraction and analysis processes.

2. Methods used in the review

Outline of chapter

WASH programmes are implemented and evaluated by experts from a wide range of disciplines such as environmental engineering, public health, marketing and anthropology. In conducting a systematic review of factors that influence sustained adoption of WASH, we drew on a large body of literature to examine the evidence base for long-term adoption of water, sanitation and hygiene technologies.

This chapter provides details of our search and analysis strategy for our systematic review, which could be classified as a 'mixed methods' review methodology (Harden and Thomas, 2005). Given our broad research questions, much of the relevant literature on sustained WASH behaviours came from programme reports, qualitative findings, and follow-up studies – all study methodologies eligible for inclusion in this review. However, this was not without challenges, and therefore we provide detail on the review process to clearly describe issues that arose and our methods for their resolution.

A detailed protocol describing study activities was written and peer-reviewed prior to the start of the project. Our four-stage review (detailed in Table 2) proceeded from a broad initial screening to descriptive mapping of existing literature on the barriers and facilitators to inform subsequent in-depth syntheses.

Table 2: Map of study stages and activities

Review stage	**Activities**
Stage 1 – Identification and screening	Peer-reviewed, grey literature, and other database search Title and abstract screen** **If the title or abstract provided little descriptive information, the full text was screened
Stage 2 – Mapping and keywording	Apply a nine-part coding form to map the content of each document: • identify study type • identify technology used • generate definitions of adoption and sustained use • study-specific information
Stage 3 – Synthesis	A detailed review of a subset of documents from Stage 2 Evaluate these studies to answer the two research questions Document the study characteristics
Stage 4 - Reporting and implications	Compile findings and prepare reports for dissemination Explore applications of the findings for public health

Standard systematic review protocols were observed. In the interest of brevity, we will briefly describe our process of article selection and data extraction. We will then describe in detail our synthesis protocols. Additional information can be found in Section 7.4 of the Annex. The timeline of our review proceeded as follows:

- Stage 1: Identification and screening
    - Developing the protocol and search strategy
    - Identifying studies: Database searches of published articles
    - Identifying studies: Grey literature searches
    - Quality control procedures
    - Defining relevant studies for this review
- Stage 2: Mapping and keywording
    - Extracting data from studies to describe the landscape of available research on adoption and sustained adoption of WASH
- Stage 3: In-depth review and synthesis
    - Selection of articles for in-depth synthesis and sub-syntheses
    - Making comparisons and drawing conclusions on factors that affect sustained adoption of WASH technologies and behaviours based on the available literature
- Stage 4: Implications and reporting
    - Exploring applications of the findings to public health, from scientific knowledge to policy and planning

2.1 Stage 1: Identification and screening

2.1.1 Developing the protocol

In early 2012, researchers at Johns Hopkins Bloomberg School of Public Health and The Johns Hopkins University Water Institute drafted a proposal for a systematic review that would assess the current literature on sustained adoption of water, sanitation, and hygiene technologies in low- and middle-income countries. The proposal and accompanying protocol were submitted for review to 3ie and substantive and methods experts, and was accepted by 3ie in May 2013. A copy of the protocol is available from the EPPI-Centre (http://eppi.ioe.ac.uk/cms/LinkClick.aspx?fileticket=vOKINfcxVWU%3d&tabid=3174).

2.1.2 Research team members and decision-making strategy

The core research team responsible for the majority of the review comprised three individuals (KH, NM, and PW), with auxiliary assistance from reserve team members and input from our advisory group and peers. All final decisions on the research strategy, process, synthesis and reporting were made in agreement with all members of the core team. Although some tasks were carried out independently by individual members, activities were always reviewed in regular group meetings and discrepancies or clarifications rectified.

The 'Quality Assurance' sections in each stage of our review provide more detail on our specific process of decision making and resolving issues encountered. As a note, all references to 'we' throughout the text refer to the core research team.

2.1.3 Defining included data and reports

We anticipated that the number of studies and programme evaluations examining sustained adoption of WASH behaviours after the end of the study or project period would be limited, and that there would be a variety of methods used. To capture as much as possible of this literature, we considered both quantitative and qualitative data for inclusion in our syntheses. No restriction was placed on study, intervention, or evaluation design; articles included randomised controlled trials, observational studies, cross-sectional surveys, process evaluations, progress reports and multi-site trials.

2.1.4 Identifying studies: Database searches of published books and articles

2.1.4.1 Search strategy

We employed a three-part search using Boolean indicators to find WASH literature from low- and middle-income countries that also included a behaviour change component to encompass the three concepts related to our research questions (See Appendix 2):

- **Concept 1 – WASH technologies:** includes terms for water treatment, sanitation and hygiene.
- **Concept 2 - Behaviour/sustained adoption**: includes terms reflecting sustained adoption of a behaviour/use of a technology, behaviour change and adherence.
- **Concept 3 – Lower- and middle-income countries (LMICs):** because we are specifically interested in determining successful interventions in countries with low existing rates of clean water, sanitation and hygiene, the included terms and countries limit our search to LMICs only.

Our initial search yielded results that were highly sensitive (our database search results were over 170,000 titles) that were highly non-specific (a very low proportion, about 1/200, were related in any way to WASH research). See Appendix 3 for more information on refining our search strategy. A full list of databases searched is available in the same section.

The searches of databases containing peer-reviewed literature were completed by 01 October 2013.

2.1.5 Identifying studies: Grey literature and hand searches

2.1.5.1 Grey literature sources

In order to capture findings from studies and evaluations produced or commissioned by implementing organisations, we conducted a systematic search of the grey literature. The aim was to identify programme evaluations, progress reports and conference or meeting proceedings not published in formal peer-reviewed journals or databases. Specifically, we targeted reports and documents published on websites of a number of international and national organisations involved in water, sanitation, and hygiene interventions. A complete list of websites is provided in Appendix 3.

Two researchers from the study team worked separately to examine a number of grey literature sources identified in the study protocol to judge whether the document addressed the topics relevant to the study, i.e. assessment of WASH technology and relevant behaviour change. Each source was only searched once. In addition, they contacted NGOs involved in WASH programming (WaterAid, BRAC, WASH Alliance, HYSAWA, VERC, Plan International, NGO Forum, and CARE), requesting any unpublished documents related to our review. If studies were deemed relevant to the search, they were added into the pool of literature for full screening.

The completed search of 20 sources of grey literature yielded more than 1,110 citations identified for screening. Members of the study team documented the search and identification process of relevant articles.

2.1.5.2 Hand search of topical journals

The objective of the hand search was to include articles from topically relevant journals that might only be available in print or were inaccessible through electronic databases. Documents recovered in this search included journals both in the peer-reviewed and grey literature. See Appendix 3 for a full list of journals we included.

2.1.5.3 Library catalogue search

We searched current Johns Hopkins University (JHU) library catalogues to find relevant anthropological and sociological literature. This search was limited to those resources located within the Sheridan Libraries collection. We worked with the JHU informationists to translate our search terms for use in the JHU library system.

Searches of grey literature and other databases were completed by 1 December 2013, and aimed to represent all material published or available by that date. In addition, we scanned reference lists of articles included in the review for additional published material. In particular, we assessed the reference lists of applicable systematic reviews and included relevant studies that had the potential to contribute to our review.

2.1.5.4 Compiling citations for screening

All citations retrieved from the databases, grey literature, hand searches, and reference list reviews were saved to EndNote files to be uploaded into EPPI-Reviewer 4 at the completion of the searching process. After all citations were uploaded, we removed duplicates using the EPPI-Reviewer 4 Duplicate checker function.

2.2 Screening process

Inclusion criteria (in the order listed below) were applied to the titles and abstracts of the entire pool of articles obtained from our searches of peer-reviewed publications, grey literature and journal hand searches. This was to exclude any articles obviously not related to our study questions. Criteria were applied sequentially: if an article satisfied the first inclusion criteria (WASH topical focus), then it was evaluated for population and study scope. This process was repeated until the article was either included or failed to meet inclusion criteria. Some articles that failed to meet multiple exclusion criteria (e.g. a systematic review of a national WASH programme) were noted as they were potentially of interest for sub-syntheses.

The criteria for inclusion/exclusion can be found in Appendix 3.

2.3 Quality assurance process: Identification and screening

Team members were trained to systematically identify relevant documents using search terms or concepts developed through group consultation (including the use of any tools such as EPPI-Reviewer, Stata or SAS), and the processes were documented throughout. Work was divided and performed individually by team members, and reviewed regularly at team meetings to resolve any discrepancies or necessity for clarifications that arose.

2.4 Stage 2: Mapping and keywording

The literature addressing sustained adoption of WASH behaviours is published in a range of journals, and utilises a variety of evaluation methods and intervention designs. Results are presented in a range of formats, from journal articles in the style typical of the epidemiology literature intended for WASH researchers, to reports on lessons learned intended for programme managers and policy makers. Due to this heterogeneity in methodology and presentation of results, we could not proceed immediately to assessing outcomes and draw conclusions without first understanding the characteristics of the studies and evaluations included in the review. To do this, we drew on Arksey and O'Malley's description of a 'scoping study' (2005), whose purpose is to provide a quick, comprehensive overview of a specific research area. We refer to this as our 'mapping and keywording' stage.

This stage provides a broad survey of the findings, methodologies and intervention strategies for studies and evaluations examining sustained adoption of WASH behaviours. As the topic of sustained use has not been studied in much depth, these findings will be informative to those looking to undertake or expand their own research, as well as

programme implementers and donors. These results also informed our selection of articles for Stage 3: In-depth synthesis.

2.4.1 Articles and reports included in the mapping and keywording phase

A 15-page structured mapping form was created with 9 sections (modules) and 96 questions (see Appendix 6). The form provided a broad yet detailed, all-encompassing look at the methodologies and results of each article mapped. We used the IBM WASH framework as a guide for creating the questions assessing behavioural factors, and developed the rest in discussion with the group based on mutual points of interest from prior work.

The sections of the form included:

- Section 1. Identification of document or article
- Section 2. Study population and scale of intervention implementation
- Section 3. Study design/methodology
- Section 4. Statement of behavioural objectives
- Section 5. Behaviour change interventions/activities
- Section 6. Implementation and evaluation of handwashing interventions
- Section 7. Implementation and evaluation of water treatment interventions
- Section 8. Implementation and evaluation of sanitation interventions
- Section 9. Factors affecting uptake or adoption of the behaviour

Sections 1 through 5 and Section 9 were completed for all articles and reports included in the mapping phase. One or more of Sections 6 through 8 were completed for each article or report, depending on the domains of intervention described.

The data from the mapping and keywording forms were entered into a multiple-tab Excel spreadsheet, with one tab corresponding to each Section. The keywords and data extracted from the reports were tabulated and analysed by two members of the study team to identify patterns in the scope of available literature and provide a descriptive overview of the types of interventions, technologies, and factors presented in the literature discussing WASH sustainability. The findings from the mapping and keywording stage are presented in Chapter 3.

2.4.2 Assessing quality of studies and weight of evidence for the review question

Due to the heterogeneity in reporting styles and study designs that we encountered during our search, we assessed the quality of studies by adapting a seven-point scale system developed by Harden and Thomas (2005). The seven criteria are:

- Does the study have an explicit conceptual model or literature review?
- Are the aims and objectives clearly stated?
- Is there a clear description of context?
- Is there a clear description of the sample and how it was recruited?
- Is there a clear description of the methods used to collect and analyse data?
- Are there attempts to establish the reliability and validity of data analysis?
- Is there inclusion of sufficient original data to mediate between evidence and interpretation?

Though Harden and Thomas assess the presence or absence of each criteria, we modified the scale to include a score if one of the factors was present, but insufficiently reported. We assigned a score of 1 (criterion not reported at all), 2 (partially, and/or incomplete description provided), or 3 (criterion is fully described). The total for these seven criteria is recorded as the study's rigour score and is summarised in Figure 5 in Chapter 3.

Calculating these scores illustrated the quality of the methods and presentation of the literature on WASH sustained adoption. However, we should note that these scores have not been used to provide 'weight of evidence'. Rather, they were treated as a way to describe and quantify the heterogeneity in data quality that we found through personal observations during the review process.

2.4.3 Quality assurance process: Mapping

At the mapping stage, the first level of quality assurance was to test the application of the mapping tool. A subset of articles was double coded by the reviewers. After resolving discrepancies and refining definitions, a single coder mapped the remainder of the articles. Ambiguous cases were resolved through discussion.

2.5 Stage 3: In-depth review and synthesis

2.5.1 Selection of studies for synthesis: Defining 'sustained' adoption

In order to answer the question about factors that affect *sustained* adoption of WASH technologies after the project period, we prioritised studies that explicitly addressed this concept. Throughout this review, we make a differentiation between measurements made during the project period (while study activities and promotion may be occurring, see definition in Background), or the post-project period.

Whereas mapped studies were restricted broadly to discussing a WASH technology plus behaviour at any point in time, studies included in the in-depth synthesis focus specifically on assessing the use of a WASH technology or behaviour practice at some point *after* the intervention had ended.

2.5.2 Selection of studies for synthesis: Identifying relevant articles

All studies included in the mapping and keywording stage were considered for in-depth review and synthesis. We further restricted our pool of articles to those that had an explicit focus on evaluating or measuring sustained WASH adoption, using information that was extracted after applying our mapping tool. These articles were then re-analysed by team members, who excluded articles that did not have post-intervention follow-up time of six months or greater. This left us with a final subset of articles that shared the following characteristics:

1. An explicit goal of evaluating sustained use or programme sustainability
2. Reported behavioural factors associated with long-term use
3. A monitoring and evaluation or follow-up period of six months or greater. Studies and programme evaluations with an follow-up period for monitoring and evaluation of less than six months, were included if there were metrics specifically to study sustained adoption (such as a longitudinal panel assessment, see Parker et al., 2006).

Our report was initially intended to review only articles measuring WASH practice after the end of the project period. Of the 44 articles we identified for in-depth synthesis, 21 met the criterion of reporting on sustained adoption more than 6 months after the end of the project period. However, given the paucity of articles when restricted to this criterion, we expanded our results to include articles that assessed adoption of WASH behaviours 6 months or more after introduction of the intervention, while still within the project period. Examples of articles in this subset would be studies that conducted monitoring and evaluation within a year-long project period.

Articles were excluded from in-depth synthesis if they were published as conference proceedings, abstracts or workshop notes, since this type of data is likely to change if presented in published form (Higgins and Green, 2011), though they may have been

already included in the mapping phase. In some cases, data originating from the same study were reported in more than one article (e.g. progress reports, mid-term and end-line evaluations). However, as we identified articles for in-depth synthesis, we prioritised the inclusion of end-line data and/or country-specific final reports over other available results.

After identifying relevant articles on sustained WASH adoption, we sorted the studies into groups corresponding to the themes of our two research questions. Some studies were included in both groups. Each study was read in detail to extract information related to our questions.

2.5.3 Synthesising results: Research Question 1 – Measuring outcomes and behavioural factors

Selection of outcome data for research Q1 was guided by a framework synthesis approach (Carroll et al., 2011), using the IBM-WASH framework as a guide. This approach helped us to identify key factors a priori and to structure the results in three categories:

- Contextual factors shared across WASH interventions (e.g. SES, climate, supply chain)
- Psychosocial factors shared across WASH interventions (e.g. perceived benefit, susceptibility, severity)
- Technological factors specific to water treatment, handwashing and sanitation technologies (e.g. user-friendly design, durability, cost).

In order to illuminate the similarities between concepts, we used factors identified in the IBM-WASH as codes for specific factors mentioned in studies. We assigned codes to factors either expressed by participants or conclusions drawn by the authors (See the codebook in Appendix 6). For example, if a study described the influence of visible cues like posters near the water pump as triggers for water treatment, this influential factor was coded as 'cues to action'. Similarly, if a survey included a question about whether members of the household helped to remind family members to wash their hands, this measure was also coded as a 'cue to action'. To compare the nature of behavioural factors reported in these articles, we read and coded articles by hand, making detailed notes about the ways in which each factor was presented.

We repeated this process for studies included in contextual, psychosocial and technology factors syntheses, and have presented these findings by technology type: hygiene (handwashing), water and sanitation.

2.5.4 Synthesising results: Research Question 2 – Process evaluations

Outcome data for research Q2 was defined iteratively using a thematic synthesis approach (Thomas and Harden, 2008). Briefly, we attempted to organise intervention/programme activities into larger descriptive themes, and used these to code all articles included in this group. We discussed the included articles in a workshop format with members of the study team to sort articles into meaningful thematic groups; two members of the research team then reviewed the articles. During analysis of the text, we first identified a set of descriptive themes after assessing each article's objectives and guiding research aims (See codebook in Appendix 6).

We synthesised reported results or findings based on intervention approach and measures of sustained use. The results for this synthesis was drawn from either qualitative description of relevant programme factors, such as barriers to water treatment mentioned in participant interviews, or quantitative associations, such as percentage of latrine users recalling discussion about latrine benefits with a health promoter. The two emergent

groups that related to our second research question on factors of programmes that influence sustained adoption are:

- **Post-intervention sustainability**: Outcome measurements methodologies and level of sustained use after implementation.
- **Programme characteristics**: Intervention characteristics and communication channels.

For both groups, outcomes included both qualitative and quantitative reported data.

2.5.5 Quality assurance process: synthesis

The synthesis process ensured quality through two approaches: first, members of the study team discussed articles included in the in-depth review in a workshop to discuss and identify themes; second, the application of framework and thematic synthesis provided a template to guide the characterisation of the study results. The work was divided between two reviewers who conducted the sub-syntheses. Data were not double-coded.

2.6 Stage 4: Deriving conclusions and implications

The aim of this study is to enhance an understanding of the factors influencing sustained adoption of WASH practices, and therefore the results of the syntheses have obvious implications for ***practice***. We identify a number of influential factors that should be included in WASH programmes. Similarly, this systematic review has implications for ***research***. The factors we identify should be incorporated in research at the outset; the impact of site-specific factors may be explored, and known factors can be identified and assessed. Deriving implications for ***policy*** necessitates consideration of the institutional support needed to conduct long-term assessments of sustained adoption. In order to come to these conclusions, we consider knowledge gaps and how policy can help to shape the research agenda for WASH interventions.

3. Identifying and describing studies: Results

Outline of chapter

This chapter describes the results of our search and the findings of the first review stage. Specifically, we describe the systematic review process through screening, mapping and keywording, and eventual selection for in-depth review and synthesis. Finally, we present the results of the mapping and keywords applied to studies.

The results presented below illustrate a systematic map of the available literature on factors that influence sustained adoption of WASH technologies, providing summary information about the nature and scope of the literature. We highlight the study designs and evaluations used to measure sustainability. Additionally, we identify factors influential in promoting initial and sustained adoption of WASH technologies. Analysis of the trends in the map has helped us to identify gaps in the literature and select studies for in-depth synthesis in Chapter 4.

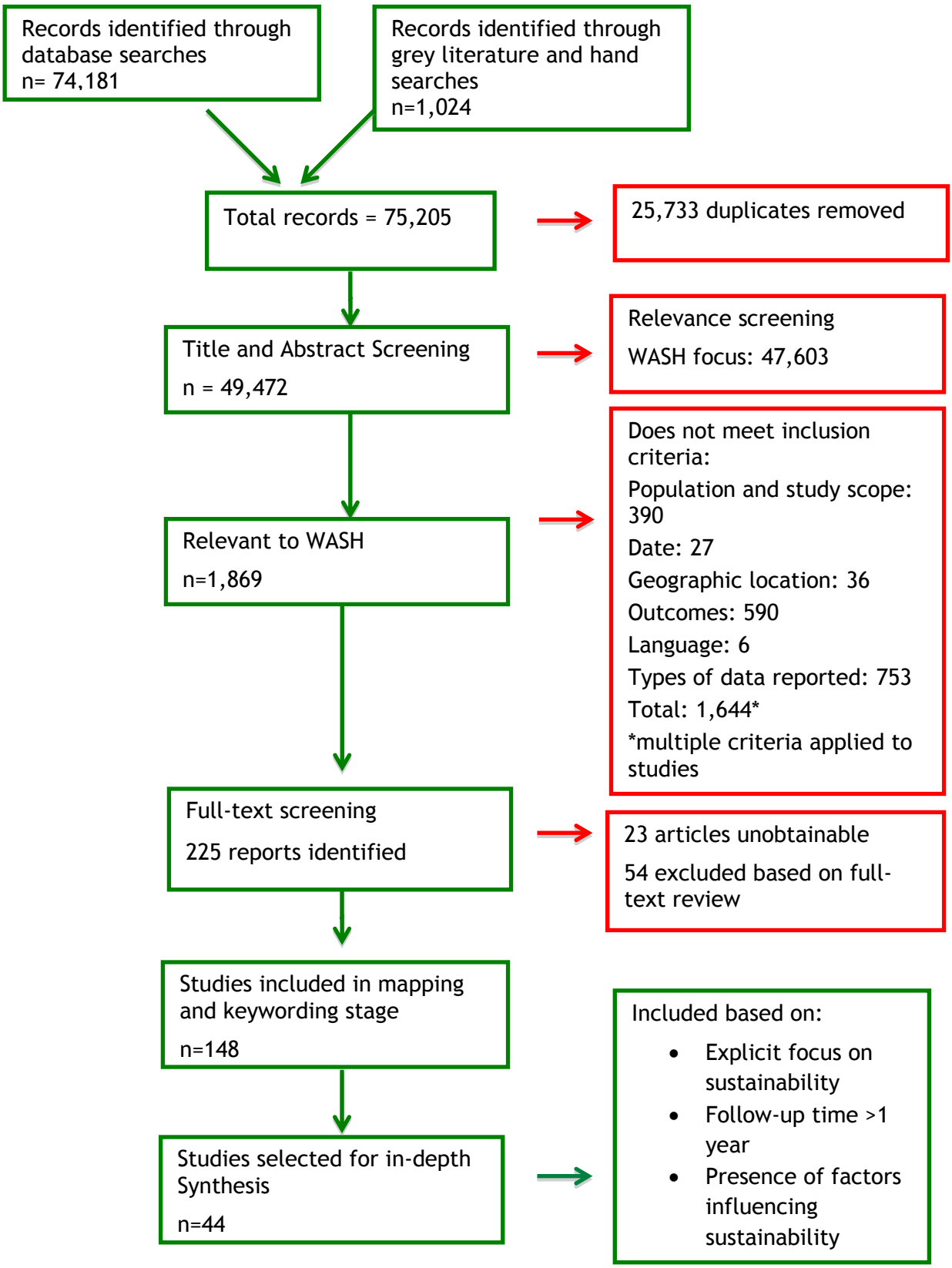
3.1 Studies included from searching and screening

Figure 2 shows the screening process to select articles for inclusion in the mapping and syntheses stages of this review. Our search strategy (See Appendix 2) was highly sensitive and yielded a total of 74,181 citations from our database search. A further 1,024 citations were identified in grey literature. We combined these two sets of documents for a total of 75,205 citations. Of these, 25,733 duplicates were removed, leaving 49,472 citations for title and abstract screening.

In the title and abstract screening, 47,603 citations were excluded as irrelevant to water, sanitation and hygiene behaviours (exclusion code used: outcome). 1,667 articles were topically relevant but did not meet other inclusion criteria. Exclusion for these reasons, such as date, LMIC and language, were low because we applied these filters directly in the database search when possible.

After applying initial inclusion criteria, there remained 225 articles requiring full-text screening, 23 of which were unobtainable. An additional 54 were excluded after full-text review, based on outcomes and type of data reported.

Figure 2: Filtering of papers from searching to map to synthesis



3.2 Mapping and keywording: Overview

The length of the articles and reports under review ranged from very short (1-2 pages) to very long (300-400 pages).

Articles and reports included in the mapping phase reported on hygiene, water treatment, and sanitation interventions with the following frequencies:

Domain	Total
Handwashing	55
Water treatment	62
Sanitation	59

Note: multiple categories were possible.

We categorised articles to the above domains based on *any* mention of technology pertaining to that domain. Some articles, e.g. Cairncross et al. (2005), described multiple WASH domains or combined interventions, such as promotion of handwashing and water treatment, during the project period. These articles could be classified under both the 'handwashing' and 'water treatment' domains. See Table 23 in Appendix 4 for a list of studies that incorporated multiple intervention domains.

3.2.1 Literature retrieved on handwashing (n=55)

Studies on handwashing account for 55 of the 148 documents found in the mapping stage of the review. Most report on the promotion or measurement of handwashing as a stand-alone behaviour (i.e. promoted in the absence of introduction or promotion of any technology to facilitate handwashing such as hand sanitiser, soapy water bottles or handwashing stations). Eight of 55 studies assessed diarrhoeal disease outcomes, whereas 31 reported on observed handwashing behaviour. Nurture is prominent when factors or determinants affecting behaviour are reported. Interventions attempt to pair messages of being a good parent and taking good care of one's children with handwashing technologies to encourage adoption of hygiene practices.

Some studies identified and described attributes of good handwashing practices (GHWP), which stipulate when and how participants should wash their hands (see Bowen et al., 2013 or Parker et al., 2006), and some described the five key times for handwashing (after defecation, after cleaning a child's faeces, before eating, before feeding a child, before preparing food) (e.g. Bowen et al., 2013; Dobe et al., 2013)[1]. However, the majority of handwashing studies do not describe the criteria used to assess handwashing practice.

Two categories of intervention for promotion of handwashing are 1) mass media/social marketing, and 2) interpersonal communication. In studies reporting on the former, the attempt is to cover a large population through mass media messages, but the intensity of intervention directed at any individual is relatively low. By contrast, in studies reporting on the effect of interpersonal communication for promotion of handwashing, the size of the population included in the study tends to be low. Interpersonal communication occurs through home visits by health promoters, women's groups or other community groups.

3.2.2 Literature retrieved on water treatment (n=62)

We divided the literature on water treatment into four groups. Each group was exclusive, meaning that all studies reported on only one technology:

[1] For further reading on key times for handwashing, see Iyer et al., 2005 and Kleinau et al., 2004.

- **Solar disinfection (SODIS).** Sixteen of 62 studies reported on solar disinfection as a water treatment method. Most of these studies have been conducted by just one research group at the Swiss Federal Institute of Aquatic Sciences and Technology. Their focus is on psychosocial factors contained in the RANAS model (Risk, Attitude, Norm, Ability, Self-regulation; Mosler, 2012), which they developed and have been disseminating. The effectiveness of SODIS in reducing bacterial contamination is the outcome most commonly reported.
- **Chlorination of water.** Thirteen of 62 studies reported on treatment with chlorine tablets (n=11) or chlorine dispensed in measured doses from a larger dispenser (n=2). These studies reported on both technology-related aspects (taste and smell of treated water), dosage and cost. The effectiveness as measured by presence of residual chlorine in water and levels of bacterial contamination are also reported.
- **Filtration devices.** Twenty-nine of 62 studies reported on filtration devices. These articles often appear in engineering journals, where the effectiveness, durability, mode of cleaning, maintenance, taste, flow rate and cost were all reported. Effectiveness in reducing bacterial contamination and presence of heavy metals is also commonly reported.
- **Other,** in which articles may have discussed a water treatment programme, but not elaborated on the technologies involved.

Though water treatment is often promoted to reduce diarrhoeal disease, few studies report on significant changes in disease prevalence or incidence. Instead, the most common outcomes are reduced bacterial contamination. Some studies report on perceived severity/susceptibility of diarrheal disease as motivation for sustained adoption of water treatment.

Compared to handwashing, water treatment interventions are more likely to provide one-time instructions and follow-up visits to assess continued or discontinued use of an introduced treatment option, rather than intensive education components.

3.2.3 Literature retrieved on sanitation (n=59)

Most of the literature on sanitation is focused on latrine building. In 10 of 59 interventions, materials were provided free of charge to the community, while 17 of 59 described selling materials to communities for the construction of latrines. Twenty trained community members on how to construct latrines and nine reported on communities constructing latrines in their own traditional fashion. Studies that did not report on latrine building included introduction of child potties or scoops (4) or observations of traditional practices (1). Twelve studies did not describe sanitation technology. Despite a focus on adoption, 34 studies assessed if latrines were functioning or maintained and 26 included direct observation of latrine use or condition.

Twenty-four articles reported both latrine construction and promotion of handwashing. Educational and handwashing promotion efforts are particularly essential prior to latrine construction.

People are reported to be more likely to use latrines if they are better constructed and better maintained (Barnard et al., 2013; Rotondo et al., 2009). New latrines should be regularly monitored to ensure construction quality and maintenance. It is also essential to note that people often choose to build latrines because they enhance their social status. People feel embarrassed when their guests are forced to practise open defecation, or feel that their households gain status if they have latrines and do not practise open defecation.

3.3 Mapping and keywording: Study design and implementation

3.3.1 Geographical spread of studies

Figure 3 shows the distribution of studies by geographic region. Sub-Saharan Africa (Kenya, Zimbabwe and Ghana are strongly represented) and South Asia (primarily India and Bangladesh) account for 67% of the studies identified at this stage of the review.

Figure 3: Percentage of total studies (N=148), divided by geographic region

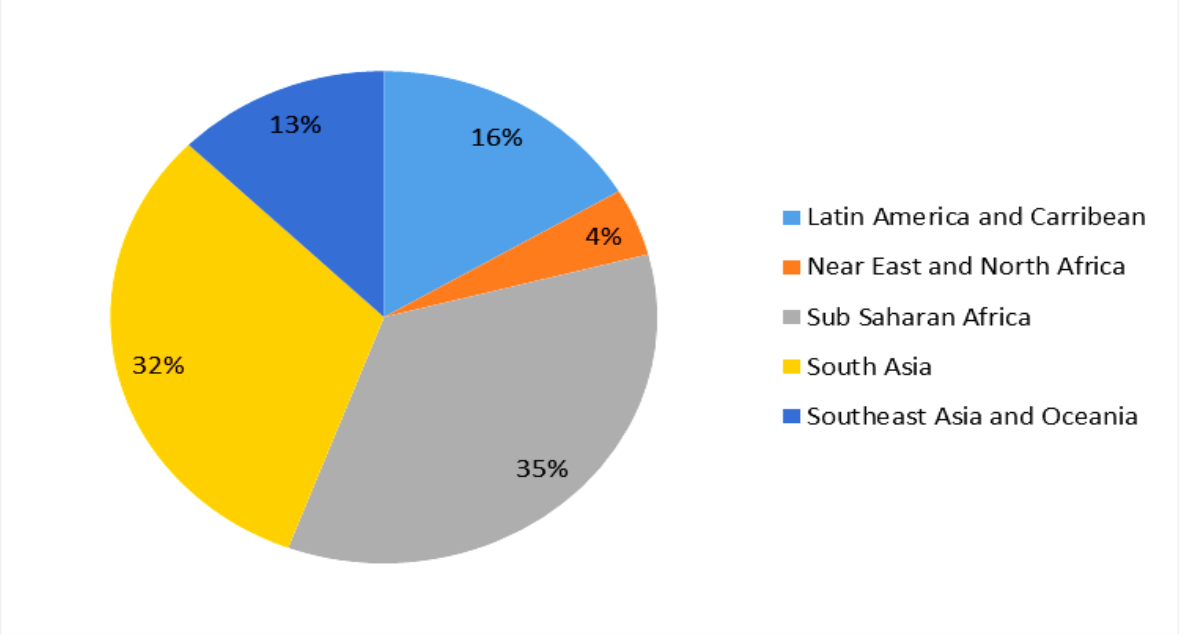


Figure 4 shows the geographic spread and report density by country. This map shows that countries such as Bangladesh, India and Kenya are well represented in the literature. Underrepresented are the Near East, North Africa and East Asia.

Figure 4: Map of geographic spread and publication density of studies

Study design: Level of intervention

We found that most of the studies represented in the literature on adoption and sustained adoption of WASH technologies are implemented on a small scale. 45% of studies and reports operated at the level of one village or several villages. Larger studies with a greater target population were generally conducted at the sub-district (10% of studies), district (18%), or provincial or regional (11%) level. These definitions varied by study and were described by study authors. They typically referred to geographic and/or political divisions established by the government or other census authorities (e.g. SEUF, 2004). Most of the reports at the national level described either mass media strategies or country-level assessments. A detailed breakdown can be found in Table 3.

Table 3: Scale of studies or programmes reported (N=148)

Scale of the study	N (out of 148)	%
One or several villages (approx.1-20 villages)	67	45
Sub-district (approx. 21-100)	15	10
District	26	18
Province/region	16	11
National	20	14
n/a	4	3

3.3.3 Study design: Overview of intervention behaviour change activities employed

Of the 148 studies, 103 described intervention activities to change WASH behaviour. Table 4 demonstrates the range of behaviour change activities reported in these studies. They include a variety of promotional strategies and implementation methods, one or more of which may be employed as part of an intervention package.

Table 4: Frequency and type of reported behaviour change activities (n=103)

Behaviour change activity	Freq.
Promotion of latrine or toilet construction by community	38
Education/communication through mass media/social marketing	3
Education/communication through youth clubs, school clubs or teachers	12
Education/communication through women's groups	26
Education/communication through community health workers or health promoters	51
Education/communication through facility-based health workers	18
Community-Led Total Sanitation	8

Note: multiple categorisations are possible.

3.3.4 Study design: Combined WASH technologies

Of the 148 studies, 52 reported on a combined water, sanitation and handwashing intervention (see Table 23 in Appendix 4). Prior research has not reported any difference

in health outcomes when interventions are promoted either separately or concurrently (Fewtrell et al., 2005; Arnold and Colford, 2007), but combined WASH interventions may have relevance when considering large-scale policy planning or donor investment (Dreibelbis et al., 2013).

3.4 Mapping and keywording: Study designs and key WASH technologies, by domain

3.4.1 Overview of WASH technologies studied: Handwashing

A variety of different handwashing enabling technologies are present in the literature; most studies encourage handwashing with soap. However, details on specific handwashing station designs, types of soap, and soap presentation mechanisms are lacking. Table 5 describes the types of technologies represented in the handwashing literature. These interventions typically included promotion of handwashing with soap and water, although a few studies focused on other enabling products, such as a handwashing station, storage containers for soap to ensure convenient, consistent access, and sanitiser products.

Table 5: Frequency of studies describing enabling handwashing technologies (N=55)

Studies describing enabling technology installed, distributed, sold or promoted as part of a handwashing intervention	**Freq.**
Handwashing stations	
Handwashing station with reservoir and tap	7
Place to wash hands at pump or other water source	6
Soap or other cleansing agents	
Bar soap	18
Soapy water/soapy water bottle	6
Ash	7
Hand sanitiser	0
Other	4
Intervention design	
The study assessed whether soap, sanitiser or other enabling technology was present, but did not provide, distribute or sell it to people	17
The study describes knowledge, attitudes, or practices of handwashing behaviours: no enabling technology was installed, distributed or sold	8
Enabling technology was part of the intervention, but no information was provided about it	14

Note: Multiple categorisations are possible

3.4.2 Overview of WASH technologies studied: Water treatment

In contrast to handwashing, water treatment and safe storage enabling technologies tended to be described in detail. The majority of safe water interventions promoted water treatment products for point-of-use. These primarily included filters, solar disinfection, chlorination and flocculent disinfectants. Also included in the safe water group were methods of safe water storage, such as narrow-necked vessels and covered containers to minimise recontamination of water after treatment or collection from a safe source.

Though less common, boiling water was discussed in 9 studies. 27 studies described a filtration device, 13 presented options for chlorination, and 16 documented solar

disinfection techniques. Table 6 demonstrates the range of products represented in the literature.

Table 6: Frequency of studies describing enabling water treatment technologies (N=62)

Studies describing of enabling technology installed, distributed, sold or promoted as part of a water treatment intervention	**Freq.**
POU water treatment technology	
Boiling water (heating for a period of time to kill bacteria and viruses)	9
Ceramic filter (filtration through a porous ceramic container)	9
Biosand filter (filtration through a layer of sand and organic material)	6
Other kinds of filter (i.e. filters to remove metals such as fluoride or arsenic)	12
Chlorine tablets (small tablets to disinfect a specified amount of water)	11
Chlorine dispenser (container with chlorine solution used to dose water prior to use)	2
Solar water disinfection	16
Other (i.e. Lifestraw®- a commercially-produced ultrafiltration device, rainwater harvesting, etc.)	16
Safe water storage (Centers for Disease Control, 2014)	
Vessel to hold specific amount of water for chlorination	3
Vessel to protect water from recontamination by hands	8
Intervention design	
The study describes knowledge, attitudes, or practices of water treatment behaviours: no enabling technology was installed, distributed or sold	6
Enabling technology was part of the intervention, but no information was provided about it	3

Note: See WHO (2011). Multiple categorisation is possible

3.4.3 Overview of WASH technologies studied: Sanitation

Sanitation programmes require more up-front investment for materials and construction. Twenty studies involved training personnel in proper latrine construction, while 10 studies provided materials free of charge, in 17 studies, they were sold to the community through local distribution points or at subsidised prices. Only five studies discussed community latrines or sanitary scoops for removal of faeces. Table 7 summarises strategies for implementing sanitation technologies.

Table 7: Frequency of studies describing enabling sanitation technologies (N=59)

Studies describing enabling technology installed, distributed, sold or promoted as part of a sanitation intervention	Freq.
Materials for latrine construction provided free of charge to community	10
Materials for latrine construction sold to community	17
Community members trained in latrine construction	20
Private company or contractors construct latrines	5
Community constructs their own latrines, in traditional way	9
Other	21
The study describes knowledge, attitudes, or practices of sanitation behaviours: No enabling technology was installed, distributed or sold	2
Enabling technology was part of the intervention, but no information was provided about it	14

3.5 Mapping and keywording: Study outcome reporting and evaluations

3.5.1 Study outcomes: Reported focus on sustainability

Though all of the studies in this report assessed factors influencing WASH adoption, only 68 of 148 studies mentioned sustainability or sustained adoption. Sixty-three of 148 studies specified target behaviours or behavioural objectives; however, the literature identified may underrepresent adoption and sustained adoption if behaviour change is not an explicit component of research at the outset of a study. Even though all 148 studies included in this review reported on a WASH behaviour or adoption of WASH practices, only 19 studies provided a full description of the behaviour of interest (i.e. 'wash both hands with soap until lather is produced, for 30 seconds or more' or 'treat water by placing bottles in full sun for eight hours before consumption').

3.5.2 Study outcomes: Data collection methods and reporting

Studies typically reported on household surveys, with a smaller number reporting on both surveys and qualitative data, and a small number that were only qualitative. Most articles and reports were incomplete in terms of both the description of the methodology and the reporting of results. Of the data that were available, only a limited subset was presented. The types of data commonly presented were:

- demographic characteristics of respondents
- description of the study site
- self-reports of behaviour based on household survey
- observed behaviour e.g. structured observation of handwashing
- proxies for behaviour e.g. detection of residual chlorine in drinking water
- WASH-related knowledge, often measured through a Knowledge-Attitudes-Practices (KAP) survey. However, the A (attitudes) itself in KAP is rarely formally measured.

Types of data and other aspects of the research that are only rarely analysed include:

- **Description of the technology**. Where technology is introduced (soap dispensers, handwashing stations, water filters, improved latrines etc.), it is not often described in detail.

- **Explicit behaviour change model**. Of the 148 studies, 63 set out to change behaviour. Only 32 mentioned or described an explicit behaviour change model. Often there was an implicit model, which could be discerned through careful reading of the article, and analysis of types of data measured and analysed.

3.5.3 Study outcomes: Comparisons between study groups

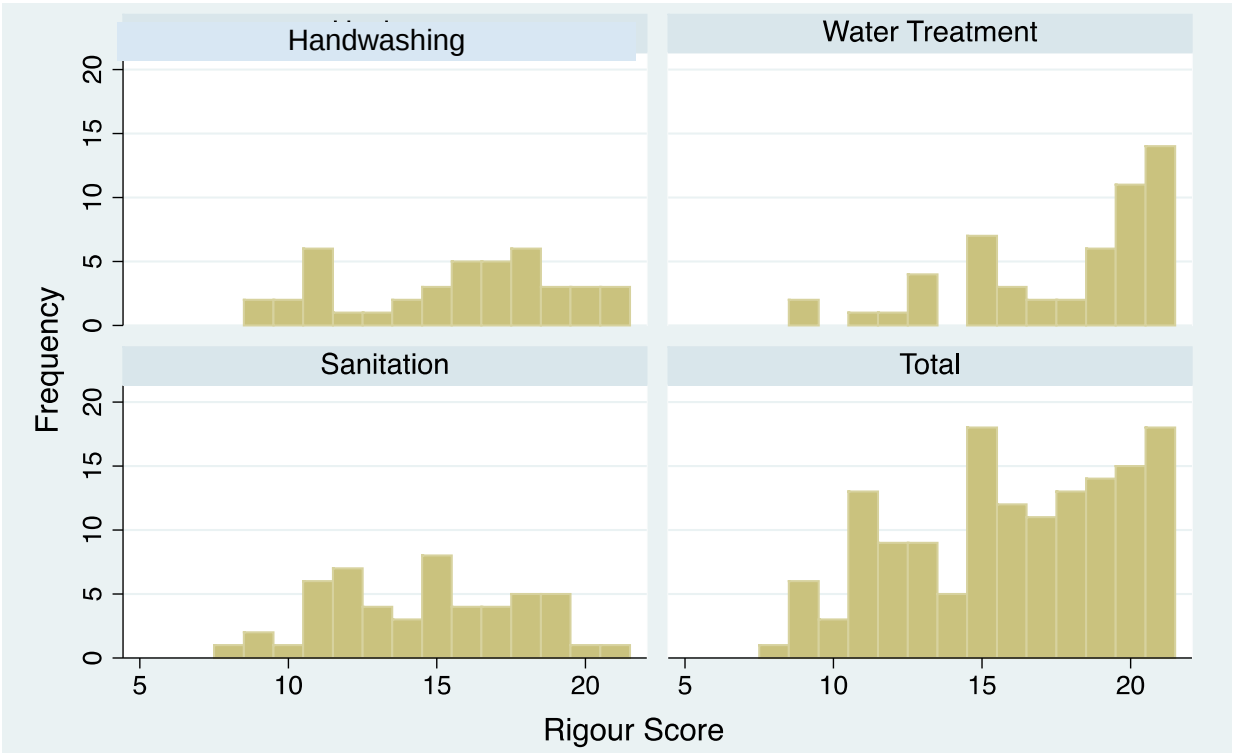
Some studies may have included multiple comparisons. We were also interested in identifying the types of comparisons made over time to demonstrate long-term use and/or sustained adoption following a period of implementation.

Of the 148 studies, 66 did not make comparisons of behaviour change over time. These were cross-sectional quantitative evaluations, a single round of qualitative research or pilot studies. The next most common comparison was between an established baseline and the mid- or end-point of a study or intervention. Thirty-nine reports provided a pre- and post-study comparison, 17 examined before-and-after large-scale distribution (for example, distribution of ceramic water filters for household water treatment following a natural disaster), 14 compared results pre- and post-community mobilisation (such as a Community-Led Total Sanitation campaign), and 23 compared changes after conclusion of the study. Twenty-five compared changes after a period of intensive implementation. Nineteen studies were designed to assess change over time: 7 studies were longitudinal panel designs, and 12 employed continuous monitoring.

3.5.4 Study outcomes: Assessment of study quality

We assessed study rigour by adapting a seven-point scale system from Harden and Thomas (2005) to describe the heterogeneity of the data quality (see Section 2.1 for a detailed description of the full criteria applied). The scores are compiled in Figure 5 for 147 of the 148 studies identified after the screening phase. One study was excluded due to incomplete responses for all the sub-scores used to calculate the final rigour score. Rigour scores are presented against the frequency of studies achieving that score, with a higher score (right side of plot) corresponding to better detail provided on study design and methodology.

Figure 5: Frequency of rigour scores for all studies, aggregated by score (of 21 possible points)



4. In-depth review: Results

Chapter overview

From the 148 articles that were mapped, we identified 44 articles with an explicit purpose to assess sustained use of WASH technologies and behaviour practice. The definition of sustained use for this review can be found in Section 1.1.3.

Sustained use differs from 'maintenance', which refers to the continued practice of a WASH behaviour or use of a technology *during* the project period. While many behavioural models specify factors that motivate *initial* adoption of a WASH technology during a project, these factors may not be same factors that motivate the sustained practices of WASH behaviours into the extended future after the project ends.

We found that we could separate our 44 articles into two distinct groups:

1. 'Sustained adoption' articles (n=21), which reported on WASH practices six months or more after the project period ended
2. 'Maintenance' articles (n=23), which reported on WASH practices at any time within the project period, regardless whether study activities (e.g. household visits or refills of chlorine) were still occurring.

In this chapter we expand on the results presented in Chapter 3. We discuss outcomes measured and level of adoption achieved by a select number of studies. We present relevant factors identified from WASH literature, broken down by IBM WASH concept. Then we discuss relevant programme characteristics, including study design and intervention strategies that support sustained adoption of WASH technologies.

Water, sanitation and hygiene interventions are often implemented as packages of (1) a WASH technology, and (2) an educational or promotional component. WASH technologies (sometimes referred to as 'hardware'), such as a handwashing station with soap, a water filter or a latrine, are important because they facilitate the practice of the behaviour, enabling a participant to carry out the behaviour multiple times and form lifelong habits. The use and availability of the technology itself, the knowledge and attitudes of the users, and the social and environmental context in which the behaviours are practised are all factors influencing this. The subset of articles selected for in-depth review in the Behavioural Factors syntheses are associated with sustained use of a technology or the practice of a specific behaviour.

Another typical component of an intervention package is education or promotion (referred to, by some, as 'software'). This takes many forms, from mass media advertisements to one-on-one discussions between a community health worker and a mother of young children. The goal of education is to introduce a user to a behaviour and technology and to discuss why, when, and how to do the behaviour. Intervention components, such as types of communication channels employed, duration of the programme, and the intensity of interactions, are discussed in the Programme Characteristics syntheses. In that section, we also identify programmes that conducted follow-up assessments after a period of time post-intervention.

We conducted five discrete syntheses on various subsets of the selected articles:

- Measuring level of adoption
    - Synthesis 1 – Measurement of WASH behaviour practice during post-intervention follow-up
- Research question 1: The syntheses focus on behavioural factors influencing adoption and sustained adoption of WASH technologies and behaviours

- Synthesis 2 - Psychosocial factors
- Synthesis 3 - Contextual factors
- Synthesis 4 - Technological factors

- Research question 2: The syntheses address programme characteristics affecting adoption of behaviours and levels of sustained adoption achieved
  - Synthesis 5 - Intervention design/intervention components affecting adoption and sustained adoption of behaviours

Some articles are included in several synthesis exercises, others in only one. Table 8 illustrates the articles included in each synthesis, by WASH category. In total there were 44 unique studies; note that seven studies assessed more than one type of WASH technology. See Table 24 in Appendix 4 for more detail.

Table 8: Studies included in syntheses

Handwashing (n=12)	**Water treatment (n=23)**	**Sanitation (n=16)**
Studies assessing only handwashing: Wilson and Chandler, 1993 Shordt and Cairncross, 2004 Devine and Koita, 2010 O'Brien and Favin, 2012 Bowen et al., 2013 **Studies assessing handwashing + other WASH interventions:** SEUF, 2004 Cairncross and Shordt, 2004 Cairncross et al., 2005 Parker et al., 2006 Arnold et al., 2009 Whaley and Webster, 2011 Eder et al., 2012	**Studies assessing only water treatment:** Parker, 1997 Hoque et al., 2004 Brown et al., 2007 Ngai et al., 2007 Altherr et al., 2008 Brown et al., 2009 Tamas et al., 2009 DuBois et al., 2010 Aiken et al., 2011 Christen et al., 2011 Kraemer and Mosler, 2011 Mosler and Kraemer, 2012 Mosler et al., 2013 Tamas and Mosler, 2011 Casanova et al., 2012 Freeman et al., 2012 Kraemer and Mosler, 2012 Peletz et al., 2012 Wood et al., 2012 Inauen et al., 2013 Wheeler and Agha, 2013 **Studies assessing water treatment + other WASH interventions:** Parker et al., 2006 Arnold et al., 2009	**Studies assessing only sanitation:** Simms et al., 2005 Waterkeyn and Cairncross, 2005 Choudhury and Hossain, 2006 Diallo et al., 2007 Qutub et al., 2008 Roma et al., 2010 Devine and Sijbesma, 2011 Kullman and Ahmed, 2011 Ross et al., 2011 Malebo, 2012 Barnard et al., 2013 **Studies assessing sanitation + other WASH interventions:** SEUF, 2004 Cairncross and Shordt, 2004 Cairncross et al., 2005 Whaley and Webster, 2011 Eder et al., 2012

4.1 Research Question 1: Defining outcomes and measuring the level of sustained WASH adoption (n=21)

To address Research Question 1,

> *What are the factors that influence the sustained adoption of clean water and sanitation technologies?*

it is necessary for a study or programme evaluation to 1) measure sustained adoption of WASH behaviours, 2) measure factors affecting or influencing sustained adoption, and 3) analyse associations between sustained adoption and these factors. In this part of the chapter, we explore how studies measured and reported WASH practices. This information is critical to anyone wishing to implement WASH programmes, or develop indicators to monitor behaviour change and assess the long-term impact of programmes. There was a great diversity in how studies were designed and collected data on both behaviour practice and use of the technology. Measurement methodologies utilised in almost all studies included:

- **self-report,** where a participant is questioned about their WASH practices (usually using a structured or semi-structured survey)
- **spot check,** where the practice of a behaviour or presence of a technology is confirmed visually at the time of the visit
- **demonstration,** where a participant is requested to show how a behaviour is practised to assess level of knowledge and ability to perform the action.

Thirty studies described explicit goals of assessing 'sustained adoption' (see Table 25 in Appendix 4). However, these assessments could be monitoring and evaluation exercises, which we defined as behaviour practice during the intervention period, or post-intervention follow-up, which assesses practice at some point after an intervention has ended. We were interested specifically in the latter, termed 'level of adoption', to quantify the change in WASH use over time after an intervention ended. As an example, the systematic review by Arnold and Colford (2007) found that the impact of point-of-use water treatment on diarrhoeal outcomes decreased in studies of longer duration, suggesting a decline in the behaviour over time and lack of habit formation. Further information on this phenomenon is critical for guiding future WASH research and programmes.

4.1.1 Selection of studies for analysis of outcome measures

Twenty-one studies in our in-depth review reported WASH practice at least six months after the end of the project period. This time period was chosen by our team as a reflection of the minimum length of time that evaluation studies waited to assess the sustainability of behaviour change resulting from a project or study; the actual time to follow-up ranged from six months to over nine years.

4.1.2 Measuring sustained adoption: Overview

Tables 9 to 11 demonstrate the study designs, outcome(s) measured, frequency of measurement, the length of time to when a follow-up assessment was conducted, and level of adoption achieved for the three domains.

Across all WASH topics, two study designs are frequently employed: cross-sectional surveys, which provide an 'at-a-glance' measurement of behaviour practice, and longitudinal surveys, which follow a population over time and allow for the assessment of trends in practice over time.

Only three studies conducted measurements at multiple time points after the end of the project period (SEUF, 2004; Parker et al., 2006; Bowen et al., 2013). Additionally, only 5

out of 21 studies attempting to assess long-term WASH use also included estimates of the level of use or adoption from the end of the project period (see Section 7.5.7 in Annex). Comparison of measurements at multiple time points is fundamental to assessing sustained adoption. In practice, the comparison can be either 1) between two or more time points after the end of the project period or 2) between the end of the project period and one time point thereafter. Making these two types of comparisons is essential to building the evidence base for the long-term sustainability of WASH behaviours after the end of the project period.

We discuss these characteristics below in more detail by WASH topic.

4.2 Measuring sustained adoption: Handwashing (n=7)

4.2.1 All studies reporting data on handwashing after the end of the project period (N=7)

Table 23 in Appendix 4 details the handwashing measures and outcomes.

4.2.1.1 Study design

Five out of seven studies employed a cross-sectional study design, where a population is sampled at one point in time and asked about their current and past practices. Two studies (Parker et al., 2006 and Bowen et al., 2013) followed a cohort and were able to compare behaviour practice over time after the end of the project period.

4.2.1.2 Technologies represented in sustained handwashing interventions

Handwashing studies focused exclusively on promotion of handwashing with soap.

4.2.1.3 Outcomes measured

Studies on sustained handwashing practice typically examined the behaviour only, not the presence or functionality of enabling technologies such as handwashing stations. The seven handwashing studies employed a variety of measurements:

- **Handwashing practice**: The act of practising handwashing as defined by the authors at the outset of the study
- **Handwashing technique**: The specific criteria used to judge handwashing practice knowledge and ability (e.g. handwashing at five key times)
- **Presence of soap or handwashing station with soap.**

Definitions of these outcomes varied widely. Some studies defined clear criteria (such as Parker et al., 2006 and Bowen et al., 2013 on handwashing technique), while others did not describe their criteria or decision-making process.

4.2.1.4 Measurement methods

Assessment of handwashing practices were made almost exclusively by participant self-report or demonstration, with additional methods of pocket voting[2] or spot check for hardware. These methods exhibit notable strengths and weaknesses, and there is no agreement on the best way to measure handwashing practice, in either community settings (Curtis et al., 1993; Ram et al., 2010; Stanton et al., 1987) even in health facility settings (Haas and Larson, 2007; Jenner et al., 2006).

[2] Anonymous voting by a person who reported their personal latrine use by indicating their answer on a piece of paper and placing it in an envelope

In interpreting these results, it is important to consider limitations in measurement and use of proxy measures. Compared to direct observation, self-report or 24-hour recalls provide inaccurate measures, overestimating both handwashing (Stanton et al., 1987) and 'good' practice of handwashing (Curtis et al., 1993). However, direct observation may also be problematic. Ram et al. (2010) compared participant reactivity to direct observation by comparing handwashing under observation to handwashing using soap with acceleration sensors and found that handwashing and soap use increased in the presence of an observer. In the evaluations of sustained handwashing we summarise here, the most common measure is self-reported handwashing on household surveys. This method is commonly considered to be the least accurate (Stanton et al., 1987; Curtis et al., 1993b). Though it is beyond the scope of this systematic review, handwashing behaviours have been studied in a variety of hospital settings. Jenner and colleagues (2006) studied handwashing opportunities on hospital wards and found that observed handwashing behaviour was unrelated to self-reported behaviour or the intentions of carers.

4.2.2 Studies reporting on handwashing at one time point after the end of the project period (n=4)

4.2.2.1 Study design

Four studies assessed indicators of handwashing practice at one point after the end of the project period. All studies were cross-sectional surveys, with length of follow-up time ranging from one to nine years.

4.2.2.2 Measurement methods

All four studies measured self-reported handwashing practice, while two out of four studies (50%) requested participants to demonstrate handwashing techniques. None conducted spot checks for the presence of soap, water, handwashing stations or other key technologies necessary to practise handwashing.

4.2.2.3 Level of adoption

Reported handwashing practice ranged from 57% (Cairncross et al., 2005) to 94% (Wilson and Chandler, 1993). One study (Arnold et al., 2009) measured no difference between sites that had received handwashing promotion interventions and control households.

In one study, when households were asked about the use and availability of soap, over 87% reported that they used soap or had access to a handwashing station. It is unknown who was practising these behaviours, though Cairncross et al. (2005) did note that the practice was less among men and children than among women in the household.

Of the two studies where participant demonstration of handwashing was measured, only one (Cairncross et al., 2005) reported the data in the final report. Their team found that of the 57% of women reporting 'always washing with soap at any time', 81% were able to perform the correct technique of rubbing hands together with soap and water. They also reported that the odds of practising the correct technique were 13.4 times higher (CI 6.3-28.3) in households where all the women reported washing hands, compared to those where they did not.

4.2.3 Studies reporting on handwashing at two time points after the end of the project period (n=3)

4.2.3.1 Study design

Three studies (Bowen et al., 2013 Parker et al., 2006; SEUF, 2004) assessed handwashing at two separate time points after the end of the project period, utilising longitudinal panel or cohort designs. Compared to studies that only conducted one assessment, these

studies are more capable of demonstrating changes in WASH use over time after the end of the project.

4.2.3.2 Measurement methods

The first measurements were made between two weeks to one year after the end of the project period, and second assessments were conducted about one year (Parker et al., 2006; SEUF, 2004) to over two-and-a-half years (Bowen et al., 2013) after the first follow-up measurement.

Handwashing technique was assessed in all three studies by participant demonstration. The definition of 'proper' technique varied from rubbing hands at least three times (Bowen et al., 2013) to performing six pre-specified actions (Parker et al., 2006). Two of the 3 studies measured the presence of handwashing technologies, while the other study (Bowen et al., 2013) conducted household spot checks. Handwashing practice was measured by one of the three studies via pocket voting (SEUF, 2004).

4.2.3.3 Level of adoption

Between the two time points, two of the three studies documented a decreasing trend in reported handwashing and ability to correctly practise the behaviour (Parker et al., 2006; SEUF 2004). However, Bowen et al., (2013) reported increased handwashing practice among two intervention groups five years after the end of the study, compared to results from a follow-up at 20 months post intervention. Intervention households were also 14 times more likely to practise correct handwashing techniques, compared to control households. The authors cited habituation as a possible explanation for this increase in handwashing practice (2013).

The presence of handwashing technologies (e.g. soap/soapy water or other cleanser, water, or a handwashing station) remained high over the follow-up period, with over 90% of households surveyed having soap or a handwashing station present at the time of the second assessment (Bowen et al., 2013; Parker et al., 2006).

4.3 Measuring sustained adoption: Water treatment (n=12)

4.3.1 Studies reporting follow-up after the end of projects promoting water treatment (n=12)

Water treatment outcomes and measures can be found in Table 24 in Appendix 4.

4.3.1.1 Study designs

A diversity of study designs was employed to assess long-term water treatment. Six of twelve studies (50%) utilised a cross-sectional survey, while five studies (58%) conducted longitudinal assessments (panel, n=4; cohort, n=1). One study (Peletz et al., 2012) reported on a randomised controlled trial. Additionally, two studies (Brown et al., 2007; DuBois et al., 2010) utilised both cross-sectional and longitudinal designs concurrently.

4.3.1.2 Technologies represented in sustained water treatment adoption studies

Five of 12 water treatment studies (42%) promoted a filter using various materials: ceramic (Brown et al., 2007; Casanova et al., 2012), biosand (Aiken et al., 2011), iron oxide-coated sand or activated alumina for the removal of arsenic (Ngai et al., 2007), or Lifestraw®, a hollow fiber membrane filter (Peletz et al., 2012). Three studies (25%) promoted chlorine solution for home water treatment (Parker et al., 2006; DuBois et al., 2010; Wheeler and Agha, 2013), and one study (DuBois et al., 2010) also promoted flocculant disinfectant. Three of 12 studies introduced solar disinfection (Arnold et al., 2009; Tamas and Mosler, 2011; Mosler et al., 2013), and one study (Arnold et al., 2009)

encouraged boiling to treat water. An early study by Parker assessed wells that were dug as part of a national water treatment campaign (1997). Two of 12 studies (Arnold et al., 2009; DuBois et al., 2010) promoted multiple treatment methods, though only DuBois et al., reported on specific treatment practices in the results.

4.3.1.3 Outcomes measured

The included studies measured one or more of the following outcomes to assess sustained water treatment practice:

- **Water treatment**: The act of treating water to make it safe for consumption, usually using a specific technology (e.g. chlorine tablets or ceramic filter). Defined by the authors at the outset of the study
- **Water quality**: The amount of physical or microbial material present in a sample of drinking water. Thresholds of quality are defined by the authors, typically in accordance with WHO guidelines (WHO, 2011)
- **Purchase of technology**: To assess whether households spent money or other resources on water treatment technologies. Many studies either provided technologies for free, at subsidised cost to households, or within local markets.
- ***Continued use of the technology***
- **Continued functionality of the technology**: Typically defined by the study authors (e.g. Aiken et al., 2011 or Casanova et al., 2012).

Water treatment practices were measured in 100% of studies, though definitions of practice varied by treatment method.

4.3.1.4 Measurement methods

Eleven of 12 studies incorporated self-report of water treatment practices. The seven studies employing spot checks assessed actual stored water quality, or the presence and functionality of a technology. One study (Parker, 1997) did not specify the methodology used to obtain the data.

4.3.2 Studies assessing water treatment practice at one time point after the end of the project period (n=11)

4.3.2.1 Study design

Six of 11 studies utilised a cross-sectional study design, and one study was a randomised controlled trial. Six studies utilised a longitudinal design: four were panel surveys, and two followed cohorts.

4.3.2.2 Measurement methods

Self-reported water treatment was measured in all studies. Participants were generally asked about their use patterns, frequency of use and perceptions about the technologies, though the exact scope of the questions varied by study. The functionality of technologies was also assessed via a survey.

Reported water treatment often compared self-reports with an observation of actual use, such as a water quality test. Spot checks were used to ascertain actual water treatment practices in six of the eleven studies. Functionality was also assessed by one study via spot check (Aiken et al., 2011).

4.3.2.3 Level of adoption

Water treatment levels at the time of follow-up, ranging from six months to six years after the project period, were extremely heterogeneous. Reported use ranged from 22% (Certeza solution, Wheeler and Agha 2013) to 96% (Peletz et al., 2012), depending on the technology type. Spot checks to assess water quality typically indicated a lower percentage of actual use, compared to reported use (Arnold et al., 2009; Peletz et al., 2012).

Of the four studies among the eleven (see Table 27 in Appendix 4) that provided reference data on use at the end of the project period, only one (Wheeler and Agha, 2013) indicated increased use of chlorine from the time the project or study ended to the follow-up assessment. However, the other studies indicated a decline in use of SODIS (Arnold et al., 2009; Tamas et al., 2009) or chlorine (DuBois et al., 2010) over time. As we do not have the reference data for the other seven studies that provided data on use at the end of the project period, it is difficult to assess long-term trends in water treatment beyond summary statements made by the authors.

The functionality of the technology at the time of follow-up was assessed by two studies (Aiken et al., 2011; Casanova et al., 2012). Both studies found that close to 90% of filters were still working one year after the end of the study, though Brown et al. (2007) reported that 65% of non-users cited filter breakage as the primary barrier to continued use.

4.3.3 Studies assessing water treatment practices at two time points after the intervention ended (n=1)

One study (Parker et al., 2006) assessed water treatment practice at two weeks and one year after an intervention study promoting water chlorination and handwashing through community nurses had concluded. Measurements included self-reported water treatment behaviour and recall of messaging, and spot checks to test water quality. Immediately after the end of the intervention study, recall of water treatment messages was high, but no information was reported on current use. At two weeks after the end of the study, recall of messaging was still high. At one year after the end of the project period, no information was provided on recall of messaging, but 71% of households had detectable chlorine residuals in drinking water, indicating recent treatment of water.

4.4 Measuring sustained adoption: Sanitation (N=7)

4.4.1 Studies reporting post-intervention follow-up after the end of sanitation projects or studies (n=7)

The sanitation outcomes and measurements can be found in Table 25 of Appendix 4.

4.4.1.1 Study design

All studies employed a cross-sectional survey design. A multi-site study from Kerala, India (SEUF, 2004), included a longitudinal panel survey at one study site, with one year between follow-up surveys.

4.4.2.2 Technologies represented in sustained sanitation interventions

All sustained sanitation interventions included latrine promotion. Three studies (Cairncross et al., 2005; Eder et al., 2012; SEUF, 2004) paired latrine promotion with handwashing interventions. No studies simultaneously promoted sanitation and water treatment technologies.

4.4.2.3 Outcomes measured

We categorised sanitation outcome measures into the following groups:

- **Latrine use:** The act of using a latrine either by individuals or other household members. Methods for measuring frequency of use were determined by study authors. *Functionality* and *quality* were also included in this measure. *Functionality* refers to the latrine's ability to safely contain faeces. *Quality* was defined by the study authors; examples of definitions include cleanliness in the area surrounding the latrine (Barnard et al., 2013; Cairncross et al., 2005; Diallo et al., 2007; SEUF, 2004), or WHO definitions (Kullman and Ahmed, 2011).
- **Latrine ownership**: A measure of an individual or household's receipt of a latrine (if latrines were provided by the study), or purchase or spending on latrine construction, maintenance or use.
- **Presence of a latrine:** The physical existence of a latrine in a household or community. Though the presence of a latrine provides access, it does not necessarily indicate use. Users may discontinue using a latrine if it is dirty, if it is inaccessible in certain seasons, or where social norms support practices of open defecation.

Six of seven studies (86%) measured latrine use, and three measured latrine ownership. The presence and functionality of latrines were assessed in two studies. Frequency or patterns of use and latrine quality were defined in four studies (Barnard et al., 2013; Cairncross et al., 2005; Diallo et al., 2007; SEUF, 2004).

4.4.2.4 Measurement methods

Five of seven studies assessed latrine use and/or ownership by participant self-report. The remaining two studies (Cairncross et al., 2005; SEUF, 2004) measured these constructs using pocket voting. Two studies reported on the presence of latrines: one measured presence during a spot check (Eder et al., 2012), and the other utilised participant self-reporting (Barnard et al., 2013). Functionality was assessed by spot check in one study (SEUF, 2004).

4.4.2 Studies assessing sanitation behaviours at one time point after the end of the project period (n=6)

4.4.2.1 Study design

All six studies utilised cross-sectional surveys to assess sanitation behaviours. Only one of these (Kullman and Ahmed, 2011), provided reference information on sanitation practices at the time the intervention ended. Follow-up assessments were made from one to nine years after the conclusion of the intervention.

4.4.2.2 Measurement methods

Five of six studies measured latrine use, ownership or physical presence by self-report; one study (Cairncross et al., 2005) utilised pocket voting. Confirmation of the presence of a latrine by spot check was not common, as it was reported in only one study (Eder et al., 2012).

4.4.2.3 Level of adoption

Reported latrine use 'all of the time' in these studies varies from 47% (Barnard et al., 2013) to 93% of adults (Diallo et al., 2007). Only two of six studies (Barnard et al., 2013; Diallo et al., 2007) reported on latrine use by household members other than the primary respondent. While Diallo et al. (2007) reported that 93% of adults used a latrine, this fell to only 55% of children under 10 years . Of the households surveyed by Barnard et al. (2013), 72% reported 'at least one member' using the latrine.

Reported access to or ownership of latrines ranged from 72% (Barnard et al., 2013) to 100% (Diallo et al., 2007) of households surveyed. In studies where the functionality or presence of a latrine was compared against participant reports (Diallo et al., 2007; Eder et al., 2012), the actual functionality or even presence of a latrine was much lower than in the reported data.

4.4.3 Studies assessing sanitation behaviours at two time points after the end of the project period (n=1)

One study (SEUF, 2004) utilised a longitudinal panel survey to assess sanitation practices at one study site in Kerala, India. The authors used pocket voting and spot checks to assess latrine use and functionality, with one year between assessments. Between follow-up measurements, the study found a slight decrease in the use of latrines: at the first assessment, 93-98% reported latrine use, while 92% reported use one year later. A greater decrease in latrine functionality was observed: 51% of households had usable latrines at the second follow-up, compared to 81% in households at the first follow-up. The study indicated that women were more likely to use latrines than men, perhaps due to participation in simultaneous handwashing education classes. Also, increased latrine use was correlated with longer project periods.

4.5 Research Question 1: Behavioural factors influencing sustained adoption (n=44)

To address Research Question 1, it is necessary for a study or programme evaluation to: 1) measure sustained adoption of WASH behaviours (see previous sections), 2) measure factors affecting or influencing sustained adoption, and 3) analyse associations between sustained adoption and these factors. In this section, we describe factors influencing sustained adoption, and their associations with WASH behaviours. All 44 articles reviewed for in-depth synthesis were included in this analysis; these include: 1) 'sustained adoption' articles assessing WASH practice over a period of six months or more after the project period ended (n=21) and 2) 'maintenance' articles reporting on WASH practice during the project period (n=23). Behavioural factors (or 'determinants') encapsulate the physical, social, psychological, environmental or technological factors that shape individual-level behaviours. For the purposes of this review, these factors have been classified into three main categories (Dreibelbis et al., 2013): psychosocial, contextual and technological. Full details of these categories can be found in Section 1.2.2.

Using the IBM WASH framework (Dreibelbis et al., 2013), we employed framework synthesis methodology to identify themes within articles that described the above factor domains. The following syntheses highlight factors reported by or associated with participant uptake and sustained practice of WASH behaviours. Thirty-six report on psychosocial factors, 29 report contextual factors and 33 report factors related to enabling technologies.

4.5.1 Synthesis 1: Psychosocial factors influencing adoption and sustained adoption (n=36)

In this synthesis we have identified 36 studies that document psychosocial factors influencing sustained behaviour. Psychosocial factors represent the emotional and mental attitudes that affect an individual's practice of a behaviour; they can be realised at multiple social levels, such as the constructs of self-efficacy or perceived susceptibility described by various individual-level models, e.g. the Health Belief Model (Becker et al., 1977; Janz and Becker, 1984), or the Theory of Reasoned Action and Theory of Planned Behaviour (Ajzen, 1991; Fishbein and Ajzen, 1975). Other models, such as the Social Cognitive Theory (Bandura, 1989), describe factors at the household and community levels, including social norms. Some programme-derived models, such as FOAM, classify

psychosocial factors as 'behavioural determinants' (Coombes and Devine, 2010; Devine, 2009).

In our sample, only 11 of the 36 studies specifically described a behavioural model or conceptual framework. The following models are represented and include psychosocial factors:

- FOAM (Coombes and Devine, 2010)
- Theory of Planned Behaviour (Ajzen, 1991)
- RANAS (Mosler, 2012)
- Elaboration of likelihood (Petty and Cacioppo, 1986)
- Diffusion of innovations (Rogers, 2003)
- PATH's Behaviour Change Continuum (Wood et al., 2012)
- Consumer Purchase Decision Process (English, 2010)
- Transtheoretical Model of Change (Prochaska and DiClemente, 1983)
- Dimensions of social research (Neuman, 1997)
- Health Belief Model (Becker et al., 1977; Janz and Becker, 1984).

Given the large numbers of studies, we present the results by intervention category: handwashing, water treatment or sanitation. We group psychosocial factors according to the levels of influence in the IBM WASH model (Dreibelbis et al, 2013) (Table 9). The psychosocial factors we identified are grouped on three behavioural levels:

- **Interpersonal/household** factors refer to practices, expectations, or 'good' behaviour in the home or family, such as household rules for handwashing or latrine use, and norms operating within the household.
- **Individual level** factors capture a person's perceptions, thoughts and motivations. Many of the specific constructs were borrowed from individual-level behaviour change theories such as the Health Belief Model (Becker et al., 1977, Janz and Becker, 1984). Constructs originating in the Health Belief Model include perceived severity and susceptibility of the WASH-related health problem, benefits and barriers to sustained practice of the behaviour.
- **Habitual** level factors describe the elements required to make a given behaviour a sustained, repeated event in a person's life, such as sensory cues for handwashing (sticky or greasy feeling on hands), and the feasibility of integrating WASH behaviours into one's daily routine.

Table 9 presents a summary of the psychosocial factors described in these 36 studies. We discuss the factors specific to each WASH topic in detail in the following sections.

Table 9: Psychosocial factors represented in the WASH literature (N=36)

Level of IBM WASH framework	**Handwashing (n=4)**	**Water treatment (n=22)**	**Sanitation (n=10)**
Interpersonal and household	Injunctive and descriptive norms • Devine and Koita, 2010 Nurture • Devine and Koita, 2010	Injunctive norms • 11/22 studies, e.g. Altherr et al., 2008; Brown et al., 2009 Descriptive norms • 8/22 studies, e.g. Tamas et al., 2009, Wheeler and Agha 2013 Subjective norms • Altherr et al., 2008; Mosler and Kraemer, 2012	Social norms • 6/10 studies e.g. Barnard et al., 2013; Kullman and Ahmed 2011 Stigma surrounding defecation • Whaley and Webster, 2011 Shared values • Roma et al., 2010
Individual	Knowledge of behaviour and disease transmission • Wilson and Chandler, 1993; SEUF, 2004; Parker et al., 2006 Knowledge of the practice • Devine and Koita, 2010; Parker et al., 2006; SEUF, 2004 Perceived benefits and barriers • SEUF, 2004; Devine and Koita, 2010 Self-efficacy • SEUF, 2004; Devine and Koita, 2010	Perceived susceptibility • 12/22, e.g. Aiken et al., 2011 Perceived severity • 9/22, e.g. Christen et al., 2011 Knowledge of behaviour and disease transmission • 7/22, e.g. Inauen et al., 2013 Self-efficacy • 8/22, e.g. Wood et al., 2012 Perceived health benefit • 9/22, e.g. Parker, 1997; DuBois et al., 2010 User preferences • Arnold et al., 2009 Aspirations • Wood et al., 2012	Perceived benefits (privacy, safety, cleanliness) • 9/10 e.g. Roma et al., 2010; Barnard et al., 2013 Perceived barriers • 6/10 e.g. Waterkeyn and Cairncross , 2005; Devine and Sijbesma, 2011 Knowledge of disease transmission • Diallo et al., 2007; Ross et al., 2011; Barnard et al., 2013; Waterkeyn 2011; Malebo, 2012) Aspirations • Diallo et al., 2007 Disgust • Ross et al., 2011; Whaley and Webster, 2011
Habitual		Behavioural cues • 6/22, e.g. Mosler and Kraemer, 2012	Ease of use • Diallo et al., 2007 Existing habits (open defecation) • Barnard et al., 2013

4.5.1.1 Psychosocial factors motivating sustained adoption of handwashing behaviour (n=4)

Four studies discussed psychosocial factors affecting handwashing practice (Table 9). Participants mentioned these factors during interviews and surveys after a period of intervention including education about handwashing or mass media campaigns. Handwashing behaviour was generally assessed by self-report or was checked by asking participants to demonstrate how to wash hands. Structured observations are underrepresented in this subset (though common among mapped handwashing articles).

Below we discuss the factors outlined in Table 9 in more detail. Factors are grouped according to the IBM WASH framework (Dreibelbis et al., 2013), at the levels at which they may affect behaviour change.

Interpersonal and household level

A number of theoretical perspectives in the literature on health behaviours and behaviour change interventions address the role of social norms as an influence on human behaviour, and the WASH behaviour change literature is no exception. The literature on WASH behaviours draws primarily from two of these theoretical perspectives: 1) The Focus Theory of Normative Conduct (FTNC) (Cialdini et al., 1990; Kallgren et al., 2000) and 2) the Theory of Reasoned Action and its later, expanded version, the Theory of Planned Behavior (TRA/TPB) (Ajzen 1991; Sheppard et al., 1988). From the former, studies drew on the concepts of injunctive norms and descriptive norms. From the latter, studies drew on the concept of subjective norms.

One of the four handwashing studies (Devine and Koita, 2010) cited injunctive and descriptive norms and nurturing characteristics as motivations to wash hands. In the Focus Theory of Normative Conduct, injunctive and descriptive norms describe extra personal expectations of behaviour, i.e. set by people and institutions outside the individual (Cialdini et al., 1990, Kallgren et al., 1990). At the interpersonal level, changing social norms leverages individual behaviours to facilitate positive support for handwashing. In Senegal, the Global Scaling up Handwashing Project employed a mass media campaign focused on reinforcing self-efficacy, injunctive norms, habit and nurturing behaviour. To illustrate this message, a well-dressed mother says, 'I commit myself to get my family to wash their hands with soap!' (Devine and Koita, 2010).

Individual level

Knowledge is commonly mentioned in studies of handwashing behaviour change, and is often presented as the implicit 'KAP' model of behaviour change where knowledge and attitudes are posited as the most important factors affecting Practices. Three of the four handwashing studies (Wilson and Chandler, 1993; SEUF, 2004; Parker et al., 2006) indicated knowledge of diarrhoea transmission as an important factor affecting WASH behaviours. Knowledge related to disease transmission increased after the conclusion of an intervention, with 19% of respondents linking diarrhoeal disease with contaminated hands in a survey two years post-intervention (Wilson and Chandler, 1993).

Knowledge of the key times to wash hands and ability to correctly complete the behaviour when prompted is also reported as a psychosocial factor affecting sustained practice (SEUF, 2004; Parker et al., 2006; Devine and Koita, 2010). A hygiene and sanitation initiative in Kerala measured knowledge of handwashing practice by asking participants to demonstrate 'good handwashing' (SEUF, 2004). Between 60% and 98% of participants (depending on the site) were able to demonstrate 'good handwashing' with both hands, and those with better handwashing skills were more likely to have knowledge of the critical times to wash hands ($p<0.002$, stratified by community).

In a doer/non-doer analysis in Senegal, Devine and Koita (2010), found that knowledge of handwashing times was better surrounding excreta-related critical times. When asked

about important times to wash hands, 78% of people mentioned after using the toilet, but only 32% before eating, 30% before preparing food, and 18% before feeding a child. Two studies (Devine and Koita, 2010; SEUF, 2004) reported on constructs from the Health Belief Model. Devine and Koita (2010) reported that 98% of mothers in Senegal who practised handwashing understood its importance for protecting their family's health. The 'ability to buy soap without having to ask someone else' was also an important enabler of handwashing.

Habitual level

Habit formation and the consistent practice of handwashing at five key times are essential to sustained adoption. However, this sub-set of four handwashing studies does not represent a number of psychosocial factors that have been discussed in the literature on initial behaviour change and motivators for adoption in studies of limited duration.

4.5.1.2 Psychosocial factors motivating sustained adoption of water treatment (n=22)

Twenty-two articles reported psychosocial factors related to point-of-use water treatment; individual- and community-level constructs were especially common. Specific factors mentioned are presented in Table 9. Like handwashing, water treatment requires consistent practice of behaviours, knowledge of how to treat water, and daily commitment to providing the household with safe drinking water. Water treatment interventions typically introduced users to the water treatment technology and trained them how to use it. Most studies also included a component of follow-up visits with community health workers or promoters to check on continued use or collect observational data on the use of the technology.

Interpersonal level

Social norms frequently appeared in this sample of the literature, and frequently utilised the concepts of injunctive and descriptive norms from the Focus Theory of Normative Conduct (Cialdini et al., 1990, Kallgren et al., 2000). Eleven of the 22 studies discussed injunctive norms - how individuals perceived that others expected them to behave (Aiken et al., 2011; Altherr et al., 2008; Brown et al., 2007; Brown et al., 2009; Casanova et al., 2012; Freeman et al., 2012; Inauen et al., 2013; Mosler et al., 2013; Mosler and Kraemer 2012 Wheeler and Agha, 2013; Wood et al., 2012). Eight of the 22 studies discussed Descriptive Norms - what respondents believe others typically do (Altherr et al., 2008; Kraemer and Mosler, 2012; Mosler and Kraemer, 2012; Tamas and Mosler, 2011; Tamas et al., 2009; Wheeler and Agha, 2013; Wood et al., 2012). Subjective norms (the expectation to perform the behaviour), derived from the Theory of Reasoned Action and the Theory of Planned Behavior (Ajzen 1991; Sheppard et al., 1988) were described in two studies (Altherr et al., 2008; Mosler and Kraemer 2012).

Several studies of solar disinfection (SODIS) include measures of social norms. Though practised by individual households, this water treatment method requires users to place clear plastic bottles in direct sunlight (most commonly on rooftops) for eight hours of sun exposure, making SODIS a publicly displayed behaviour. Tamas and Mosler (2011) measured descriptive norms by asking, 'What do you think - how many other people (neighbours) use SODIS?' (scale of 0 [almost no one] to 1 [almost everyone]) and 'How many people you know have you seen using SODIS during the last month?'(Open numeric variable. They found that descriptive norms were associated with a significant difference between relapsers (discontinued users) and continuous users ($p < 0.001$).

Asking similar questions, Mosler et al. (2013) made comparisons between several different user groups: non-users, tryers, relapsers and users. They reported that descriptive norms (perceptions of what others do) along with memory factors increased significantly during the transition from 'tryer' to user, compared to people who remained tryers. Another

method for reporting descriptive norms is to compare how users versus non-users perceive SODIS to be practised by their neighbours. In a logistic regression, Altherr et al. (2008) found no significant differences between users and non-users.

Individual level

Twelve of 22 water treatment studies report on perceived susceptibility (Aiken et al., 2011; Brown et al., 2009; Christen et al., 2011; DuBois et al., 2010; Inauen et al., 2013; Kraemer and Mosler, 2012; Mosler et al., 2013; Mosler and Kraemer, 2012; Peletz et al., 2012; Tamas and Mosler, 2011; Wheeler and Agha, 2013; Wood et al., 2012), and 9 studies reported on perceived severity of diarrhoeal or other water-borne diseases as influential factors in the uptake of sustained water treatment (Brown et al., 2009; Christen et al., 2011; DuBois et al., 2010; Inauen et al., 2013; Mosler et al., 2013; Mosler and Kraemer, 2012; Tamas and Mosler, 2011; Wheeler and Agha, 2013; Wood et al., 2012). Wheeler and Agha (2013) reported that 92.7% of survey respondents agreed that contaminated water can cause serious health problems. Knowledge of transmission of diarrhoea and water-borne diseases was another motivating factor of sustained use reported by seven studies. Furthermore, a study examining acceptance and use of a variety of arsenic-safe water technologies indicates that perceived risk and vulnerability to disease were higher among users of arsenic-safe options than non-users (Inauen et al., 2013).

Nine of the 22 water treatment studies reported on perceived benefits of treating water (Altherr et al., 2008; DuBois et al., 2010; Inauen et al., 2013; Kraemer and Mosler, 2012; Mosler and Kraemer, 2012; Ngai et al., 2007; Parker, 1997; Tamas and Mosler, 2011; Wood et al., 2012), which may include improved health, changes in social status, or ease and convenience of use. Ngai et al. (2007) discussed high social acceptability of the Kanchan Arsenic Filter and link sustained use after one year to perceived improvements in taste, smell, and health status. Though many perceive benefits, user preferences may negatively affect water treatment behaviours. Of non-adopters, 14% cited the bad taste as their reason for not treating water (Arnold et al., 2009).

Aspirations and nurturing actions are reasons why people choose to continually treat water at home. In one study, a husband and current user of WaterGuard, a point-of-use water treatment product, described nurturing aspirations and familial support to keep his family healthy, ‘If I get sick, how can I take care of my family? So in order to prevent diarrhoea and cholera, we decided as a family to start using the product’ (Wood et al., 2012). Self-efficacy to practice water treatment was cited in 8 of 22 water treatment studies (Inauen et al., 2013; Kraemer and Mosler, 2011; Kraemer and Mosler, 2012; Mosler et al., 2013; Mosler and Kraemer 2012; Parker 1997; Wheeler and Agha, 2013; Wood et al., 2012).

Habitual level

Six of the 22 water treatment studies reported on habitual level factors (Kraemer and Mosler, 2012; Mosler et al., 2013; Mosler and Kraemer, 2012; Tamas and Mosler, 2011; Tamas et al., 2009; Wood et al., 2012). Outcome expectations and behavioural cues to action were facilitating factors in sustained adoption of water treatment technologies. SODIS interventions provide good examples of visible cues, also called ‘memory factors’: seeing SODIS bottles on a rooftop reminds users that water treatment is occurring (Mosler and Kraemer, 2012; Mosler et al., 2013; Tamas and Mosler, 2011). Verbal reminders and discussion can also help create habit. In a study in Malawi, a WaterGuard user says, ‘I discuss about WaterGuard and water treatment with friends, especially when we meet at places where we draw water. We discuss and remind each other to treat our water with WaterGuard as soon as we get home’ (Wood et al, 2012).

4.5.1.3 Psychosocial factors motivating sustainability of sanitation (n=10)

Ten articles were included in this synthesis. Table 9 shows the range of psychosocial factors represented in the literature on sustained sanitation use.

Interpersonal and household levels

Six of the 10 sanitation studies described interpersonal- and household-level factors, including descriptive (Barnard et al., 2013; Kullman and Ahmed 2011; Malebo, 2012; Whaley and Webster, 2011), injunctive (Barnard et al., 2013; Kullman and Ahmed 2011; Malebo, 2012), and subjective norms (Barnard et al., 2013; Devine and Sijbesma, 2011; Kullman and Ahmed, 2011; Waterkeyn and Cairncross, 2005). Two of the 10 sanitation studies (Barnard et al., 2013; Whaley and Webster, 2011) were reports of total sanitation programmes; these mobilise communities to commit to building and using latrines, often leveraging disgust and social pressure to transition communities away from the practice of open defecation and elicit a commitment to latrine construction and use.

In an interview with a Community Led Total Sanitation participant, a user described social stigma for latrine construction, saying, 'We felt embarrassed. And all the people who were there said that we must build the toilet so we don't eat each other's faeces' (Whaley and Webster, 2011). Though implicit in total sanitation, stigma and social mobilisation were not discussed in detail in the articles included in this synthesis.

Use of community latrines involves psychosocial factors like shared values, social norms and collective efficacy to keep facilities clean and operational. In a series of case studies conducted in South Africa, users of community ablution blocks cited health, comfort, a cleaner environment and easy access as benefits to using communal latrines (Roma et al., 2010). However, the authors found that over time the perceived health benefits reported by interviewees decreased by 24%, and they suggest this decrease may be attributed to a loss of enthusiasm for the facilities and decreased motivation to keep the toilets well maintained. In contrast, changing normative behaviour was a key factor reported by Kullman and Ahmed (2011) in encouraging latrine use for both rich and poor.

Individual level

All 10 sanitation studies reported on individual-level factors. The perceived benefits of sanitation were most frequently reported, representing nine of the ten sanitation studies (Barnard et al., 2013; Choudhury and Hossain, 2006; Devine and Sijbesma, 2011; Diallo et al., 2007; Kullman and Ahmed, 2011; Malebo, 2012; Roma et al., 2010; Ross et al., 2011; Waterkeyn and Cairncross, 2005). Sanitation campaigns often appeal to aspirations and outcome expectations to promote latrine use. In a study assessing the post-implementation latrine use in rural Niger, participants listed perceived benefits such as privacy, proximity and environmental hygiene (Diallo et al., 2007). Additionally, promoting the benefits associated with use, such as reducing unpleasant smells and the presence of flies as well as creating privacy and safety (Barnard et al., 2013), may be used to leverage sustained use of latrines. However, recognition of the benefits of sanitation does not necessarily influence sustained use. Though most people interviewed didn't mention disadvantages, 12% of old latrine owners and 18% of new owners disliked a foul smell, and one new latrine owner mentioned flies as a problem (Diallo et al., 2007).

In a cross-sectional study in Orissa, Barnard et al. (2013) examine latrine use among communities where the Indian Government had implemented Total Sanitation Campaigns (TSC). Among those surveyed, 66% mentioned health benefits associated with sanitation, 39% suggested that latrines provided safety for women, and 27% mentioned privacy. Despite high latrine coverage – 72% of households in TSC areas had latrines – 39% of households with latrines reported that they were unused; one of the primary reasons for

disuse was open defecation. Disgust was mentioned in only two studies (Ross et al., 2011; Whaley and Webster, 2011).

Knowledge of the mode of transmission of diarrhoea (Malebo, 2012; Waterkeyn and Cairncross, 2005) and awareness of other water related diseases (Barnard et al., 2013; Diallo et al., 2007; Malebo, 2012; Ross et al., 2011) were commonly reported as factors associated with sanitation practices.

Habitual level

At the habitual level, having consistent, easy access to latrines facilitated long-term behaviour change. In a study in Niger, 46.5% of previous latrine owners, and 63.1% of new latrine owners mentioning this factor (Diallo et al., 2007) responded that this was the primary benefit of latrine ownership. Previous open defecation habits were cited in one study as a possible barrier to uptake of sanitation facilities (Barnard et al., 2013).

4.5.2 Synthesis 2: Contextual factors influencing adoption and sustained adoption (n=29)

Twenty-nine articles discussed contextual factors relevant to the adoption of WASH practices. Contextual factors represent the constellation of external influences that shape an individual's behaviours. These include socio-economic and demographic factors, climate, gender/gender roles, and larger institutional or governmental policies that affect daily WASH practice.

Table 10 summarises the range of contextual factors represented in the literature on sustained adoption, divided by WASH domain. Using the IBM WASH model as a coding guide (Dreibelbis et al., 2013) (see Table 1), we extracted information on factors at the different social levels of influence. The contextual factors identified could be grouped into four of the five levels in the IBM WASH model:

- **Societal/structural** factors refer to the larger geographic, environmental and political environments in which individuals and communities exist. Examples of influential factors include national WASH policies (e.g. India's Total Sanitation campaign), seasonal weather patterns, or natural geography, such as the specific considerations for water treatment in a desert versus in a tropical climate.
- **Interpersonal/household** factors refer to the physical or social characteristics of an individual's daily environment, such as household wealth, the number of family members who use the technology, or available physical space.
- **Individual-level** factors refer to acquired and innate traits, such as education, work habits or gender, that influence a person's decision to practise a behaviour. Many of these factors (e.g. religion, gender or ethnicity) may be shared by many people in a group, but affect behaviour change on an individual basis.
- **Habitual-level** factors refer to the elements required to make a given behaviour a sustained, repeated event in a person's life or that predispose an individual to change behaviour. One example is that having ever previously been exposed to a WASH intervention may make practice of a new WASH behaviour more likely.

These factors were generally identified by the study authors at the outset of the study (e.g. characteristics described in their demographic tables) and were included in survey instruments. We discuss these factors in more detail by WASH topic below.

Table 10: Summary of contextual factors affecting sustained WASH adoption (N=29)

Level of IBM WASH framework	**Handwashing (n=5)**	**Water treatment (n=14)**	**Sanitation (n=10)**
Societal/ structural level		Seasonality • Hoque et al., 2004, Wood et al., 2012 Natural disasters, political upheaval • Casanova et al., 2012	Seasonality • Simms et al., 2005, Whaley and Webster 2011 Infrastructure • Malebo, 2012
Interpersonal and household	Household income/wealth • Shordt and Cairncross 2004, Cairncross et al., 2005, O'Brien and Favin 2012 Level of education • Shordt and Cairncross 2004, Cairncross et al., 2005, O'Brien and Favin 2012 HH structure/roles • Devine and Koita 2010, O'Brien and Favin 2012	Income/SES • Brown et al., 2007, Brown et al., 2009, DuBois et al., 2010, Aiken et al., 2011, Christen et al., 2011, Freeman et al., 2012, Casanova et al., 2012, Inauen et al., 2013 Level of education • Tamas et al., 2009, DuBois et al., 2010, Aiken et al., 2011, Christen et al., 2011, Tamas and Mosler 2011, Freeman et al., 2012, Inauen et al., 2013 Household structure/roles • Brown et al., 2007, DuBois et al., 2010, Christen et al., 2011, Freeman et al., 2012, Inauen et al., 2013	Household income/SES • Cairncross et al., 2005, Waterkeyn and Cairncross 2005, Choudhury and Hossain 2006, Kullman and Ahmed 2011, Whaley and Webster 2011, Malebo, 2012 Level of education • Malebo, 2012 Household structure • Barnard et al., 2013
Individual	Income generation/work patterns • O'Brien and Favin 2012 Gender • SEUF, 2004	Income generation/work patterns • Parker, 1997 Religion • Inauen et al., 2013	Income generation/work patterns • Roma et al., 2010, Ross et al., 2011 Age • Simms et al., 2005 Religion • Qutub et al., 2008, Barnard et al., 2013 Ethnicity • Qutub et al., 2008, Roma et al., 2010

Level of IBM WASH framework	Handwashing (n=5)	Water treatment (n=14)	Sanitation (n=10)
Habitual		Prior WASH habits • Brown et al., 2007, Brown et al., 2009, Christen et al., 2011, Freeman et al., 2012 Access to other WASH products • Brown et al., 2007, Brown et al., 2009, Aiken et al., 2011 Christen et al., 2011	

4.5.2.1 Contextual factors motivating handwashing practice (n=5)

Five of 29 articles describing sustained WASH use reported on contextual factors influencing handwashing. These factors are summarised in Table 10.

Interpersonal and household level

Household income, level of education and relationship structure were important factors influencing handwashing practice. Three of five handwashing studies reported on household wealth or a proxy measure for socio-economic status (Cairncross et al., 2005; Shordt and Cairncross 2004; O'Brien and Favin 2012). One study, assessing handwashing and sanitation in Kerala, found that consistent hygiene and sanitation practice was linked to the socio-economic status of the household; however the level of association between socio-economic status and handwashing was not reported (Cairncross et al., 2005).

Level of education was assessed in three handwashing studies. Reporting on study sites in Nepal and Kenya, Shordt and Cairncross (2004) cited the association of educational background of women and increased knowledge in handwashing procedures, good handwashing skills and higher reported handwashing practice. Education can also include information received during the project promotion activities. A handwashing campaign in Peru included educational sessions as part of the conditions for cash payments (O'Brien and Favin 2012). Cairncross et al. (2005) described how participant recall of health education classes was significantly associated with good handwashing practice (OR2.04, CI 1.05-3.96).

Household roles and structures were assessed in two studies. In a handwashing campaign in Senegal, as part of the Global Scaling Up Handwashing Programme, messages describing women as 'responsible for the health of the family' were broadcast; these were later revised to include men to increase household commitment and practice (Devine and Koita, 2010). Women as caretakers were also the primary targets of the Global Scaling Up Handwashing Programme (O'Brien and Favin, 2012).

Individual level

At the individual level, there are a variety of factors that determine which members of the household are targeted for intervention, or how these individuals adopt behaviours. Gender and household roles are closely linked factors. One of the handwashing studies discussed how work patterns in the household influenced the intervention target: as

caretakers, women were most likely to receive handwashing messaging (O'Brien and Favin 2012). Similarly, a study in rural India identified that gender considerations (addressing both men and women separately) were important in hygiene and sanitation programmes (SEUF, 2004).

4.5.2.2 Contextual factors influencing water treatment practice (n=14)

Fourteen studies reported on contextual factors that were enablers or barriers to water treatment. These are summarised in Table 10.

Societal/structural level

Four of 14 water treatment studies described structural factors that affected continued water treatment practice. Individuals may adopt certain strategies to reflect their needs on a seasonal basis. Hoque et al. (2004) found that seasonal water availability influenced rainwater harvesting behaviour and Wood et al. (2012) described how some users chose to use WaterGuard only during the rainy season, when water quality was assumed to be the worst. Additionally, very few studies reported on experiences of WASH promotion in unstable situations: Casanova et al. (2012) was the only study among the 14 water treatment studies detailing uptake of technologies after natural disasters or instability.

Community, interpersonal, and household levels

Socio-economic status (SES) was assessed and reported on in 8 of 14 water treatment studies (Aiken et al., 2011; Brown et al., 2007; Brown et al., 2009; Casanova et al., 2012; Christen et al., 2011; DuBois et al., 2010; Freeman et al., 2012; Inauen et al., 2013). For example, in three studies, higher SES was associated with use of household-level chlorination (DuBois et al., 2010), improvement in water quality after using Pureit filters (Freeman et al., 2012), and use of arsenic filters (Inauen et al., 2013). Additionally, DuBois et al. (2010) discussed the influence of high cost of products in determining which treatment products households used regularly. The other six studies may have routinely assessed this information but withheld it from analyses.

Level of education is also commonly assessed in water treatment studies, either as demographic information (Aiken et al., 2011; DuBois et al., 2010; Tamas and Mosler 2011), or as a determinant of behaviour practice (Christen et al., 2011; Freeman et al., 2012; Inauen et al., 2012; Tamas et al., 2009). Seven studies reported on the education levels of respondents. Investigating the use of water filters, Freeman et al. (2012) found that there was a significant difference in education level between adopters and non-adopters. Tamas et al. (2009) indicated that increased knowledge of SODIS was associated with higher levels of education.

Household structure was also discussed in five studies (36%) (Brown et al., 2007; Christen et al., 2011; DuBois et al., 2010; Freeman et al., 2012; Inauen et al., 2013). Christen et al. (2011) described households more likely to actively use SODIS as including women or families with severely ill children, implying that the decision of water treatment was made to benefit the entire household.

Individual level

Two of the 14 water treatment studies assessed the influence of religion (Inauen et al., 2013) or income generation (Parker, 1997) on water treatment practices. Reporting on a study in Bangladesh, Inauen et al. (2013) found no significant difference by religion in a group of arsenic filter users and non-users. In his study of well and latrine use in rural Mali, Parker (1997) noted that many villagers were engaged in agricultural labour and were not able to access safe well water at allotted times.

Habitual level

Four of the 14 water treatment studies linked prior experience with WASH practices of any kind to continued performance of WASH behaviours. A study of water filtration in Cambodia demonstrated that handwashing practices and access to a latrine were associated with water treatment (Brown et al., 2009). Adoption of SODIS in Bolivia was associated with latrine ownership (OR: 3.38; 95% CI 1.07-10.7) (Christen et al. et al., 2011). WASH practices like handwashing and observed safe water storage were also associated with adoption of ceramic filters in Cambodia (Brown et al., 2007) or use of POU water treatment technologies (Freeman et al., 2012). Other studies noted that access to a water source (Aiken et al., 2011; Christen et al., 2011), latrine (Brown et al., 2007; Brown et al., 2009; Christen et al., 2011), or handwashing materials (Brown et al., 2007; Brown et al., 2009) improved likelihood of water treatment. This suggests that adoption of new WASH behaviours is supported by prior habits.

4.5.2.3 Contextual factors influencing sustained sanitation adoption (n=10)

Ten studies reported on contextual factors assessing sustained sanitation use. These are summarised in Table 10.

Societal/structural level

Three of the 10 sanitation studies (Malebo, 2012; Simms et al., 2005; Whaley and Webster, 2011) described structural factors that affected sanitation use and continuation. Similar to water treatment, latrine adoption in Zimbabwe was modified by seasonal work, because regular access was limited for field labourers (Whaley and Webster, 2011). Rainy seasons also contributed to the likelihood of latrine collapse (Simms et al., 2005), and were influential in determining long-term viability of latrine use. Infrastructure is a crucial factor in determining how materials are transported and made available in the community. In scaling up the Mtumba sanitation project, the poor condition of roads had implications for latrine construction because transporting materials was difficult (Malebo, 2012).

Community, interpersonal, and household levels

Five of the 10 sanitation studies (50%) measured household income (Choudhury and Hossain 2006; Kullman and Ahmed, 2011; Malebo 2012; Waterkeyn and Cairncross 2005; Whaley and Webster 2011). Higher SES is typically thought to be correlated with higher initial sanitation coverage (Cairncross and Shordt, 2004; Christen et al., 2011). A report on a handwashing and sanitation study in Kerala, India specified that sanitation coverage and the use of latrines by men was closely correlated with the socio-economic status of the neighbourhood (Cairncross et al., 2005). The physical structure and building materials of dwellings were significantly associated with having a latrine in a study in rural India (Barnard et al., 2013); higher household SES may enable a family to purchase more durable construction materials, resulting in longer latrine use.

One of the 10 sanitation studies assessed the education of household members; however, it reported that sustained adoption of latrines was not associated with education (Malebo, 2012).

Individual level

Four of the 10 sanitation studies measured individual-level contextual factors, although many of these were demographic surveys (Kullman and Ahmed, 2011; Qutub et al., 2008; Roma et al., 2010; Ross et al., 2011). In a study of latrine provision in the Gambia, 94% of households restricted young children from using the latrine, and some households reserved the use of the latrine for the household head and first wife, only men, or only women (Simms et al., 2005).

Synthesis 3: Technology factors influencing adoption and sustained adoption (n=33)

Thirty three articles reported factors of water treatment, sanitation or handwashing technologies that affected long-term WASH use. The 'use' of a technology is essential to WASH practice, and includes the physical utilisation, maintenance, repair, and purchase or acquisition of supplies needed for the technologies to function. These technologies are sometimes referred to as 'enabling technologies' or 'facilitating technologies'. Examples of technologies used in each WASH topic are listed below:

- Correct handwashing practice depends on access to water and soap in a convenient place. Sometimes where the water supply is intermittent, a handwashing station consisting of a reservoir for the water with a tap and bucket or pan to collect the water is promoted. Soap itself can come in several forms, such as bar soap, soapy water in a dispenser bottle, or hand sanitiser.
- Water treatment technologies may have two components for 1) treatment of the water, and 2) safe storage of the water. The former may take the form of a tablet or drops to be added to a measured amount of water, liquid chlorine from a dispenser added to a measured amount of water, filters made of a wide range of shapes, sizes and materials, such as ceramic water filters, and units for solar disinfection of water. Safe storage usually introduces a vessel with a narrow opening or cover to prevent recontamination.
- Sanitation technologies include the above-ground structures (toilet or concrete slab) and building where users enter, and other structures below ground or away from the toilet or latrine to receive, empty and/or treat the waste.

Table 11 summarises the technology factors assessed or reported in the 33 articles assessing WASH adoption.

We grouped technology factors according to the levels of influence in the IBM WASH model (Dreibelbis et al, 2013) (see Table 1). The technology factors we identified could be grouped into four of the five levels in the model:

- **Societal** factors refer to the larger social, political, and cultural environments in which communities and individuals exist. Examples include national WASH policies or access to supplies.
- **Community-level** factors describe how a technology is used by various groups, such as the social agreements or responsibilities that enable people to maintain, use and access a technology.
- **Individual-level** factors refer to the direct and indirect experiences a person has when using a technology. This could be physical (e.g. labour required to install a latrine; cost of chlorine tablets), or cognitive (e.g. perceived social status).
- **Habitual** factors represent elements of a technology that promote sustained, repeated use. This is often measured as perceived ease of use of a product or physical design.

Across WASH topics, *cost* was described as a barrier or enabler in 27 of the 33 articles reporting on technology factors. In low- and middle-income countries, the cost of the initial technology and any associated parts or replacements are of great significance to users. If technologies are too expensive, no level of psychosocial motivation will be enough for adoption and sustained use. Technologies classified as 'low-cost' may still require recurrent expenditures or have a high upfront cost - as occurs with the construction of a latrine. Income-restricted households must be able to afford to operate WASH technologies over a long period.

Though some factors are shared across WASH technologies, below we talk about those that are specific to handwashing, water treatment or sanitation.

Table 11: Summary of technology factors in WASH literature (n=33)

Level of IBM WASH framework	**Handwashing (n=5)**	**Water treatment (n=17)**	**Sanitation (n=11)**
Societal/ structural	Distribution or importation of the technology • O'Brien and Favin, 2012	Distribution, importation or procurement of technology supplies • Parker, 1997; Ngai et al., 2007; Altherr et al., 2008; DuBois et al., 2010; Casanova et al., 2012; Wood et al., 2012; Wheeler and Agha, 2013	Procurement and distribution of sanitation supplies • Qutub et al., 2008; Malebo, 2012
Interpersonal and household	Access to technologies, ability to maintain • Whaley and Webster, 2011	Availability of replacement parts or supplies • Parker, 1997; Altherr et al., 2008; DuBois et al., 2010; Casanova et al., 2012; Wood et al., 2012 Capacity for maintenance • Hoque et al., 2004; Brown et al., 2007; Ngai et al., 2007; Casanova et al., 2012; Wood et al., 2012; Wheeler and Agha, 2013	Local manufacturing and maintenance • Choudhury and Hossain, 2006; Simms et al., 2006; Qutub et al., 2008; Roma et al., 2010; Kullman and Ahmed, 2011; Ross et al., 2011; Eder et al., 2012; Malebo, 2012; Barnard et al., 2013
Individual	Cost associated with use • Parker et al., 2006; Devine and Koita, 2010; Whaley and Webster, 2011; O'Brien and Favin, 2012 Perceived value of soap or other technology • O'Brien and Favin, 2012	Cost • Parker, 1997; Hoque et al., 2004; Brown et al., 2007; Ngai et al., 2007; DuBois et al., 2010; Tamas and Mosler et al., 2013; Casanova et al., 2012; Kraemer and Mosler, 2012; Wood et al., 2012; Mosler, 2013 Status of using the technology • Wood et al., 2012 Expectations of technology outcomes	Cost • 11/11 studies discussed issues related to cost/affordability Installation mechanisms • Simms et al., 2005; Waterkeyn and Cairncross, 2005; Choudhury and Hossain, 2006; Diallo et al., 2007; Kullman and Ahmed, 2011; Eder et al., 2012; Malebo, 2012 Ownership/responsibility • Waterkeyn and

Level of IBM WASH framework	Handwashing (n=5)	Water treatment (n=17)	Sanitation (n=11)
		(smell, taste, time to use) • Hoque et al., 2004; Parker et al., 2006; Altherr et al., 2008; Ngai et al., 2007; DuBois et al., 2010; Tamas and Mosler, 2011; Kraemer and Mosler, 2012; Wood et al., 2012	Cairncross, 2005; Choudhury and Hossain, 2006; Malebo 2012; Barnard et al., 2013 Status of using/owning the technology • Diallo et al., 2007; Kullman and Ahmed, 2011; Ross et al., 2011; Malebo, 2012
Habitual	Consistent access to soap and water • O'Brien and Favin, 2012 Appropriate design • Parker et al., 2006; O'Brien and Favin, 2012 Durable construction • Devine and Koita, 2010; Whaley and Webster 2011	Appropriate design ('ease of use') • 11 /17 e.g. DuBois et al., 2010; Wheeler and Agha, 2013 Durability • 11/17 e.g. Brown et al., 2009; Casanova et al., 2012	Appropriate design • Simms et al., 2005; Choudhury and Hossain, 2006; Qutub et al., 2008; Roma et al., 2010; Kullman and Ahmed, 2011; Malebo, 2012; Barnard et al., 2013; Ross et al., 2011 Durability • Kullman and Ahmed, 2011; Simms et al., 2005; Roma et al., 2010; Ross et al., 2011; Qutub et al., 2008

4.5.3.1 Technology factors related to handwashing (n=5)

Five of 33 studies measured technology factors related to handwashing practice. A summary of factors associated with hygiene technology are presented in Table 11.

Societal/structural level

One study (O'Brien and Favin, 2012) described procedures to obtain handwashing technologies. This study reviews four country-level programmes under the World Bank's Global Scaling Up Handwashing Program, highlighting various partnerships and strategies that ensure the availability of technology for distribution to local programmes.

Interpersonal and household levels

One study (Whaley and Webster, 2011) reported that both convenient access to and maintenance of a handwashing station influenced handwashing practice. Households must have access to water to complete the behaviour. If the water source is located at a distance from the house, practising handwashing can be an additional inconvenience. Some studies have promoted handwashing stations to bring water and soap together in a place that is convenient. Whaley and Webster found that handwashing facilities were more likely to be present in Community Health Club intervention areas (37% had handwashing stations in the sustainability study) compared to the Community Led Total Sanitation areas

(2%), but also stated that temporary handwashing stations could be broken or dismantled over time.

Individual level

Four studies reported on individual-level factors that affected handwashing behaviours, namely cost of materials and perceived value of the technology (Devine and Koita, 2010; O'Brien and Favin, 2012; Parker et al., 2006; Whaley and Webster, 2011). Soap may be present for domestic purposes like washing clothes and dishes, but the purchase of cosmetic soap, i.e. soap for handwashing, is an extraneous cost. Low perceived cost increases the likelihood that households will purchase soap, allowing for consistent practice of the behaviour. The Peru programme found that mothers were concerned with wasting soap and water, so liquid hand soap was included at all handwashing stations (O'Brien and Favin, 2012).

Habitual level

Three studies reported on factors affecting the formation of habitual handwashing practice. Design of the handwashing station, particularly with attention to the intended audience, is very important to ensure the technology is actually used and the behaviour can be performed. In the Global Scaling up Handwashing Project handwashing technologies were tailored to the setting. In Vietnam, an affordable, durable handwashing station was developed through a public private partnership; in Tanzania, households were motivated to construct their own 'tippy-taps' from recycled or readily available materials (O'Brien and Favin, 2012). Recognising the importance of enabling technologies in facilitating behaviour change, the Water and Sanitation Program has documented a number of handwashing station designs.[3]

4.5.3.2 Technology factors related to water treatment (n=17)

Seventeen of 33 studies (52%) reported on factors of water treatment technologies that affected sustained water treatment practice. Table 11 presents a summary of these factors. Water treatment technologies are often described in the greatest detail, compared to handwashing stations or latrine construction.

Societal/structural level

Seven of the 17 water treatment studies discussed factors influencing how supplies for water treatment were imported, procured or distributed (Altherr et al., 2008; Casanova et al. 2012; DuBois et al., 2010; Ngai et al., 2007; Parker, 1997; Wheeler and Agha, 2013; Wood et al., 2012). In a study introducing the chlorine solution WaterGuard to markets in Malawi, the organisation Population Services International (PSI) worked to ensure adequate supply and prevent stock outs of the solution during the project period (Wood et al., 2012). This occurred amidst the Malawian government's current policy of providing free generic chlorine; some users reported switching between WaterGuard and generic chlorine due to issues with product availability. A similar strategy was also employed by PSI in distributing the Certeza chlorine solution to markets in Mozambique (Wheeler and Agha, 2013). In a study of SODIS in Nicaragua, a limited number of PET bottles (other plastics are not as efficacious when used for SODIS) were available per family, restricting the amount of treated water available for consumption (Altherr et al., 2008).

[3] See https://www.wsp.org/global-initiatives/Global-Scaling-Up-Handwashing-Project/Enabling%20Technologies%20for%20Handwashing%20with%20Soap

Interpersonal and household levels

Seven studies presented community- and household-level factors that influenced how families gained access to water treatment technologies (Brown et al., 2007; Casanova et al., 2012; Hoque et al., 2004; Ngai et al., 2007; Parker, 1997; Wood et al., 2012; Wheeler and Agha, 2013). Inability to locate replacement parts contributed to high rates of disuse of ceramic filters that were distributed to households in Sri Lanka after the 2004 tsunami (Casanova et al., 2012). Lack of water chlorination products in the market place or difficulty in procuring them was an issue in several studies (DuBois et al., 2010; Parker, 1997; Wood et al., 2012).

Maintenance was an issue in seven studies. In a study of ceramic filter use in Cambodia, the primary reason for reported disuse of a filter was breakage and inability to repair the filter (Brown et al., 2007). This finding was mirrored in similar studies from Sri Lanka (Casanova et al., 2012) and Bangladesh (Hoque et al., 2004). Studies involving the promotion of chlorine-based water treatment products (Wheeler and Agha, 2013; Wood et al., 2012) did not report issues with the physical chlorine solutions (e.g. incorrect concentrations or poor packaging).

Individual level

Cost was the primary individual-level factor reported to influence water treatment behaviour, cited in 10 studies. Respondents in a study of chlorine solution promotion in Malawi indicated that the primary reason for disuse of the promoted solution (WaterGuard) was the prohibitively high cost, especially considering that free chlorine was available from the government (Wood et al., 2012). In a study from Kenya, use of sodium hypochlorite far overtook the use of the more expensive flocculant disinfectant as a household water treatment product (DuBois et al., 2010).

Although the purchase of a water treatment technology may present a high initial cost to households, Brown et al. (2007) reported that any investment in the technology was associated with continued water treatment, compared to households that received the technology for free.

Nine studies reported on respondent expectations of the water treatment technology, with emphasis on taste or time expended on performing the behaviour. Participants found that SODIS took too much time and did not produce good-tasting water (Altherr et al., 2008), compared to the water they previously drank. Tamas and Mosler (2011) studied reasons why people discontinue using SODIS in Bolivia, and found that satisfaction with taste and perceived ease of use were higher in continuers than in relapsers. In another study in Zimbabwe, promoters also emphasised cheap cost and good taste as benefits of SODIS (Kraemer and Mosler, 2012).

Smell and taste were also factors influencing filter use in Bangladesh; however, slow flow rates were seen as barriers to frequent use in some households (Hoque et al., 2004). In Nepal, the preferred filtration method was feasible and acceptable for daily use, and taste and clarity of the water were also important factors (Ngai et al., 2007). The main complaint against the practice of treating water with chlorine was the smell and/or taste of the treated water (Parker et al., 2006), though some found that they became accustomed to it over time (Wood et al., 2012).

A study in Kenya of flocculent disinfectant and sodium hypochlorite products found that using turbid source water was a positive predictor of use of flocculent disinfectant because users enjoyed the clarity of the treated water (DuBois et al., 2010).

Habitual level

Two important characteristics of water treatment technologies were described in 11 studies (Aiken et al., 2011; Altherr et al., 2008, Brown et al., 2007; Brown et al., 2009; Hoque et al., 2004; Ngai et al., 2007; Parker, 1997; Peletz et al., 2012; Tamas and Mosler, 2011; Wheeler and Agha, 2013; Wood et al., 2012): 1) durability of a technology, and 2) user-appropriate design.

A study of ceramic filters in Cambodia showed that filter use declined by around 2% per month since implementation due to breakage (cited by 65% of non-users), inadequate capacity for household needs or slow filtration speed, or it had passed the recommended lifespan (Brown et al., 2009). Similarly, a study of ceramic filters in Sri Lanka showed that use over two years declined by 24% and reasons for discontinuation were breakage and access to a household tap that generally had better quality water (Casanova et al., 2012).

'Ease of use' can also describe aspects of appropriate design in participant responses. Wheeler and Agha studied water treatment practice in a population-based survey after social marketing of Certeza, a diluted sodium hypochlorite system. They found that use of Certeza increased from 11% in 2007 to 22% in 2012 and that an increasing number of respondents felt that Certeza was easy to use (Wheeler and Agha, 2013). In a study promoting chlorine and flocculant disinfectant in Kenya, the study authors found that some users preferred the sodium hypochlorite treatment because it was lower cost and easier to use (DuBois et al., 2010).

4.5.3.3 Technology factors related to sanitation (n=11)

Eleven articles assessed factors related to sanitation uptake and continued use. These factors are summarised in Table 11.

Societal/structural level

Two of 11 sanitation studies (Malebo, 2012; Qutub et al., 2008) discussed structural factors, namely the availability and delivery mechanisms of sanitation technology materials. Certain technologies may be easier or harder to procure or produce locally, and policy makers and other stakeholders must take into account long-term supply of materials when considering sanitation interventions.

Interpersonal and household level

Nine studies reported on factors at the interpersonal or household levels, with eight measuring issues of maintenance affecting continued sanitation use (Eder et al., 2012; Barnard et al., 2013; Choudhury and Hossain, 2006; Malebo; 2012; Qutub et al., 2008; Roma et al., 2010; Ross et al., 2011; Simms et al., 2005) and one (Kullman and Ahmed 2011) exploring local manufacturing within the community. In a study of community latrines in South Africa, sustained adoption seemed to decrease over time due to decreased cleanliness and privacy, and malfunctioning (Roma et al., 2010). Working with local artisans to provide latrine platforms and enclosures was a facilitating factor (Malebo, 2012). Community mobilisation and ownership can aid in effecting long-term changes; successful programmes such as Community-led Total Sanitation (CLTS) in part rely on a community to initiate the introduction of WASH technologies.

Individual level

The major factor related to technology adoption in low-income settings is the cost of building a latrine. Every one of the 11 sanitation studies mentioned cost as a relevant factor affecting sanitation use. Interventions promoting sanitation address cost in a number of ways. Some interventions cover the cost of both the materials and the labour needed to install latrines (Eder et al., 2012; Ross et al., 2011; Simms et al., 2005). Others

shared the cost by providing materials while the beneficiaries provided the labour (Diallo et al., 2007; Kullmann and Ahmed, 2011; Qutub et al., 2008).

Seven studies looked at installation mechanisms; some drew on promoting individual responsibility and ownership to motivate communities to construct their own latrines (Barnard et al., 2013; Choudhury and Hossain, 2006; Malebo 2012; Waterkeyn and Cairncross, 2005), while others drew on the social status associated with owning a latrine (Diallo et al., 2007; Kullman and Ahmed, 2011; Ross et al., 2011).

Habitual level

Seven studies assessed the effects of sanitation technology designs on sanitation use. 'Design' here may refer to additional features to assist with menstrual management or child-friendly latrine pans. In Tanzania, a number of latrine designs were assessed for feasibility and acceptability in the community (Malebo, 2012). In this project, the factors of the technology that influenced adoption were sustainability and appropriate structural design.

Durability is another significant factor that is shared across a number of technologies, and was assessed by five studies. Because WASH behaviours take place multiple times per day, every day, materials must be able to withstand repeated use. Whaley and Webster (2011) found that temporary latrines constructed from locally available resources were an unpopular option because of their low durability. These structures break easily or are deteriorated by wind, rain and termites (see section 4.6.3.1). Even when sanitary latrines with cement slabs were provided, durability remains an issue. A post-implementation study in the Gambia showed that in three years, 78 out of 666 latrines were damaged, mostly due to latrine collapse during the rainy seasons (Simms et al., 2005).

Latrines require a high upfront cost for materials and installation and they fill up within a few years, requiring further cost and effort to remain functioning. This presents a challenge to interventions promoting long-term latrine use. In a sanitation project in Zimbabwe, among households that could not afford a permanent latrine, temporary latrines were strongly disliked because they filled up or broke (Whaley and Webster, 2011). Ross and colleagues (2011) found that structural problems and lack of affordability were barriers to latrine use.

4.5.3.4 Long-term functionality (N=3)

Other important factors include maintenance, feasibility of using the technology over time and continued functionality, and installation. Table 12 shows that there is very limited data available on continued functionality of technology in post-implementation studies.

Table 12: Outcomes of functionality in post-implementation studies (N=3)

Measure	Method	Reported level of sustained practice	Post-intervention follow-up time	Citation
Continued functionality of water treatment device	Functionality of biosand filters (BSF)	89% functioning (cross-sectional survey)	1 year	Aiken et al., 2011
	Observed in use	Ceramic filters working 98% of time	1 year	Casanova et al., 2012
Continued use of wells		20/22 still operational four years on	4 years	Parker, 1997

4.6 Research Question 2: Programme characteristics favouring adoption and sustained adoption (N=14)

To answer Research Question 2, we identified 14 studies explicitly assessing sustained adoption that described programme characteristics influential in sustained WASH adoption. These characteristics included various communication strategies, length of follow-up, and time since follow-up; they are discussed below.

4.6.1 Communication: One-on-one interactions (n=14)

The most personal and personnel-intensive channel of communication is a one-on-one discussion in a participant's household. In this method, education or communication is delivered via a community health worker, health promoter or volunteer.

In all 14 studies in this synthesis, one-to-one interactions were associated with positive changes in behaviour. Wilson and Chandler (1993) found that interpersonal communication improved recall of study messages or target behaviours. Similarly, latrine adoption as part of a trachoma control programme was found by Ross et al. (2011) to be significantly associated with visits by health extension workers ($p<0.00001$) compared to non-adopters, and participants in Bangladesh receiving household visits about latrine use were more likely to have an improved or shared latrine compared to those who did not receive a household visit (Kullmann and Ahmed, 2011). Even up to eight years after a the social marketing of Certeza, a water treatment product promoted by Population Services International, a follow-up survey showed that 68% of those exposed to interpersonal contact reported use compared to 35% unexposed (Wheeler and Agha, 2013).

In a six-country study of handwashing interventions Cairncross and Shordt (2004) compared the association between household visits and improvement in hygiene-related behaviours in the two countries where home visits were made. In Ghana, home visits were significantly associated with handwashing skills and the provision of soap and water in the household for handwashing. In India, these visits were significantly associated with handwashing practice and consistent latrine use among women. This article provided information about factors associated with positive changes in behaviour; however, the authors did not define measures of handwashing skills or practice in this publication.

Mosler and Kraemer have gone into great detail examining the psychological factors involved in the adoption of solar water disinfection (SODIS) and the intervention components that are associated with uptake. They found that household visit by a promoter in conjunction with persuasive messaging produced the most SODIS users. They reported that 65% of people who had contact with promoters in the household were SODIS users more than two years after promotion, and six months after the interventions ended (Kraemer and Mosler, 2012; Mosler et al., 2013). These rates were significantly higher than groups that did not receive household promotion.

Parker et al. (2006) presented findings from a clinic-based programme where nurses provided mothers with hygiene kits and information about use of a water treatment product. They found that knowledge retention of the steps of handwashing was high, despite the 'low-intensity' delivery, one session of 5-10 minutes. This finding may suggest that health messaging through authoritative figures in a health setting might encourage adoption and sustained adoption.

4.6.2 Communication: Group meetings and group involvement (n=3)

Group meetings are another popular strategy for communicating about intervention behaviours. In this format, a community health worker or volunteer will present to a group of people, often in women's groups, to share and discuss information.

One programme reporting on sustaining hygiene changes in Kerala, India, utilised hygiene classes as a communication strategy. At the end of the study, participating in hygiene

classes and receiving training on hygiene and sanitation was linked to better practices (SEUF, 2004). Another sanitation study, comparing Community Led Total Sanitation (CLTS) with Community Health Clubs (CHCs), found that though both approaches encouraged construction of latrines, CHCs were effective at sustaining change due to the use of face-to-face interactions and positive messaging (Whaley and Webster, 2011), as opposed to the disgust and shame-driven triggers of CLTS.

Cairncross and Shordt (2004) found a significant association between behaviour and participation in group meetings; however, more permanent changes in practice, like consistent handwashing and latrine use required more intensive follow-up of up to 10 home visits.

Though group involvement is often promoted as a positive way to foster community responsibility, advisory committees were not always successful in sustaining change in the long term. In a follow-up study in Mali one year after a rural water supply project, researchers found that village water committees were ineffective (Parker, 1997). Though committees were formed, they fell apart or ceased to function without follow-up. In the one of 15 committees still functioning, the group met to raise funds for maintenance and repair of the water source.

4.6.3 Communication: Mass media and public events (n=5)

Face-to-face communication is reportedly effective in promoting sustained practice, yet it is labour-intensive and reaches a limited audience. An alternative is providing information via mass media strategies, such as television or radio or during public events like health fairs. Five studies in this review used a combination of interpersonal communication and mass media, while one study (Kullman and Ahmed, 2011) exclusively reported on the influence of mass media.

Mass media was a key component in the Global Scaling up Handwashing campaign promoted by the Water and Sanitation Programme of the World Bank. In each of the four countries, Peru, Senegal, Tanzania and Vietnam, it was important for each country to develop a shared vision and implementation strategy (O'Brien and Favin, 2012). In Senegal, the communications plan had the goal of fortifying intentions to practise handwashing with soap and to use a handwashing station. Using mass media and direct consumer contact, the programme could reach thousands at a time to engage the target audience and refresh their knowledge while interpersonal communication helped to build self-confidence in practising the behaviour (Devine and Koita, 2010).

4.6.4 Duration of interventions

Other factors of programmes assessed in these studies included measures of programme duration. Though anecdotal evidence suggests that longer interventions favour sustained adoption of behaviours, the results from studies with specific measures for this factor are inconclusive. Comparing the six countries participating in the hygiene sustainability study, project duration had no impact on behaviour change in India, but in Nepal it increased the likelihood of practising the behaviour (Cairncross and Shordt, 2004; Shordt and Cairncross, 2004; SEUF, 2004).

4.7 Summary of the results of the synthesis (n=44)

- Research Question 1: Measuring sustained WASH adoption outcomes
  - Twenty-one of the 44 studies were 'sustained adoption' studies that assessed WASH practices at least six months or more after the end of a study's project period. Due to the heterogeneity of the outcome definitions, measurement methodologies and comparisons made, WASH use trends over time appear variable.

    - Post-intervention sustainability is often measured by a combination of survey, interview and observation. There is no clear definition for sustained adoption employed in WASH literature, and sustained adoption is measured through self-report, observed practice, functionality and recalled knowledge.
- Research Question 1: Behavioural factors that influence sustained adoption:
    - Psychosocial factors (n=36): Perceived susceptibility and severity of disease and perceived benefits and barriers are common psychosocial factors reported to affect sustained adoption. However, some other psychosocial factors, such as injunctive and descriptive norms and nurture, may be more predictive as motivators to continue behaviours over time.
    - Contextual factors (n=29): These factors are often included in the study design. Age and gender are important factors influencing both who is able to practise the behaviour at the household level, as well as indicating roles in providing water, soap and childcare.
    - Technology factors (n=33): Cost is an important factor, no matter what type of technology is in question. However, some factors, like durability, rate of water flow and maintenance are key factors in ensuring that technologies withstand frequent use over a long period.
- Research Question 2: Programmes that assess sustainability:
    - Fourteen studies evaluated characteristics important to sustained adoption. Evidence from this review suggests that the most influential programme factors associated with sustainability include frequent, personal contact with a health promoter and accountability over a period of time. Personal follow-up in conjunction with other measures like mass media advertisements or group meetings may further increase sustained adoption.

5. Implications

Outline of chapter

In this chapter, we discuss the main findings of our review as well as the strengths and limitations of our methodology. We then discuss the larger implications for policies and programmes to promote WASH technologies and behaviours. The findings of this review imply a need for direction and leadership in guiding the research agenda on sustained adoption of WASH technologies. We discuss the steps necessary in examining sustained adoption, including establishing *intentions*, *planning* and *funding* assessments of long-term behaviour change; *executing* robust interventions that clearly define intervention activities and metrics for assessment; and *interpreting* and *disseminating* of these findings.

5.1 Key findings of our review

Our review aimed to answer two research questions:

> Q1. What are the factors that influence the sustained adoption of clean water and sanitation technologies, including definitions of sustained adoption and behavioural factors?
>
> Q2. What are the characteristics of interventions intended to improve adoption of clean water and sanitation technologies and how successful are these interventions at fostering adoption and sustained adoption?

Table 13 summarises the key behavioural factors and programme characteristics identified in our review, which are described in more detail below.

Table 13: Levels of behavioural factors and key findings

Determinant category	Why this is important…	Key findings	How this can be used
Research Question 1: Measuring sustained adoption			
Measuring outcomes	Well-defined indicators and measurements are essential to developing solid evaluations methodology They help to understand the abilities and limitations of current measurement metrics	'Sustained' adoption is interpreted in many ways by studies Studies employ a variety of measures, and rely heavily on verbal forms of participant report Observations of practice were not performed, beyond spot checks	Establish metrics that capture WASH practice, particularly over longer periods or 'automatic behaviours' Provide an evidence base for selecting and evaluating WASH programming
Research Question 1: Behavioural factors			
Psychosocial	Psychosocial factors are the core of various behaviour change theories They provide the basis for intervention design	Knowledge of the practice, self-efficacy, perceived benefits and social norms all affect behaviour Pre-existing habits and	Designing intervention content Developing effective communication strategies

Determinant category	Why this is important…	Key findings	How this can be used
	and rationale	perceived susceptibility or severity also contribute to sustained practice	
Technological	'Enabling technologies' Direct interface between user and behaviour practice Positive or negative aspects can alter behaviour adoption	Cost and durability are the most important factors across all three sectors	Designing intervention content Selecting an appropriate technology Implementation logistics
Contextual	Factors external to the user or technology influence sustained adoption The context forms the environment in which behaviour change occurs	Socio-economic status, level of education, age, and gender are all strongly tied to adoption Existing infrastructure and prior exposure to interventions are also relevant 'Habit forming' environments are not emphasised	Programme planning and implementation Communicating results across different groups and settings
Research Question 2: Programme characteristics			
Communication strategies	Communication and education provide participants with ways to learn about and troubleshoot WASH technologies They can incorporate key behavioural factors (above)	Interpersonal communication was strongly linked to better recall and continued WASH practices Mass media events and group communication are also represented in the literature	Inform programme planning and intervention design Identify key communication channels to effect sustained behaviour change

5.1.1 Measuring sustained adoption

In our analysis of outcome measurement methodologies in a subset of articles assessing WASH practices after a project period has ended, we have found that there is an extremely diverse array of operational definitions of 'sustained adoption'. This poses difficulties in making overarching conclusions about WASH use, as there are currently no standard measurement methodologies or definitions of WASH practice. Also, only 5 of 21

studies of 'sustained use' (according to our definition[4]) provided reference data from the end point of the project period, limiting our ability to determine the overall trends in adoption from the end of the project period to the time of the study's assessment.

5.1.2 Behavioural factors influencing sustained adoption: Psychosocial, contextual and technology

We found that individual psychosocial factors, such as perceived benefit, self-efficacy and other factors derived from individual-level behavioural models, strongly dominate the WASH literature. Interpersonal factors such as social norms are also reported to strongly affect an individual's continued practice of WASH behaviours. Understanding these factors can better inform target groups and intervention content, to achieve lasting WASH behaviour change.

The greater context around an individual was found to be highly influential. Particularly in latrine use and handwashing practice, age and gender were strong determinants of an individual's continued WASH practice: individuals may be barred from using latrines or unable to practise handwashing or water treatment if they are too young, or otherwise restricted culturally or physically from accessing enabling technologies.

Surprisingly, although referenced in behavioural models, e.g. FOAM (the World Bank) or RANAS (Mosler, 2012), the concept of the 'enabling environment' was not discussed in any studies in this review. As we will discuss later, an environment that is conducive not only to the uptake, but also to the *continued maintenance* of WASH behaviours is crucial to establishing sustained WASH practice.

Cost and durability were the two most important factors related to a technology, indicating areas where more research could be done on balancing cost-effectiveness of materials and supply-chain systems that support long-lasting hardware and long-term behaviour practice.

5.1.3 Programme and intervention characteristics influencing sustained adoption

Evidence from this review suggests that the most influential programme factors associated with sustainability include frequent, personal contact with a health promoter and accountability over a period of time. Personal follow-up in conjunction with other measures like mass media advertisements or group meetings may further increase sustained adoption.

5.2 Two understandings of WASH behaviour change interventions

The key purposes of this review were to understand 'intervention' and 'sustained adoption'. Both turned out to be more difficult to define than anticipated. A 'WASH behaviour change intervention' is a planned series of activities that create the conditions for WASH behaviours to be practised, or promote the WASH behaviours directly. Activities that create the conditions for the WASH behaviours to be practised include the construction or installation of hardware such as wells, pumps, and latrines, or distribution of technology such as handwashing stations, water filters or water solar disinfection units. Activities that directly promote the behaviours include home visits by health promoters, mass media communication and promotion by community groups.

We encountered two variant understandings of 'WASH behaviour change intervention'. One understanding was focused on, or even limited to, the construction or installation of hardware. This typically took place during a short time, weeks to months, at any one

[4] 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

location. This understanding was more common in reports and articles on large-scale water and sanitation projects funded by development banks. The 'intervention' happens when the borehole is drilled or the toilet is built. It follows that 'sustained adoption' refers to use or adoption of the hardware in the months or years after its installation in the home or the community.

A second understanding of 'WASH behaviour change intervention' refers to the entire period of external funding to a WASH project, whose activities include promotion of WASH behaviours. In this report, we refer to this as the 'project period'. This second meaning is more common among NGOs and research groups. The 'project period' typically lasts from one to five years. Activities during the project period include introducing the project to the community and adapting the implementation plan based on their feedback, activities to create the conditions for behaviour change (installation of hardware), and activities to directly promote the behaviour. It follows that 'sustained adoption' refers to use or adoption of the hardware in the months of years after the end of the project period and/or after the end of external funding for project activities.

We now provide an example of the effect of these two different understandings of 'WASH behaviour change intervention' on sustained adoption. If latrines were constructed at the outset of a two-year project, one meaning of sustained adoption would be adoption of the behaviour and use of the latrines in the months or years following construction of the latrines - including the two year project period. A second meaning would be use of the latrines in the months or years following the end of external funding. With the end of external funding, support for household and community-level promotion of latrine use and maintenance comes to an end and the users become solely responsible for the continuation of the behaviour and associated maintenance of the technology.

Of the 44 papers selected for in-depth review because they examined sustained practice of WASH behaviours six months or more after the WASH behaviour change intervention, 23 followed the first understanding, in that they examined sustained behaviour change six months or more after installation of hardware – we termed these 'maintenance' studies. In the 'maintenance' studies, the 'sustained behaviour change' was still during the period of external project funding. Only 21 of these 44 studies followed the second understanding, in that they examined sustained adoption six months or more after the end of the project period. We termed these 'sustained adoption' studies.

5.3 Theory of change

As we noted in the previous section, a subset of articles assessed sustained adoption at least six months after the end of the project period, while the remainder measured sustained adoption at some point during the project period, or within six months of the end of the project period. We contend that measurement at these different time points addresses very different research questions. To provide a stronger foundation for future evaluations, we felt it necessary to define the different periods in the life of a WASH behaviour change project, which could be taken into account in evaluation design.

Most behaviour change models only describe or examine initial adoption. They do not make allowances for, or provide a framework for sustained adoption. We identified two articles that provide a framework for examining sustained adoption: Mosler (2012) and Wood et al. (2012). The Mosler article presents a framework for effecting behaviour change, and also provides an 'eight step protocol' for changing behaviour (pp. 443-445), where they briefly discuss the timing of evaluations and definitions to assess sustained adoption. Ideally, measurements should be made '6–12 months after the last intervention to assess sustainable change' (p. 445). The Wood article presents a behaviour change framework adapted from PATH, and describes three broad stages: awareness, action, and maintenance. This framework is one of the few frameworks to our knowledge that makes

distinctions between initial and sustained adoption, and the factors or other considerations that are influential at these stages.

Returning to the understandings of 'WASH behaviour change intervention' that we found in our review, these definitions will continue to exist in the literature. Taking this and the aforementioned model into account, we have therefore developed a Theory of Change that recognises both (Table 14, Figure 6). The far right column of Table 14 indicates the two understandings of sustained adoption that we encountered in the literature:

- Definition 1 on the left examines sustained adoption from the point at which hardware such as a well, a toilet or a water treatment technology was installed or distributed until the end of the project period.
- Definition 2 on the right examines sustained adoption from the point at which external funding for the WASH behaviour change intervention came to an end.

We divide the life of a WASH behaviour change project into four time periods:

1. Early project period
2. Late project period
3. Early post-project period
4. Late post-project period.

During each of these periods, there is a different context for practising WASH behaviours. Details on the enabling and constraining factors in each of the four periods are provided in Table 14 and Figure 6. Here we sketch the main features of the four periods.

1. **Early project period** – This is frequently a period of excitement and enthusiasm. New technology is introduced into a community at low cost or no cost, and project personnel and/or community promoters explain the new technology and its advantages. The novelty of the technology, the promotional activities and other special events all encourage people to try the technology or practice the new behaviour. Conversely, failure of the project to adequately adapt the technology and behavioural recommendations to the needs of the population and the specific environmental conditions may slow adoption.
2. **Late project period** – The initial enthusiasm for the technology or the behavioural recommendations diminishes, and community members have the chance to weigh the advantages and disadvantages of the new against the pre-existing. The continued presence of project staff may ensure that cost and availability do not constitute significant barriers to use. Health promoters help people to solve problems related to new technologies. At the same time, people may realise that the promised benefits have not materialised, and return to previous technologies and behaviours. It is during this period that the studies that we describe as 'maintenance' assess whether behaviour has been sustained. Ideally there is planning in the late project period, so that community members are in a position to maintain the functionality of the technology, restock on essential supplies and continue to practice the recommended behaviours after the end of external funding and support.
3. **Early post-project period** – While external support ends, the promotional messages and instructions disseminated by the project are still fresh in people's minds. Projects may have left extra supplies. People may be motivated to continue practising the behavioural recommendations in order to maintain health benefits. At the same time, breakdowns in equipment or stock outs in essential supplies may start to bring down the previous level of adoption. The behavioural cue (reminder) of regular household visits by promoters may be lost. Household members who from

the outset have been sceptical of the new technology or behavioural recommendation may reassert their position, and encourage other household members to revert to previous ways. Studies assessing WASH behaviours in this and the following period were classified as 'sustained adoption' studies in this review.

4. **Late post-project period** – Problems with breakdowns in equipment and stock outs may worsen, further decreasing levels of adoption. However, the desire to maintain the benefits of the technology or behaviour, and new habits and social norms that resulted from the intervention activities during the project period may help sustain previous levels of practice of the WASH behaviours.

Table 14: Theory of change for sustained adoption of WASH behaviours

Period	Main activities	Enablers	Barriers	Sustained adoption
	1. Early project period			
Project period	Introduction of project or intervention to community Installation or distribution of hardware: Pumps, wells, latrines, water filters, handwashing stations Early promotion of behaviour change	Promotion efforts and messaging Individual knowledge, skills, self-efficacy Availability, acceptability, cost (usually free) and novelty of WASH technology Perceived benefits	Difficulties reaching populations Dislike of technology Familiarity with prior WASH habits Reluctance of household members	**LEFT**: Definition 1 **RIGHT**: Definition 2
	2. Late project period			
	Continued promotion of target behaviours Preparation of community for end of external support Identification of alternative sources of supplies and repairs	Health promoter available to assist with problems that may arise New social norms and habits are established Continued support from promoters and project supervisors	Actual and perceived benefits do not align Problems with communication and supply logistics Timing of practice Loss of interest	
End of project				
	3. Early post-project period			
Post-project period	Continued use or adoption Structures left in place for resupply and repair start to function	Messaging still 'fresh' in minds Extra supplies remaining from the project period Desire to maintain health benefits	Lack of supplies or technology functionality Preferences of influential household members re-emerge Regular behavioural cue (home visit) lost	
	4. Late post-project period			
	Continued use or adoption Structures left in place for resupply and repair continue to function Problem solving by users or community groups	Habitual behaviour established from continued practice Desire to maintain benefits of WASH practice New children born who benefit from and motivate behaviour practice	Lack of supplies or inability to repair or maintain technology Cues to behaviour are lost or forgotten Cost of materials may be unsustainable	

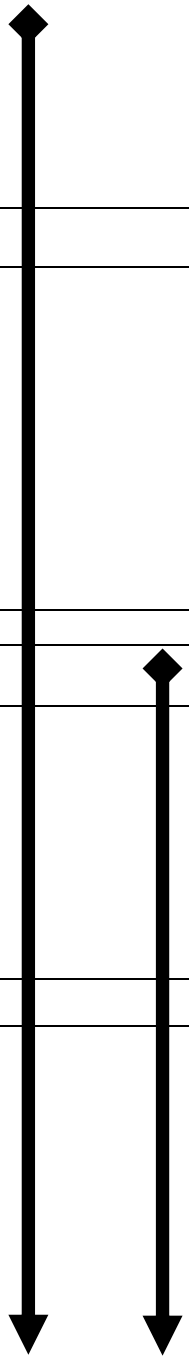
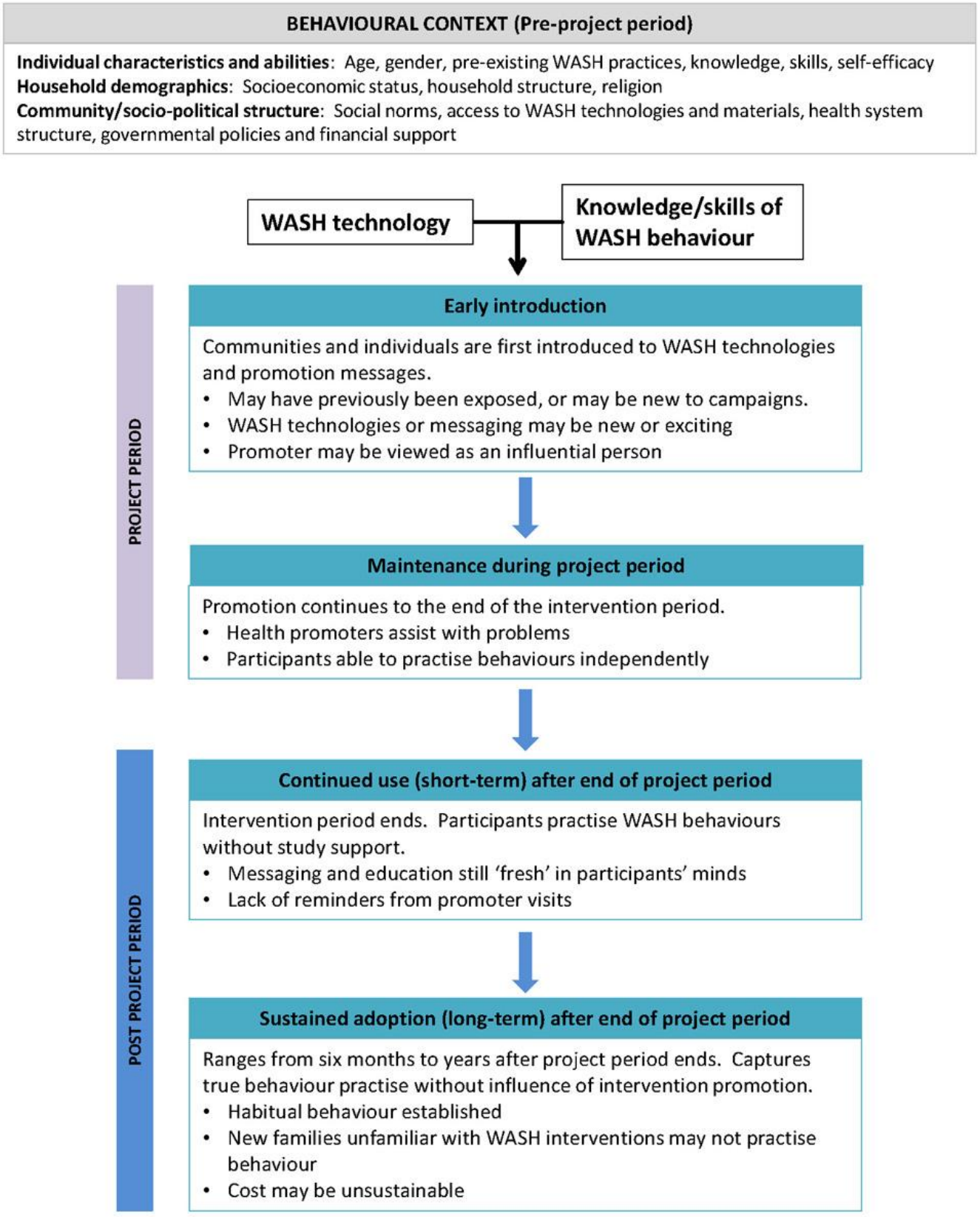


Figure 6: Flow diagram of our theory of change



5.4 Assessing evaluation quality in relation to the theory of change

In Section 3.5.4 of this report we presented our assessment of study rigour measured through a seven-point scale system adapted from Harden and Thomas (2005). An alternative way to conceptualise evaluation quality is to consider how the available studies do or do not build the knowledge base in relation to our theory of change. If this theory of change is accepted as a basis for examining sustained adoption of WASH behaviours, then the ideal evaluation study would have the characteristics summarised in Table 15. This table is meant to be a resource for individuals designing evaluations that adequately capture sustained adoption of WASH behaviours.

Table 15: Characteristics of an ideal evaluation in relation to the theory of change

Characteristic	**Description**	**Quality of available literature in relation to this characteristic**
Clear specification of the period in the life of the project for each measurement	Indication of whether each measurement occurred in the early project period, late project period, early post-project period or late post-project period	• It is difficult to identify the start and end dates of the project period in many studies • It is difficult to know which period corresponds to each measurement in many studies
Description of context for sustained adoption of WASH technologies	Description of key factors affecting sustained adoption at any point in time: 1. Availability of technology 2. availability of spare parts and/or repair services 3. availability of essential supplies	• Contextual descriptions are typically limited to a listing of demographic characteristics • Qualitative literature exists to describe WASH practices (e.g. DuBois et al., 2010 or Tamas et al., 2009), but the focus is on establishing psychosocial enablers/barriers over the context of WASH practice
Measurements at multiple time points	At a minimum, measurement at baseline and at the end of the project period, and at two time points in the post-project period	• Only three studies conducted measurements at multiple time points after the end of the project period (SEUF, 2004; Parker et al., 2006; Bowen et al., 2013) • Only 5 out of 21 studies attempting to assess long-term WASH behaviours also included estimates of the level of use or adoption from the end of the project period
Measurements of WASH behaviours in a valid and reliable way at each time point	Are WASH behaviours measured in a way known to be valid and reliable based on current literature?	• Overreliance on verbal report to assess WASH behaviours • Most handwashing studies do not describe the criteria used to assess handwashing practice • Water treatment outcomes are the best described group. Typically self-reported practice is

Characteristic	Description	Quality of available literature in relation to this characteristic
		combined with a chemical spot check to verify use (if chlorine) • Sanitation measurements are limited almost exclusively to self-reported use and observation of latrine presence. Issues arise with the reliability of such data to accurately represent latrine use
Measurement of the range of factors affecting sustained adoption	Specification of a model or framework for factors affecting sustained adoption Valid and reliable measurement of factors in the model Psychosocial factors assessed through multi-item scales	• Most studies are not guided by a model or framework (32/148 explicitly describe a behavioural framework) • Many psychosocial factors are assessed through single items on a questionnaire, rather than through a multi-item scale and confirmed with an appropriate psychometric method

As we have shown through our findings, this systematic review is limited in its abilities to draw conclusions about sustained adoption by the very fact that this is a loosely-defined term with inconsistent applications. For one group, 'sustained adoption' may be households continuing to wash their hands during a project period, whereas for another group it may be the presence of a latrine nine years after the project period ended, without mention of patterns of latrine use. The heterogeneity of interventions, study designs, and outcome measures make it difficult to draw definitive conclusions for specific studies. Instead, we have focused on the application of outcomes and a range of influential factors to provide WASH promoters with a framework for future reporting.

5.5 Strengths and limitations of this systematic review

5.1.1 Overview

In Chapter 1, we describe the landscape of research, policy and practice for behaviour change related to water, sanitation and hygiene. We highlight the fact that WASH behaviours need to be practised daily and repeatedly for them to have a public health impact, and thus we classify them as habitual behaviours. Though there is considerable political and institutional support for WASH in lower- and middle-income countries, there are significant challenges in promoting behaviour change and sustained adoption. One challenge is limited technical capacity to analyse, understand and measure habitual behaviours, and a dearth of research examining automaticity of daily WASH behaviours. A second challenge is the narrow evidence base on sustained adoption of WASH behaviours beyond the project period. Specifically, this review finds that sustained adoption after the end of external funding and support is infrequently assessed, and as indicated in Table 15, the timing and type of measurements leave much to be desired:

- Only three studies conducted measurements at multiple time points after the end of the project period (SEUF, 2004; Parker et al., 2006; Bowen et al., 2013).

- Only 5 out of 21 studies attempting to assess long-term WASH behaviours also included estimates of the level of use or adoption from the end of the project period.

The strengths in this review are in providing a landscape overview of the literature on adoption and sustained adoption of WASH technologies as well as a more in-depth look into the types of factors reported in the literature on sustained adoption and how these factors are evaluated.

In answering a broad research question, the evidence compiled in this review must be considered through the lenses we employed in examining the available literature.

5.5.2 Methodological limitations

5.5.2.1 Level of detail, quality and heterogeneity of the findings

The studies identified in this review represent a diverse range of programmatic designs, outcome definitions, measurement methodologies and the level of detail provided on all these steps. This heterogeneity makes it extremely difficult to make conclusions about sustained WASH adoption, as there is no standardized outcome or reporting format. To address this issue of diverse definitions of sustainability and sustained WASH behaviour practice, we used a flexible, mixed-methods review methodology (Harden and Thomas, 2005).

We have summarised the quality of the available literature in two ways. In Section 3.5.4 of this report we presented our assessment of study rigour measured through a seven-point scale system adapted from Harden and Thomas (2005). In Section 5.4 immediately above, we assessed evaluation quality in relation to the theory of change. By both measures, the general methodological quality leaves much to be desired.

5.5.2.2 Content included

The research methodology used in conducting this review provides a filter with which we identified studies. The inclusion and exclusion criteria limit the material we chose to review.

- **Electronic availability:** We attempted to access as much of the peer reviewed and grey literature on this topic as possible. However, reports and studies from lower- and middle-income countries may have been missed if not electronically available or searchable.
- **Geographic scope:** We limited this search to low- and middle-income countries where infrastructure for water, sanitation and hygiene are restricted or inadequate, and also where water-borne diseases are most prevalent. Even considering this geographic limit, we have identified that the reports on sustained adoption are concentrated in a few distinct areas where research groups or implementation organisations have a strong presence. There are few reports from the Middle East and East Asia.
- **Language:** Due to the limitations of our research team, we were only able to include articles published in English, French, German or Spanish.
- **Primary data:** We limited our search to primary data, including both qualitative and quantitative studies. The motivation for this was to be able to assess empirical evidence for sustained adoption. However, data gathered through secondary sources such as government surveys, programme reviews, etc. are not included in this review.

- **Study quality:** Because we included a broad range of literature from peer-reviewed sources and programmatic reports, the quality and depth of the reported factors varied greatly.
- **Outcome measures:** In order to answer our research question, studies included in the mapping and in-depth review stages of the review must have reported on behavioural factors or programme characteristics related to the use of WASH technologies. In addition, we were looking for evidence of adoption or sustained adoption reported in primary data. Overview reports of several programmes or articles reporting on levels of sustained adoption (without citing related factors) would not have been eligible for inclusion.

5.5.2.3 Selecting studies for in-depth review

In our review of the evidence base for sustained adoption of WASH practices, we selected only articles that directly reported on sustained adoption of WASH technologies over several months or years. Though sustained adoption was a specific priority for this review, there is substantial evidence published on factors influencing behaviour change over much shorter periods - weeks to months - that may relate to factors for sustained adoption. The mapping section of this review provides detailed summaries of the available literature, and should be considered in research and practice on this topic.

5.5.2.4 Limitations of published material

We recognise that information available to us in reports and published literature is limited to the priorities of the research groups, funding agencies and implementing organisations. Assessments may have been made of factors associated with sustained adoption, but presentation of these factors has not been included in the final published reports. Likewise, institutional knowledge gained from long-term implementation projects may show evidence of sustained adoption that is not available in accessible, published form.

5.6 Expanding knowledge of sustained water, sanitation and hygiene

5.6.1 Contribution to public health practice

This review is intended to be useful to all manner of individuals interested in delivering clean water and safe sanitation to populations in order to improve health and wellbeing. We anticipate that the findings of this report will apply to any of the following dimensions of public health practice:

- **Scientific research:** Contribute to understanding the mechanisms by which people adopt new practices and behaviours. Develop better metrics to study sustained adoption. Identify information and knowledge gaps that can influence other researchers to contribute to the body of knowledge about initial and sustained adoption of WASH technologies.
- **Programme planning and intervention design:** Develop relevant, appropriate interventions to achieve lasting disease impact and behaviour change. Influence intervention design and development to more effectively address the factors that promote or inhibit the sustained adoption of small-scale water and sanitation technologies. Improve intervention design, execution, analysis and communication of results.
- **Funding:** Promote the funding of demonstrated cost-effective technologies and create a set of criteria for evaluating the sustainability and feasibility of proposed projects.

- **Policy planning:** Identify gaps in WASH promotion strategies to ensure sustained adoption of current solutions. Influence policy discourse around the viability of small-scale technologies to improve access to safe drinking water and sanitation.

We provide more detail in the following sections.

5.6.2 Scientific research: Defining 'sustained adoption' and evaluation methodologies

'Sustained adoption' is a highly variable term with different applications, depending on each implementing group's background and interests. We do not suggest that there should be standard definitions for what sustained adoption of WASH technologies is: each project context is unique and differences in the ways that various groups perceive and perform WASH behaviours should be considered in overall intervention design. Rather, as our findings have suggested, more discussion is essential to understanding, measuring and ultimately achieving sustained WASH practices across the world. We encourage users to contribute to the evidence base for sustained adoption of WASH technologies by helping to develop mechanisms that consider a range of behavioural factors in the design, delivery and assessment of WASH interventions.

Indicators for assessing both post-implementation sustainability and key behavioural factors should be defined prior to programme implementation and measured throughout the lifespan of the intervention and beyond. Using clearly defined indicators is essential to comparing study outcomes across locations and methodologies.

Measurement of factors influencing sustained adoption is important in interpreting why it was successful or unsuccessful. Factors associated with use include psychosocial, contextual and technology factors:

- **Psychosocial** motivators identified in this review include knowledge of disease transmission, social norms, including social support and peer accountability, cues to action, and the desire to fulfil a good role as nurturer or caretaker of the household.
- **Contextual** factors like gender, socio-economic status and education are often associated with measures of sustained adoption. These factors are often taken into account at the outset of a programme. However, additional factors like infrastructure, access to markets, social roles in the household and seasonal or climatic factors also play a large role in determining sustained adoption.
- Finally, factors of the **enabling technologies** associated with WASH are important to consider. In addition to affordability, key factors are durability, local availability and ease of maintenance and operation.

Factors associated with disuse may vary by setting, but some consistent themes were reported in several studies and discussed earlier. Designing effective interventions should include careful examination of technical design to maximise user satisfaction and feasibility of use in the long term.

Lastly, by establishing better metrics to study sustained behaviour change and adoption, the scientific and public health community can identify areas where more research needs to be conducted to understand the means by which the transition to sustained WASH adoption occurs.

5.7 Designing more effective interventions and programmes

5.7.1 Intervention planning and design

A well-planned intervention is crucial to the success of any WASH promotion programme. Using evidence-based technologies and promotion strategies as well as including plans for

post-intervention evaluations with relevant metrics will strengthen the rigour and consistency of WASH promotion studies. Groups undertaking sustained adoption should note the following key points (see Table 15 for specific indicators):

- **Emphasise habit formation from the start:** Many studies have elaborated on the factors influencing *initial* adoption of WASH behaviours, but projects should plan to adapt their strategies as motivations change throughout the course of the project and post-project periods.
- **Plan for follow-up to assess sustained adoption:** Many WASH programmes introduce new behaviours, and these programmes must be assessed over time. Planning for and conducting post-intervention follow-up helps to build an evidence base for sustained adoption.
- **Consider context**: In addition to basic demographic information, intervention design should incorporate factors of the local environment, roles and responsibilities within households, working patterns, climate and seasonality, and governmental and institutional support.
- **Use technologies that are feasible and acceptable for long-term use**: A user-centred design approach ensures that specific recommendations of the users themselves are incorporated into the design. Pilot testing and qualitative feedback are helpful in identifying factors that facilitate or discourage the use of technologies.

5.7.2 Interpretation

Interpretation and application of the results of this review require an understanding of the strengths and limitations of the original intervention plans. This review reveals the need for consistent reporting within the field of water and sanitation. Regardless of the motivation for research and intervention, measures of sustained adoption could be incorporated to leverage the evidence base for WASH related benefits.

5.7.3 Analysing factors associated with sustained adoption

In order to analyse and compare factors associated with sustained adoption, these factors must first be defined and assessed using robust methods. Analysis of factors could draw on either quantitative outcomes or qualitative data, but appropriate methods must be used to make comparisons between heterogeneous outcome measures. The use of an explicit conceptual model can guide analysis of these factors.

5.7.4 Reflexivity

It is important that researchers reflect on their role in the research. Individuals' points of view can influence their methods, biases and decisions, and the overall direction of the research and the knowledge generated from the research process. Reflexivity aids the objective interpretation of findings by demonstrating the limitations and biases inherent in the research.

5.7.5 Disseminating results

In order to build the evidence base for factors that influence sustained adoption of WASH behaviours and technologies, it is essential to disseminate findings among researchers and practitioners. Reports of sustained adoption should ideally include the following elements:

- A clear description of the intervention
- Selection of metrics used to evaluate WASH behaviour practise

- Identifying deductive factors: Using a conceptual model can help researchers and programmers to identify, define and measure behavioural factors. Identifying some factors at the outset of an intervention can leverage facilitators and address known barriers
- Definition of inductive factors
- The role of temporal comparison in WASH promotion
- Inclusion of reflexivity.

Dissemination strategies should also ideally include stakeholders and policy makers.

5.8 Identifying areas of funding

5.8.1 Developing an intention to support WASH programming

In order to promote and study sustained adoption of WASH practices, it is essential to create a supportive environment for examining sustained adoption. The first step is to develop the intention to fund and design programmes that facilitate long-term use and measure sustained adoption among policy makers, donors, programmers, and intervention recipients.

5.8.2 Funding for post-intervention evaluation

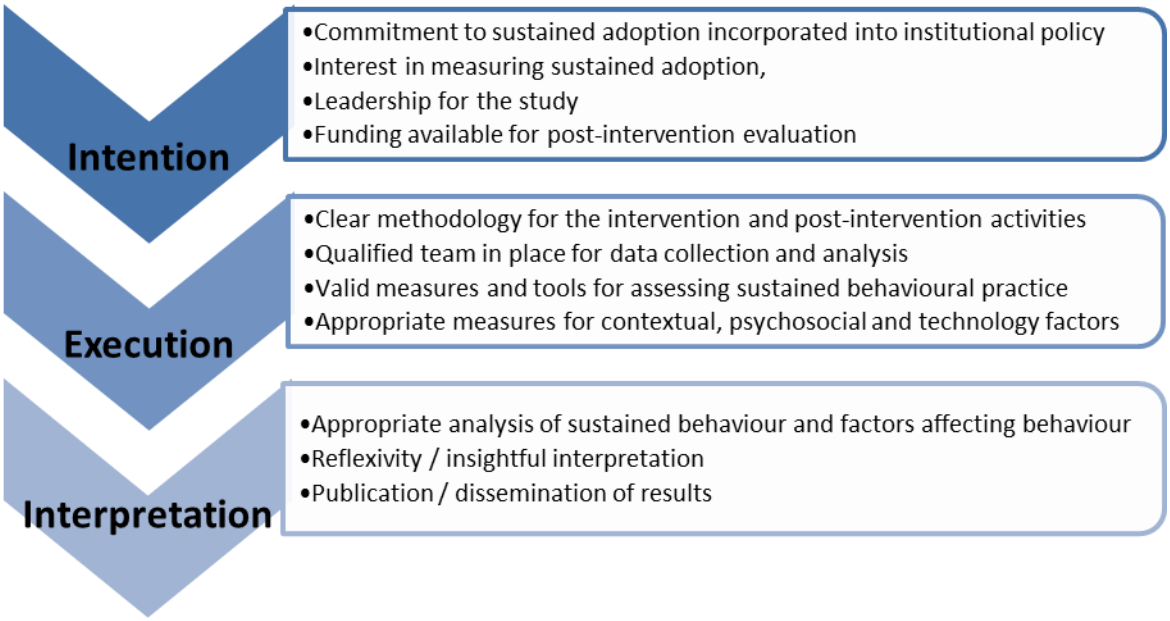
Though sustained adoption is the goal of many WASH programmes, follow-up studies or post-implementation evaluations are few and far between. Funders should consider post-intervention follow-up as a key aspect of successful programmes and provide funding mechanisms to ensure long-term follow-up.

5.9 Setting an agenda for policy, programming and research

The findings in this review reveal that sustained adoption, and the factors that motivate or impede sustained adoption of WASH practices are underrepresented in the WASH literature. In order to increase the evidence base for what actually works, we outline the steps for examining sustained adoption. These steps, outlined in Figure 7, require support from policy makers, programme implementers and evaluators at three key stages:

- Intention – Institutional mechanisms, policy and leadership must incorporate sustained adoption at the outset of programme development
- Execution – WASH interventions must be designed to measure and evaluate sustained adoption and the impact of factors affecting sustained adoption
- Interpretation – The results must be appropriately analysed and reported.

Figure 7: Steps in examining sustained adoption of WASH



5.9.1 Changing institutional policy

Commitment to sustained adoption at the donor and institutional levels is essential to building the evidence base for the benefits of sustained adoption. This review is intended to help inform policy in the following ways:

- **Influence policy discourse around the viability of small-scale technologies**: There is evidence to show that small-scale household technologies can be viable solutions in the long term. However, the challenge with promoting WASH behaviours at the individual, household and community levels is ensuring that all people participate habitually over time. Without large-scale participation and long-term commitment, communities may not see the multiple benefits of practising WASH behaviours.
- **Influence intervention design and development**: The findings of this systematic review can guide policy makers in identifying contextual, psychosocial and technology factors influential in sustained adoption. It may also highlight factors that inhibit the sustained adoption of small-scale water and sanitation technologies.
- **Identify information and knowledge gaps**: This systematic review has shown that sustained adoption is difficult to measure and that few researchers define their measures. Even fewer define and measure factors influencing behavioural uptake. Policy makers may be able to address these gaps by enhancing institutional commitment to measuring factors associated with sustained adoption.

5.9.2 Leadership

Leadership is essential at both the policy and programmatic levels. This review illustrates that most programmes and studies lack a clear focus on sustainability. Leadership is essential for setting the research agenda and executing rigorous evaluations of sustained adoption.

5.10 Conclusion

The success of water, sanitation, and hygiene schemes worldwide depend on daily practices and long-term commitment, in conjunction with appropriately usable and durable technologies. This review begins the conversation on factors that motivate sustained adoption of WASH technologies, and provides a platform from which to guide further research in behaviour change and post-intervention sustainability.

We found that studies often inconsistently defined sustained behaviour change. This inconsistency makes it difficult to compare results across studies or to draw general conclusions about the factors that affect sustained WASH adoption.

Individual psychosocial factors, such as perceived benefit, self-efficacy and other factors derived from individual-level behavioural models, strongly dominate the WASH literature. Interpersonal factors such as social norms are also reported to strongly affect an individual's continued practice of WASH behaviours. The greater context around an individual was found to be highly influential. Particularly in latrine use and handwashing practice, age and gender were strong determinants of an individual's continued WASH practice. Finally, cost and durability were the two most important factors related to a technology, indicating areas where more research could be done on balancing cost-effectiveness of materials and supply-chain systems that support long-lasting hardware and long-term behaviour practice.

Evidence from this review suggests that the most influential programme factors associated with sustainability include frequent, personal contact with a health promoter and accountability over a period of time. Personal follow-up in conjunction with other measures like mass media advertisements or group meetings may further increase sustained adoption.

More emphasis needs to be placed on defining 'sustainability' and translating this into metrics and programme elements that can be used to implement, evaluate and further the discussion on sustained WASH adoption. Programmes and technologies need to be designed to be supportive and flexible to motivators of both initial and long-term WASH practice. Funding mechanisms need to emphasise the importance of routine monitoring and evaluation, and be willing to invest in longer-term behaviour maintenance. Finally, policies and regulations need to be established at the governmental and intergovernmental levels that support the right to safe water, hygiene and improved sanitation for all people globally.

6. References

6.1 Studies included in mapping and synthesis

*Papers included in the in-depth review are marked with **

Abt Associates Inc (2010) *Pakistan safe drinking water and hygiene promotion project: final report*. Islamabad: USAID

Academy for Educational Development Inc (2007) *Conducting trials of improved practices in Madagascar*. Washington, DC: USAID.

Acharjee SK, Biswas, A, De C (2000) Adoption of rural sanitary system in terms of some predictor variables. *Environment and Ecology*, 18(2): 487-489.

Achieng NO, Foyeke, T (2007) Hand washing research on utilization of bush proof hand washing containers (BPHWC) in humanitarian emergencies. http://www2.wsp.org/scalinguphandwashing/enablingtechnologies/docs/5._Hand_Washing__Research_on_Bush_Proof_HWC_-_Zim.pdf (accessed 12 February 2015).

Ahmad J, Goldar B, Misra, S (2006) Rural communities' preferences for arsenic mitigation options in Bangladesh. *Journal of Water Health,* 4(4): 463-477.

Ahmed NU, Zeitlin MF, Beiser AS, Super CM, Gershoff SN, Ahmed MA (1991) Community-based trial and ethnographic techniques for the development of hygiene intervention in rural Bangladesh. *The International Quarterly of Community Health Education*, 12(3): 183-202.

*Aiken BA, Stauber CE, Ortiz GM, Sobsey MD (2011) An assessment of continued use and health impact of the concrete biosand filter in Bonao, Dominican Republic. *American Journal of Tropical Medicine and Hygiene*, 85(2): 309-317.

Aini MS, Fakhrul-Razi A, Mumtazah O, Meow Chen JC (2007) Malaysian households' drinking water practices: A case study. *International Journal of Sustainable Development and World Ecology*, 14(5): 503-510.

Akter T, Mehrab Ali ARM (2011) *Knowledge and practice of hygiene in BRAC's WASH Programme areas*. http://research.brac.net/new/environmenttag/practice (accessed 12 February 2015).

Al-Sa'ed R, Mubarak S (2006) Sustainability assessment of onsite sanitation facilities in Ramallah-Albireh district with emphasis on technical, socio-cultural and financial aspects. *Management of Environmental Quality*, 17(2): 140-156.

Albert J, Luoto J, Levine D (2010) end-user preferences for and performance of competing POU water treatment technologies among the rural poor of Kenya. *Environmental Science and Technology*, 44(12): 4426-4432.

Ali R (2013) Women's participation in the water, sanitation and hygiene program at community level in Bangladesh. *Journal of Third World Studies*, 30(1): 193-208.

Allan SC (2003) *The WaterAid Bangladesh/VERC 100% sanitation approach: cost, motivation and sustainability*. Masters dissertation. London: London School of Hygiene and Tropical Medicine.

*Altherr A-M, Mosler H-J, Tobias R, Butera F (2008) Attitudinal and relational factors predicting the use of solar water disinfection: A field study in Nicaragua. *Health Education and Behavior*, 35(2): 207-220.

Amelink, C (2010) Global Scaling Up Handwashing Project: Second annual progress report: Peru, Tanzania, Vietnam and Senegal. http://www.wsp.org/sites/wsp.org/files/publications/GSP_Handwashing_2009_Annual.pdf (accessed 12 February 2015).

Andrade EL (2013) Thinking outside the soapbox: Evaluating the effectiveness of a community-based hygiene promotion intervention in Santa Clara, EL Salvador. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, 73(8-B)(E).

Arman S, Unicomb L, Luby SP (2013) A qualitative exploration of factors affecting uptake of water treatment technology in rural Bangladesh. In: Arman S, Luby S, Unicomb L (eds) *When culture impacts health*. New York: Elsevier, pages 205-214.

*Arnold B, Arana B, Mäusezahl D, Hubbard A, Colford Jr JM (2009) Evaluation of a pre-existing, 3-year household water treatment and handwashing intervention in rural Guatemala. *International Journal of Epidemiology*, 38(6): 1651-1661.

Aunger R, Curtis V, Nizame F, Choudhury R (2010a) *Formative research on hand-washing in Bangladeshi households for SHEWA-B*: London School of Hygiene and Tropical Medicine, icddr,b.

Aunger R, Schmidt WP, Ranpura A, Coombes Y, Maina PM, Matiko CN, Curtis V (2010b) Three kinds of psychological determinants for hand-washing behaviour in Kenya. *Social Science and Medicine*, 70(3): 383-391.

Baguma D, Hashim JH, Aljunid SM, Hauser M, Jung H, Loiskandl W (2012) Safe water, household income and health challenges in Ugandan homes that harvest rainwater. *Water Policy*, 14(6): 977-990.

Bahardjo B, O'Brien D (1994) Community self-financing of water and sanitation systems. *Waterlines: Journal of Appropriate Water Supply and Sanitation*, 12(3): 10-13.

*Barnard S, Routray P, Majorin F, Peletz R, Boisson S, Sinha A, Clasen, T (2013) Impact of Indian Total Sanitation Campaign on latrine coverage and use: A cross-sectional study in Orissa three years following programme implementation. *PLoS ONE*, 8(8) e71438.

Bendahmane DB (2004) Summary report: Combining hygiene behavior change with water and sanitation in the Dominican Republic. http://www.ehproject.org/PDF/Activity_Reports/AR-139%20DR%20Summary%20Report%20Format.pdf (accessed 12 February 2015).

Beyene H, Hailu D (2013) Assessment of knowledge, attitude and practice regarding water, sanitation and hygiene for people living with HIV/AIDS. *Journal of Water, Sanitation and Hygiene for Development*, 3(1): 81-85.

Bhardwaj A, Surana A, Mithra P, Singh A, Panesar S, Chikkara P (2013) A community based cross-sectional study on use of sanitary latrines in a rural setup in Maharashtra. *Healthline*, 4(1): 89-93.

Bilqis AH, Zeitlyn S, Ali N, Hoque BA, Yahya FSM, Shaheed NM (1994) Promoting sanitation in Bangladesh. *World Health Forum*, 15(4): 358-362.

Bolt E, Postma L, Karanja, B (2003) Measuring the effectiveness of hygiene promotion interventions. Paper presented at the *29th WEDC International Conference*, Abuja, Nigeria. http://wedc.lboro.ac.uk/resources/conference/29/Bolt.pdf (accessed 12 February 2015).

*Bowen A, Agboatwalla M, Ayers T, Tobery T, Tariq M, Luby SP (2013) Sustained improvements in handwashing indicators more than 5 years after a cluster-randomised, community-based trial of handwashing promotion in Karachi, Pakistan. *Tropical Medicine and International Health*, 18(3): 259-267.

BRAC-ICDDR, B Joint Research Project (1996) *Studies on the inputs of BRAC in Matlab: Sanitary latrines, training, monthly meetings, legal awareness and credit*. http://research.brac.net/workingpapers/Working_Paper_15.pdf (accessed 12 February 2015).

Brown J, Sobsey MD (2012) Boiling as household water treatment in Cambodia: A longitudinal study of boiling practice and microbiological effectiveness. *American Journal of Tropical Medicine and Hygiene*, 87(3): 394-398.

*Brown J, Sobsey M, Proum S (2007) Use of ceramic water filters in Cambodia. http://www.unicef.org/eapro/WSP_UNICEF_FN_CWP_Final.pdf (accessed 12 February 2015).

*Brown J, Proum S, Sobsey MD (2009) Sustained use of a household-scale water filtration device in rural Cambodia. *Journal of Water and Health*, 7(3): 404-412.

*Cairncross S, Shordt, K (2004) It does last! Some findings from a multi-country study of hygiene sustainability. *Water Lines*, 22(3): 4-7.

*Cairncross S, Shordt K, Zacharia S, Govindan BK (2005) What causes sustainable changes in hygiene behaviour? A cross-sectional study from Kerala, India. *Social Science and Medicine*, 61: 2212-2220.

*Casanova LM, Walters A, Naghawatte A, Sobsey MD (2012) Factors affecting continued use of ceramic water purifiers distributed to tsunami-affected communities in Sri Lanka. *Tropical Medicine and International Health*, 17(11): 1361-1368.

Chase C, Do, Q-T (2012) *Handwashing behavior change at scale: Evidence from a randomized evaluation in Vietnam*. Washington, DC: World Bank.

*Choudhury N, Hossain MA (2006) Exploring the current status of sanitary latrine use in Shibpur Upazila, Narsingdi District. http://research.brac.net/reports/Exploring_the_current_status.pdf (accessed 12 February 2015).

*Christen A, Duran P, Hattendorf J, Arnold BF, Cevallos M, Indergand S, Colford JM, Mäusezahl D (2011) Factors associated with compliance among users of solar water disinfection in rural Bolivia. *BMC Public Health*, 11: 210.

Cole B, Pinfold J, Ho G, Anda M (2012) Investigating the dynamic interactions between supply and demand for rural sanitation, Malawi. *Journal of Water Sanitation and Hygiene for Development*, 2(4): 266-278.

Curtis V, Kanki B, Mertens T, Traore E, Diallo I, Tall F, Cousens S (1995) Potties, pits and pipes: Explaining hygiene behaviour in Burkina Faso. *Social Science and Medicine*, 41(3): 383-393.

De Ver D, Apondi R, Lugada E, Kahn JG, Sandiford-Day MA, Dasbanerjee T (2011) A qualitative assessment of beliefs, attitudes, and behaviors related to diarrhea and water filtration in rural Kenya. *American Journal of Public Health*, 101(8): 1515-1520.

Development Alternatives Inc (2006a) *Action research on point of use drinking water treatment alternatives as appropriate for underprivileged households in Jakarta*. Washington, DC: USAID.

Development Alternatives Inc (2006b) *Formative research report: Hygiene and health*. http://pdf.usaid.gov/pdf_docs/PNADL923.pdf (accessed 12 February 2015).

Devine, J (2010) Beyond tippy-taps: The role of enabling products in scaling up and sustaining handwashing. *Waterlines*, 29: 304-314.

*Devine J, Koita SN (2010) *Senegal: Global Scaling Up Handwashing Project: a handwashing behavior change journey*. New York: World Bank.

Devine J, Peschiera RF (2010) *Peru: A handwashing behavior change journey*. New York: World Bank.

*Devine J, Sijbesma, C (2011) Sustainability of rural sanitation marketing in Vietnam: Findings from a new case study. *Waterlines*, 30(1): 52-60.

*Diallo MO, Hopkins DR, Kane MS, Niandou S, Amadou A, Kadri B, Amza A, Emerson PM, Zingeser JA (2007) Household latrine use, maintenance and acceptability in rural Zinder, Niger. *International Journal of Environmental Health Research*, 17(6): 443-452.

Dobe M, Mandal RN, Jha A (2013) Social determinants of good hand-washing practice (GHP) among adolescents in a rural Indian community. *Family and Community Health*, 36(2): 172-177.

*DuBois AE, Crump JA, Keswick BH, Slutsker L, Quick RE, Vulule JM, Luby SP (2010) Determinants of use of household-level water chlorination products in rural Kenya, 2003-2005. *International Journal of Environmental Research and Public Health,* 7(10): 3842-3852.

*Eder C, Schooley J, Fullerton J, Murguia, J (2012) Assessing impact and sustainability of health, water, and sanitation interventions in Bolivia six years post-project. *Revista Panamericana de Salud Pública*, 32(1): 43-48.

Flanagan SV, Meng X, Zheng Y (2013) Increasing acceptance of chlorination for household water treatment: Observations from Bangladesh. *Waterlines*, 32(2): 125-134.

*Freeman MC, Trinies V, Boisson S, Mak G, Clasen T (2012) Promoting household water treatment through women's self help groups in rural India: Assessing impact on drinking water quality and equity. *PLoS One,* 7(9): e44068.

Fuchs VJ, Mihelcic JR (2011) Analysing appropriateness in sanitation projects in the Alto Beni region of Bolivia. *Waterlines*, 30(2): 122-134.

Govindan B, Sijbesma C, Appleton B (2007) "Hygiene and Health Promotion in Kerala: Actions and Implications." *Local initiatives for better hygiene: Four case studies from Asia*. Delft: IRC International Water and Sanitation Centre.Halperin M, Paz-Soldan VA, Quispe V, Paxton A, Gilman RH (2011) Sustainability of solar disinfection to provide safe drinking water in rural Peru. *Public Health Reports*, 126(5): 762-767.

Heri S, Mosler H-J (2008) Factors affecting the diffusion of solar water disinfection: A field study in Bolivia. *Health Education and Behavior*, 35(4): 541-560.

*Hoque BA, Hoque MM, Ahmed T, Islam S, Azad AK, Ali N, Hossain M, Hossain MS (2004) Demand-based water options for arsenic mitigation: An experience from rural Bangladesh. *Public Health*, 118(1): 70-77.

Huber AC, Mosler HJ (2013a) Determining the differential preferences of users of two fluoride-free water options in rural Ethiopia. *Journal of Public Health,* 21(2): 183-192.

Huber AC, Mosler HJ (2013b) Determining behavioral factors for interventions to increase safe water consumption: A cross-sectional field study in rural Ethiopia. *International Journal of Environmental Health Research*, 23(2): 96-107.

Hulland KR, Leontsini E, Dreibelbis R, Unicomb L, Afroz A, Dutta NC, Nizame FA, Luby SP, Ram PK, Winch PJ (2013) Designing a handwashing station for infrastructure-restricted communities in Bangladesh using the integrated behavioural model for water, sanitation and hygiene interventions (IBM-WASH). *BMC Public Health*, 13(1): 877.

*Inauen J, Hossain MM, Johnston RB, Mosler H-J (2013) Acceptance and use of eight arsenic-safe drinking water options in Bangladesh. *PLoS ONE*, 8(1): e53640.

Jenkins MW, Curtis, V (2005) Achieving the 'good life': Why some people want latrines in rural Benin. *Social Science and Medicine*, 61(11): 2446-2459.

Johnson SM, Peletz RL, Murcott S (2008) Results from household ceramic filter evaluation in northern Ghana. Paper presented at: *33rd WEDC International Conference*, Accra, Ghana.

Kaida L, Sobsey M, Stauber, C (2010) Improving household drinking water quality: Use of biosand filters in Cambodia. http://www.wsp.org/sites/wsp.org/files/publications/WSP_biosand_cambodia.pdf (accessed 12 February 2015).

Kamal A, Sijbesma C, Appleton B (2007) "Testing a Community-managed Approach for Effective Sanitation and Hygiene Education in Natuapura Village in Bangladesh." *Local initiatives for better hygiene: Four case studies from Asia*. Delft: IRC International Water and Sanitation Centre.

Kapur D, Kumar P (2012) Formative research on sanitation and hygiene behaviours: Current status, knowledge, attitudes, barriers and enablers: Primary research findings. Paper presented at: *Asia Regional Sanitation and Hygiene Practitioners Workshop*, Dhaka, Bangladesh, 31 January -2 February.

Katukiza AY, Ronteltap M, Oleja A, Niwagaba CB, Kansiime F, Lens PNL (2010) Selection of sustainable sanitation technologies for urban slums: A case of Bwaise III in Kampala, Uganda. *Science of the Total Environment*, 409(1): 52-62.

Kraemer SM, Mosler HJ (2010) Persuasion factors influencing the decision to use sustainable household water treatment. *International Journal of Environmental Health Research*, 20(1): 61-79.

*Kraemer SM, Mosler HJ (2011) Factors from the transtheoretical model differentiating between solar water disinfection (SODIS) user groups. *Journal of Health Psychology*, 16(1): 126-136.

*Kraemer SM, Mosler, HJ (2012) Effectiveness and effects of promotion strategies for behaviour change: Solar water disinfection in Zimbabwe. *Applied Psychology: An International Review*, 61(3): 392-414.

*Kullmann C, Ahmed, R (2011) *Long term sustainability of improved sanitation in rural Bangladesh: Water and Sanitation Program*. New York: World Bank.

Kwaku Kwashie HB (2009) Motivational orientation of persons managing community water supply and sanitation programmes in the Volta region of Ghana: An empirical study. *Journal of Humanities and Social Sciences,* 3(1): 1-9.

Lenton R, Wright A, Lewis K. UN Millenium Project 2005: Health Dignity and Development: What Will It Take? Task Force on Water and Sanitation. In. London: Earthscan; 2005.

Luoto J, Najnin N, Mahmud M, Albert J, Islam MS, Luby S, Unicomb L, Levine DI (2011) What point-of-use water treatment products do consumers use? Evidence from a randomized controlled trial among the urban poor in Bangladesh. *PloS One,* 6(10): e26132.

Lynch M, West SK, Munoz B, Kayongoya A, Taylor HR, Mmbaga BBO (1994) Testing a participatory strategy to change hygiene behaviour: Face washing in central Tanzania. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 88(5): 513-517.

Makutsa P, Nzaku K, Ogutu P, Barasa P, Ombeki S, Mwaki A, Quick RE (2001) Challenges in implementing a point-of-use water quality intervention in rural Kenya. *American Journal of Public Health*, 91(10): 1571-1573.

*Malebo HM (2012) *Outcome and impact monitoring for scaling up Mtumba sanitation and hygiene participatory approach in Tanzania*. Dar es Salaam, Tanzania: Tanzanian National Institute for Medical Research (NIMR).

Mangoua-Allali ALC, Coulibaly L, Ouattara JMP, Gourene G (2012) Implementation of biosand filters in rural area for drinking water production. *African Journal of Food Science*, 6(24): 574-582.

Mäusezahl D, Christen A, Pacheco GD, Alvarez T, Iriarte M, Zapata ME, Cevallos M, Hattendorf J, Cattaneo MD, Arnold B, Smith TA, Colford Jr JM (2009) Solar drinking water disinfection (SODIS) to reduce childhood diarrhoea in rural Bolivia: A cluster-randomized, controlled trial. *PLoS Medicine*, 6(8): e1000125.

McLennan JD (2000) To boil or not: Drinking water for children in a periurban barrio. *Social Science and Medicine*, 51(8): 1211-1220.

Ministry of Public Health and Sanitation, Kenya (2009) *Are your hands clean enough? Study findings on handwashing with soap behaviour in Kenya*. Nairobi: Water and Sanitation Program Africa Region.

Morgan P, Mekonnen AT (2013) *Paving the way to scaling-up: Factors contributing to the adoption of Eco-San toilets and safety of humanure in Malawi*. London: Department for International Development.

Morshed G, Sobhan A (2010) The search for appropriate latrine solutions for flood-prone areas of Bangladesh. *Waterlines*, 29: 236-245.

Moser S, Mosler HJ (2008) Differences in influence patterns between groups predicting the adoption of a solar disinfection technology for drinking water in Bolivia. *Social Science and Medicine*, 67(4): 497-504.

**Mosler, HJ, Kraemer S (2012) Which psychological factors change when habitual water treatment practices alter? *Journal of Public Health*, 20(1): 71-79.

Mosler HJ, Blochliger OR, Inauen J (2010) Personal, social, and situational factors influencing the consumption of drinking water from arsenic-safe deep tubewells in Bangladesh. *Journal of Environmental Management*, 91(6): 1316-1323.

*Mosler HJ, Kraemer S, Johnston RB (2013) Achieving long-term use of solar water disinfection in Zimbabwe. *Public Health*, 127(1): 92-98.

Muchiri E, Muellegger, E (2009) Operation and maintenance strategies for resource-oriented sanitation systems in Nakuru, Kenya. Paper presented at: *34th WEDC International Conference*, Addis Ababa, Ethiopia.

Mugure A, Mutua BM (2009) Norms, attitudes and gender perspectives in ecological sanitation. Paper presented at: *34th WEDC International Conference*, Addis Ababa, Ethiopia.

Mukherjee N, Josodipoero R (2000) *Is it selling toilets? No, a lifestyle: Learning from communities with sanitation success stories in Indonesia*. New York: World Bank.

Musabayane N (2000) Management of rural drinking water supplies and waste using the participatory hygiene and sanitation transformation (PHAST) initiative in Zimbabwe. *Schriftenreihe des Vereins für Wasser-, Boden- und Lufthygiene*, 105: 81-87.

Nepal Water for Health (2004) *Making latrines user friendly for everyone: An exploratory research study on the discomfort faced by pregnant women, elderly, overweight, sick and disabled people when using squat latrines*. http://www.ircwash.org/sites/default/files/NEWAH-2004-Making.pdf (accessed 12 February 2015).

*Ngai TKK, Shrestha RR, Bipin D, Makhan M, Murcott SE (2007) Design for sustainable development: household drinking water filter for arsenic and pathogen treatment in Nepal. *Journal of Environmental Science and Health: Part A: Toxic Hazardous Substances and Environmental Engineering*, 42(12): 1879-1888.

Nguyen NK (2010) Designing evidence-based communications programs to promote handwashing with soap in Vietnam. Paper presented at: *South Asia Hygiene Practitioners Workshop*, Dhaka, Bangladesh.

Niewoehner J, Afonso JF (1995) *Mid-point internal evaluation of the Niassa Province rural water and sanitation project*. Washington, DC: USAID.

*O'Brien C, Favin M (2012) Four country synthesis of the enabling environment for handwashing with soap: Endline analysis. http://www.wsp.org/sites/wsp.org/files/publications/WSP-HWWS-Four-Country-Enabling-Environment-Endline-Synthesis.pdf (accessed 12 February 2015).

Omotade OO, Kayode CM, Adeyemo AA, Oladepo O (1995) Observations on handwashing practices of mothers and environmental conditions in Ona-Ara Local Government Area of Oyo State, Nigeria. *Journal of Diarrhoeal Diseases Research*, 13(4): 224-228.

Ondieki T, Mbegera M (2009) *Impact assessment report on the PeePoo Bag, Silanga Village, Kibera, Nairobi, Kenya*. Bonn: Deutsche Gesellschaft für Technische Zusammenarbeit.

*Parker AA, Stephenson R, Riley PL, Ombeki S, Komolleh C, Sibley L, Quick R (2006) Sustained high levels of stored drinking water treatment and retention of hand-washing knowledge in rural Kenyan households following a clinic-based intervention. *Epidemiology and Infection*, 134(5): 1029-1036.

*Parker, R (1997) Sustaining rural water systems: The case of Mali. *OED Précis*, 154.

Pattanayak SK, Yang JC, Dickinson KL, Poulos C, Patil SR, Mallick RK, Blitstein JL, Praharaj P (2009) Shame or subsidy revisited: Social mobilization for sanitation in Orissa, India. *Bulletin of the World Health Organization*, 87(8): 580-587.

*Peletz R, Simunyama M, Sarenje K, Baisley K, Filteau S, Kelly P, Clasen T (2012) Assessing water filtration and safe storage in households with young children of HIV-positive mothers: A randomized, controlled trial in Zambia. *PLoS One,* 7(10): e46548.

Pinfold JV, Horan NJ (1996) Measuring the effect of a hygiene behaviour intervention by indicators of behaviour and diarrhoeal disease. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 90(4): 366-371.

PRISMA (2004) Behavioral study of handwashing with soap in peri-urban and rural areas of Peru. http://www.ehproject.org/PDF/Joint_Publications/JP0011E-%20Peru%20Handwashing%20format.pdf (accessed 12 February 2015).

Prokopy SL, Thorsten R, Bakalian A, Wakeman W (2008) Evaluating the role of postconstruction support in sustaining drinking water projects: Evidence from Peru. *Journal of Planning Education and Research*, 27(3): 294-305.

Quick R (2003) Changing community behaviour: Experience from three African countries. *International Journal of Environmental Health Research*, 13: S115-S121.

*Qutub SA, Salam N, Shah K, Anjum D (2008) Subsidy and sustainability in urban sanitation: The case of Quetta Katchi Abadis environment management programme. *Waterlines*, 27(3): 205-223.

Rabbi SE, Dey NC (2013a) Exploring the gap between hand washing knowledge and practices in Bangladesh: A cross-sectional comparative study. *BMC Public Health*, 13: 89.

Rabbi SE, Dey NC (2013b) Impact of BRAC WASH-I programme on hygiene knowledge and practice in rural areas. In BRAC (ed.) *Achievements of BRAC Water, Sanitation and Hygiene Programme towards Millennium Development Goals and Beyond*. Dhaka: BRAC, pages 51-68.

Ramani SV, SadreGhazi S, Duysters G (2012) On the diffusion of toilets as bottom of the pyramid innovation: Lessons from sanitation entrepreneurs. *Technological Forecasting and Social Change*, 79(4): 676-687.

Rao S, Pai M, Iyanar A, Joseph A (1997) Sanitation for rural communities: First win the people's support. *World Health Forum*, 18(3-4): 262-265.

Rodgers AF, Ajono LA, Gyapong JO, Hagan M, Emerson PM (2007) Characteristics of latrine promotion participants and non-participants; inspection of latrines; and perceptions of household latrines in Northern Ghana. *Tropical Medicine and International Health*, 12(6): 772-782.

*Roma E, Buckley C, Jefferson B, Jeffrey P (2010) Assessing users' experience of shared sanitation facilities: A case study of community ablution blocks in Durban, South Africa. *Water SA*, 36(5): 589-594.

*Ross RK, King JD, Damte M, Ayalew F, Gebre T, Cromwell EA, Teferi T, Emerson PM (2011) Evaluation of household latrine coverage in Kewot woreda, Ethiopia, 3 years after implementing interventions to control blinding trachoma. *International Health,* 3(4): 251-258.

Rotondo LA, Ngondi J, Rodgers AF, King JD, Kamissoko Y, Amadou A, Jip N, Cromwell EA, Emerson PM (2009) Evaluation of community intervention with pit latrines for trachoma control in Ghana, Mali, Niger and Nigeria. *International Health,* 1(2): 154-162.

Russell TJE (2008) All people, all access: WATSAN for disabled people in Mali. Paper presented at: *33rd WEDC International Conference*, Accra, Ghana.

Santos AC, Roberts JA, Barreto ML, Cairncross S (2011) Demand for sanitation in Salvador, Brazil: A hybrid choice approach. *Social Science and Medicine*, 72(8): 1325-1332.

Schmidt WP, Aunger R, Coombes Y, Maina PM, Matiko CN, Biran A, Curtis V (2009) Determinants of handwashing practices in Kenya: The role of media exposure, poverty and infrastructure. *Tropical Medicine and International Health*, 14(12): 1534-1541.

Scott B, Curtis V, Rabie T, Garbrah-Aidoo N (2007) Health in our hands, but not in our heads: Understanding hygiene motivation in Ghana. *Health Policy and Planning*, 22(4): 225-233.

Seraj KF bin (2008) *Willingness to pay for improved sanitation services and its implementation on demand responsive approach of BRAC water, sanitation and hygiene programme*. Dhaka: BRAC.

*SEUF (2004) *Sustaining changes in hygiene behaviour: A multi country research: Findings from Kerala study 2001-2004*. The Hague: Socio Economic Unit Foundation.

Shordt, K (2005) Sustainability of hygiene promotion and education. Paper presented at: *30th WEDC International Conference*, Vientiane, Lao PDR.

*Shordt K, Cairncross S (2004) *Sustainability of hygiene behaviour and the effectiveness of change interventions*. Delft: IRC International Water and Sanitation Centre.

Sijbesma C, Truong TX, Devine J (2010) *Research on the sustainability of rural sanitation marketing in Vietnam*. Water and Sanitation Program learning note. New York: World Bank.

Sijbesma C, Sikoki B, Suriastini W, Ponsonby M (2011a) Methodological lessons and findings from an impact evaluation of a WASH project in Indonesia. Paper presented at: *The future of water, sanitation and hygiene in low-income countries: Innovation, adaptation and engagement in a changing world: 35th WEDC international conference*, Loughborough.

Sijbesma C, Truong TX, Devine J (2011b) *Research on the sustainability of rural sanitation marketing in Vietnam*. Water and Sanitation Program. New York: World Bank.

*Simms VM, Makalo P, Bailey RL, Emerson PM (2005) Sustainability and acceptability of latrine provision in The Gambia. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 99(8): 631-637.

Sultana R, Mondal UK, Rimi NA, Unicomb L, Winch PJ, Nahar N, Luby SP (2013) An improved tool for household faeces management in rural Bangladeshi communities. *Tropical Medicine and International Health*, 18(7): 854-860.

*Tamas A, Mosler HJ (2011) Why do people stop treating contaminated drinking water with solar water disinfection (SODIS)? *Health Education and Behavior*, 38(4): 357-366.

*Tamas A, Tobias R, Mosler, HJ (2009) Promotion of solar water disinfection: Comparing the effectiveness of different strategies in a longitudinal field study in Bolivia. *Health Communication*, 24(8): 711-722.

Torres MP, Gavin J, Kleinau E, Johnson E, Post M, Kolesar R, Gil C, Cruz V de la, Cordero F (2004) *Combining hygiene behavior change with water and sanitation: Monitoring progress in Hato Mayor, Dominican Republic, Activity Report 125(April 2000-May2002)*. Arlington, VA: Environmental Health Project.

Unicef (2008) *Sanitation, hygiene and water supply (GOB-UNICEF) health impact study: Baseline survey results: Final report*. http://www.unicef.org/bangladesh/Health_impact_study.pdf (accessed 13 February 2015).

USAID (2008) *Safe Drinking Water Alliance: Experiences in Haiti, Ethiopia, and Pakistan: Lessons for future water treatment programs*. Washington, DC: USAID, Global Development Alliance.

Water and Sanitation Program (2007) *Are Ugandans' hands clean enough? Summary findings of a formative and baseline survey on handwashing with soap*. Washington, DC: Water and Sanitation Program Africa Region, Nairobi.

Water and Sanitation Program (2011) Tanzania: A handwashing behavior change journey. http://www.wsp.org/sites/wsp.org/files/publications/WSP-Tanzania-Behavior-Change-Journey-HWWS.pdf (accessed 13 February 2015).

Water and Sanitation Program (2012) *Behavioral determinants of handwashing with soap among mothers and caretakers: Emergent learning from Senegal and Peru*. http://www.wsp.org/sites/wsp.org/files/publications/WSP-Behavioral-Determinants-Handwashing-With-Soap.pdf (accessed 13 February 2015).

WaterAid Nepal (2011) *People's perceptions of sanitation: report findings from Nepal*. Lalitpur: WaterAid in Nepal.

WaterAid Australia (2011) *Sustainability of WaterAid projects in Timor-Leste: Annual GMF Report 2011*. Dili, Timor-Leste: WaterAid Australia.

*Waterkeyn J, Cairncross S (2005) Creating demand for sanitation and hygiene through community health clubs: A cost-effective intervention in two districts in Zimbabwe. *Social Science and Medicine*, 61(9): 1958-1970.

*Whaley L, Webster J (2011) The effectiveness and sustainability of two demand-driven sanitation and hygiene approaches in Zimbabwe. *Journal of Water Sanitation and Hygiene for Development*, 1(1): 20-36.

*Wheeler J, Agha S (2013) Use of Certeza point-of-use water treatment product in Mozambique. *Journal of Water Sanitation and Hygiene for Development*, 3(3): 341-348.

Whiteford L, Laspina C, Torres M (1996) *Monitoring the effect of behavior change activities on cholera: A review in Chimborazo and Cotopaxi, Ecuador*. Arlington, VA: Camp Dresser and McKee International Environmental Health Project.

Wicken J, Verhagen J, Sijbesma C, Silva C da, Ryan P (eds) (2008) *Beyond construction: Use by all: A collection of case studies from sanitation and hygiene promotion practitioners in South Asia*. London: WaterAid.

*Wilson JM, Chandler GN (1993) Sustained improvements in hygiene behaviour amongst village women in Lombok, Indonesia. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 87(6): 615-616.

*Wood S, Foster J, Kols A (2012) Understanding why women adopt and sustain home water treatment: Insights from the Malawi antenatal care program. *Social Science and Medicine*, 75(4): 634-642.

World Bank (2005) *Lessons learned from Bangladesh, India, and Pakistan: Scaling-up rural sanitation in South Asia*. Washington, DC: World Bank.

Yeager BAC, Huttly SRA, Diaz J, Bartolini R, Marin M, Lanata CF (2002) An intervention for the promotion of hygienic feces disposal behaviors in a shanty town of Lima, Peru. *Health Education Research*, 17(6): 761-773.

6.2 Other references used in the text of the technical report

Ajzen I (1991) The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50: 179-211.

Aledort J, Lurie N, Wasserman J, Bozzette S (2007) Non-pharmaceutical public health interventions for pandemic influenza: An evaluation of the evidence base. *BMC Public Health*, 7(1): 208.

Amonker RG, Brinker GD (1997) Determinants of infant and child mortality in India. *International Review of Modern Sociology*, 27(2): 1-22.

Andrews BR (1903) Habit. *The American Journal of Psychology*, 14(2): 121-149.

Arksey H, O'Malley L (2005) Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, 8(1): 19-32.

Arnold B, Colford J (2007) Treating water with chlorine at point-of-use to improve water quality and reduce child diarrhea in developing countries: A systematic review and meta-analysis. *American Journal of Tropical Medicine and Hygiene*, 76(2): 354-364.

Arnold BF, Null C, Luby SP, Unicomb L, Stewart CP, Dewey KG, Ahmed T, Ashraf S, Christensen G, Clasen T, Dentz HN, Fernald LC, Haque R, Hubbard AE, Kariger P, Leontsini E, Lin A, Njenga SM, Pickering AJ, Ram PK, Tofail F, Winch PJ, Colford JM Jr (2013) Cluster-randomised controlled trials of individual and combined water, sanitation, hygiene and nutritional interventions in rural Bangladesh and Kenya: the WASH Benefits study design and rationale. *BMJ Open*, 3(8): e003476.

Bain RE, Gundry SW, Wright JA, Yang H, Pedley S, Bartram JK (2012) Accounting for water quality in monitoring access to safe drinking-water as part of the millennium development goals: Lessons from five countries. *Bulletin of the World Health Organization*, 90: 228-235.

Bandura A (1989) Human agency in social cognitive theory. *American Psychologist*, 44(9):1175-1184.

Becker MH, Maiman LA, Kirscht JP, Haefner DP, Drachman RH (1977) The health belief model and prediction of dietary compliance: A field experiment. *Journal of Health and Social Behavior*, 18(4): 348-366.

Beede DN, Bloom DE (1995) The economics of municipal solid waste. *The World Bank Research Observer*, 10(2): 113-150.

Bhutta ZA, Gupta I, de'Silva H, Manandhar D, Awasthi S, Hossain SM, Salam MA (2004) Maternal and child health: Is South Asia ready for change? *BMJ: British Medical Journal*, 328(7443): 816-819.

Black RE, Cousens S, Johnson HL, Lawn JE, Rudan I, Bassani DG, Jha P, Campbell H, Walker CF, Cibulskis R, Eisele T, Liu L, Mathers C (2010) Global, regional, and national causes of child mortality in 2008: A systematic analysis. *Lancet*, 375(9730): 1969-1987.

Bloom DE (1995) International public opinion on the environment. *Science,* 269(5222): 354-358.

Blowfield M (1999) Ethical trade: A review of developments and issues. *Third World Quarterly*, 20(4): 753-770.

Borroto RJ (1998) Global warming, rising sea level, and growing risk of cholera incidence: A review of the literature and evidence. *GeoJournal*, 44(2): 111-120.

Brühl C, Crutzen PJ (1990)Ozone and climate changes in the light of the Montreal Protocol: A model study. *Ambio*, 19(6/7): 293-301.

Brack D (1995) Balancing trade and the environment. *International Affairs*, 71(3): 497-514.

Britto PR, Ulkuer N (2012) Child development in developing countries: Child rights and policy implications. *Child Development*, 83(1): 92-103.

Brody JG, Rudel R, Maxwell NI, Swedis SR. Mapping out a Search for Environmental Causes of Breast Cancer. Public Health Reports (1974-) 1996;111(6):494-507.

Brown J, Clasen T (2012) High adherence is necessary to realize health gains from water quality interventions. *PLoS ONE*, 7(5): e36735.

Cairncross S, Hunt C, Boisson S, Bostoen K, Curtis V, Fung IC, Schmidt WP (2010) Water, sanitation and hygiene for the prevention of diarrhoea. International Journal of Epidemiology, 39(Suppl. 1): i193-205.

Carroll C, Booth A, Cooper K. A worked example of "best fit" framework synthesis: A systematic review of views concerning the taking of some potential chemopreventive agents. BMC Medical Research Methodology 2011;11(1):29.

Centers for Disease Control (2014) The safe water system: Household water treatment. http://www.cdc.gov/safewater/household-water.html (accessed 20 February 2015).

Cialdini RB, Reno RR, Kallgren CA (1990) A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology,* 58(6): 1015-1026.

Clasen T, Boisson S. 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 2006;1(02).

Clasen T, Schmidt WP, Rabie T, Roberts I, Cairncross S (2007) Interventions to improve water quality for preventing diarrhoea: Systematic review and meta-analysis. *BMJ*, 334(7597): 782.

Clasen TF, Bostoen K, Schmidt WP, Boisson S, Fung IC, Jenkins MW, Scott B, Sugden S, Cairncross S (2010) Interventions to improve disposal of human excreta for preventing diarrhoea. *Cochrane Database of Systematic Reviews*, 2010(6): CD007180.

Higgins J, Green S (eds) (2011) *Cochrane Handbook for Systematic Reviews of Interventions,* Version 5.1.0. http://community.cochrane.org/handbook (accessed 20 February 2015).

Coombes Y, Devine J (2010) Introducing FOAM: A framework to analyze handwashing behaviors to design effective handwashing programs.

http://www.wsp.org/sites/wsp.org/files/publications/WSP_IntroducingFOAM_HWWS.pdf (accessed 20 February 2015).

Curtis V, Cousens S, Mertens T, Traore E, Kanki B, Diallo I (1993) Structured observations of hygiene behaviours in Burkina Faso: Validity, variability, and utility. *Bulletin of the World Health Organization*, 71(1)23-32.

Davidoff F, Florance V (2000) The Informationist: A new health profession*? Annals of Internal Medicine*, 132(12): 996-998.

Devine J (2009*) Introducing SaniFOAM: A framework to analyze sanitation behaviors to design effective sanitation programs*. New York: WSP.

Dore MHI (2005) Climate change and changes in global precipitation patterns: What do we know? *Environment International*, 31(8): 1167-1181.

Dreibelbis R, Winch PJ, Leontsini E, Hulland KR, Ram PK, Unicomb L, Luby SP (2013) The Integrated Behavioural Model for Water, Sanitation, and Hygiene: a systematic review of behavioural models and a framework for designing and evaluating behaviour change interventions in infrastructure-restricted settings. *BMC Public Health*, 13: 1015.

Dunkle SE, Mba-Jonas A, Loharikar A, Fouché B, Peck M, Ayers T, Archer WR, De Rochars VM, Bender T, Moffett DB, Tappero JW, Dahourou G, Roels T, Quick R (2011) Epidemic cholera in a crowded urban environment, Port-au-Prince, Haiti. *Emerging Infectious Diseases*, 17(11): 2143-2146.

Edmond K, Zaidi A (2010) New approaches to preventing, diagnosing, and treating neonatal sepsis. *PLoS Medicine*, 7(3): e1000213.

Engell RE, Lim SS (2013) Does clean water matter? An updated meta-analysis of water supply and sanitation interventions and diarrhoeal diseases. *The Lancet*, 381: S44.

Enger KS, Nelson KL, Clasen T, Rose JB, Eisenberg JNS (2012) Linking quantitative microbial risk assessment and epidemiological data: Informing safe drinking water trials in developing countries. *Environmental Science and Technology*, 46(9): 5160-5167.

Enger KS, Nelson KL, Rose JB, Eisenberg JNS (2013) The joint effects of efficacy and compliance: A study of household water treatment effectiveness against childhood diarrhea. *Water Research*, 47(3): 1181-1190.

English R (2010) *Consumer behaviour*. San Diego: San Diego State University.

Esrey SA, Potash JB, Roberts L, Shiff C (1991) Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bulletin of the World Health Organization*, 69(5): 609-621.

Fewtrell L, Kaufmann RB, Kay D, Enanoria W, Haller L, Colford JM, Jr (2005) Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. Lancet Infectious Diseases, 5(1): 42-52.

Figueroa ME, Kincaid DL (2010) Social, cultural, and behavioral correlates of household water treatment and storage. Baltimore: Johns Hopkins Bloomberg School of Public Health, Center for Communication Programs.

Fishbein M, Ajzen I (1975) *Belief, attitude, intention, and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Freeman MC, Stocks ME, Cumming O, Jeandron A, Higgins JPT, Wolf J Prüss-Ustün A, Bonjour S, Hunter PR, Fewtrell L, Curtis V (2014) Systematic review: Hygiene and health: Systematic review of handwashing practices worldwide and update of health effects. *Tropical Medicine and International Health*, 19(8): 906-916.

Gleick PH (1998) The human right to water. *Water Policy*, 1(5): 487-503.

Haas JP, Larson EL (2007) Measurement of compliance with hand hygiene. *Journal of Hospital Infection*, 66(1): 6-14.

Harden A, Thomas J (2005) Methodological issues in combining diverse study types in systematic reviews. *International Journal of Social Research Methodology*, 8(3): 257-271.

Hunt P (2006) The human right to the highest attainable standard of health: New opportunities and challenges. *Transactions of The Royal Society of Tropical Medicine and Hygiene*, 100(7): 603-607.

Hunter PR (2009) Household water treatment in developing countries: Comparing different intervention types using meta-regression. *Environmental Science and Technology*, 43(23): 8991-8997.

Iyer P, Sara J, Curtis V, Scott B, Cardosi J (2005) *The handwashing handbook: A guide for developing a hygiene promotion program to increase handwashing with soap*. Washington, DC: World Bank.

Janz NK, Becker MH (1984) The Health Belief Model: A decade later. Health Education Quarterly, 11(1): 1-47.

Jenner EA, Fletcher B, Watson P, Jones FA, Miller L, Scott GM (2006) Discrepancy between self-reported and observed hand hygiene behaviour in healthcare professionals. *Journal of Hospital Infection*, 63(4): 418-422.

Kallgren CA, Reno RR, Cialdini RB. A Focus Theory of Normative Conduct: When Norms Do and Do not Affect Behavior. Personality and Social Psychology Bulletin 2000, 26(8): 1002-1012.

Keusch GT, Rosenberg IH, Denno DM, Duggan C, Guerrant RL, Lavery JV Tarr PI, Ward HD, Black RE, Nataro JP, Ryan ET, Bhutta ZA, Coovadia H, Lima A, Ramakrishna B, Zaidi AK, Burgess DC, Brewer T (2013) Implications of acquired environmental enteric dysfunction for growth and stunting in infants and children living in low- and middle-income countries. *Food and Nutrition Bulletin*, 34(3): 357-365.

Kleinau E, Pyle DF (2004) Assessing hygiene improvement guidelines for household and community levels. http://ec.europa.eu/echo/files/evaluation/watsan2005/annex_files/EHP/EHP1%20-%20Assessing%20hygiene%20improvement.pdf (accessed 20 February 2015).

Korpe PS, Petri WA (2012) Environmental enteropathy: critical implications of a poorly understood condition. *Trends in Molecular Medicine*, 18(6): 328-336.

Lin A, Arnold BF, Afreen S, Goto R, Huda TMN, Haque R Raqib R, Unicomb L, Ahmed T, Colford JM Jr, Luby SP (2013) Household environmental conditions are associated with enteropathy and impaired growth in rural Bangladesh. *The American Journal of Tropical Medicine and Hygiene*, 89(1): 130-137.

Luby SP, Agboatwalla M, Bowen A, Kenah E, Sharker Y, Hoekstra RM (2009) Difficulties in maintaining improved handwashing behavior, Karachi, Pakistan. *American Journal of Tropical Medicine and Hygiene*, 81: 140–145.

Mahamud AS, Ahmed JA, Nyoka R, Auko E, Kahi V, Ndirangu J, Nguhi, M, Burton JW, Muhindo BZ, Breiman RF, Eidex RB (2012) Epidemic cholera in Kakuma Refugee Camp, Kenya, 2009: The importance of sanitation and soap. *Journal of Infection in Developing Countries*, 6(3): 234-241.

Meierhofer R, Landolt G (2009) Factors supporting the sustained use of solar water disinfection: Experiences from a global promotion and dissemination programme. *Desalination*, 248(1): 144-151.

Mosler H-J (2012) A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: A conceptual model, a review, and a guideline. *International Journal of Environmental Health Research*, 22(5): 431-449.

Neuman L (1997) *Social research methods: Qualitative and quantitative approaches*. 3rd. ed. Needham Heights, MA: Allyn and Bacon.

Ngai TKK, Shrestha RR, Dangol B, Maharjan M, Murcott SE (2007) Design for sustainable development: Household drinking water filter for arsenic and pathogen treatment in Nepal. *Journal of Environmental Science and Health, Part A*, 42(12): 1879-1888.

Ngure FM, Reid BM, Humphrey JH, Mbuya MN, Pelto G, Stoltzfus RJ (2014) Water, sanitation, and hygiene (WASH), environmental enteropathy, nutrition, and early child development: Making the links. *Annals of the New York Academy of Sciences*, 1308(1): 118-128.

Parker FA, Person B, Quick RE, Vindigni SM, Jhung M, Bowen A, Riley PL (2012) Systematic review of behavior change research on point-of-use water treatment interventions in countries categorized as low- to medium-development on the human development index. *Social Science and Medicine* 75(4): 622-633.

Pearson J, McPhedran K (2008) A literature review of the non-health impacts of sanitation. *Waterlines*, 27(1): 48-61.

Petty RE, Cacioppo JT (1986) The elaboration likelihood model of persuasion. *Advances in Experimental Social Psychology*, 19: 123-205.

Plutchak TS (2000) Informationists and librarians. *Bulletin of the Medical Library Association*, 88(4): 391-392.

Prochaska JO, DiClemente CC (1983) Stages and processes of self-change of smoking: toward an integrative model of change. *Journal of Consulting and Clinical Psychology*, 51(3): 390-395.

Ram PK, Halder AK, Granger SP, Jones T, Hall P, Hitchcock D et al., (2010) Is Structured observation a valid technique to measure handwashing behavior? Use of acceleration sensors embedded in soap to assess reactivity to structured observation. *The American Journal of Tropical Medicine and Hygiene*, 83(5): 1070-1076.

Rogers EM (2003) *Diffusion of innovations*. 5th ed. New York: Free Press,.

Scanlon BR, Keese KE, Flint AL, Flint LE, Gaye CB, Edmunds WM, Simmers I (2006) Global synthesis of groundwater recharge in semiarid and arid regions. *Hydrological Processes*, 20(15): 3335-3370.

Shafiquzzaman M, Azam MS, Nakajima J, Bari QH (2011) Investigation of arsenic removal performance by a simple iron removal ceramic filter in rural households of Bangladesh. *Desalination*, 265(1–3): 60-66.

Sheppard BH, Jon H, Warshaw PR (1988) The theory of reasoned action: A meta-analysis of past research with recommendations for modifications and future research. *Journal of Consumer Research*, 15(3): 325-343.

Sobsey MD, Stauber CE, Casanova LM, Brown JM, Elliott MA (2008) Point of use household drinking water filtration: A practical, effective solution for providing sustained access to safe drinking water in the developing world. *Environmental Science and Technology*, 42(12): 4261-4267.

Sorenson SB, Morssink C, Campos PA (2011) Safe access to safe water in low income countries: Water fetching in current times. *Social Science and Medicine*, 72(9): 1522-1526.

Stanton BF, Clemens JD, Aziz KM, Rahman M (1987) Twenty-four-hour recall, knowledge-attitude-practice questionnaires, and direct observations of sanitary practices: A comparative study. *Bulletin of the World Health Organization*, 65(2): 217-22.

Tappero JW, Tauxe RV (2011) Lessons learned during public health response to cholera epidemic in Haiti and the Dominican Republic. *Emerging Infectious Diseases*, 17(11): 2087.

Taylor RG, Scanlon B, Doll P, Rodell M, van Beek R, Wada Y, Longuevergne L, Leblanc M, Famiglietti JS, Edmunds M, Konikow L, Green TR, Chen J, Taniguchi M, Bierkens MFP, MacDonald A, Fan Y, Maxwell RM Yechieli Y, Gurdak TJ, Allen DM, Shamsudduha M, Hiscock K, Yeh PJF, Holman I, Treidel H (2013) Ground water and climate change. *Nature: Climate Change*, 3(4): 322-329.

Thomas J, Harden A. Methods for the thematic synthesis of qualitative research in systematic reviews. BMC Medical Research Methodology 2008;8(1):45

van Dillen J, Zwart J, Schutte J, van Roosmalen J (2010) Maternal sepsis: Epidemiology, etiology and outcome. *Current Opinion in Infectious Diseases*, 23(3): 249-254.

Vergnano S, Sharland M, Kazembe P, Mwansambo C, Heath P (2005) Neonatal sepsis: An international perspective. *Archives of Disease in Childhood: Fetal and Neonatal Edition*, 90(3): F220-FF224.

Vindigni SM, Riley PL, Jhung M (2011) Systematic review: Handwashing behaviour in low-to middle-income countries: outcome measures and behaviour maintenance. *Tropical Medicine and International Health*, 16(4): 466-477.

Waddington H, Snilstveit B, White H, Fewtrell L (2009) *Water, sanitation and hygiene interventions to combat childhood diarrhoea in developing countries*. New Delhi: International Initiative for Impact Evaluation.

Walker CLF, Rudan I, Liu L, Nair H, Theodoratou E, Bhutta ZA, O'Brien KL, Campbell H, Black RE (2013) Global burden of childhood pneumonia and diarrhoea. *The Lancet*, 381(9875): 1405-1416.

Watt J (1988) The Tippy Tap: A simple handwashing device for rural areas. *Journal of Tropical Pediatrics*, 34(2): 91-92.

WHO (2011) *Guidelines for drinking water quality*. Geneva: World Health Organization.

WHO and UNICEF (2014) *Progress on drinking water and sanitation*: 2014 update. Geneva: World Health Organization.

Wilby RL, Dessai S (2010) Robust adaptation to climate change. *Weather*, 65(7): 180-185.

Wolf J, Prüss-Ustün A, Cumming O, Bartram J, Bonjour S, Cairncross S et al., (2014) Assessing the impact of drinking water and sanitation on diarrhoeal disease in low- and middle-income settings: Systematic review and meta-regression. *Tropical Medicine and International Health*, 19(8): 928-942.

Wood S, Foster J, Kols A (2012) Understanding why women adopt and sustain home water treatment: Insights from the Malawi antenatal care program. *Social Science and Medicine*, 75(4): 634-642.

Wood W, Quinn JM, Kashy DA (2002) Habits in everyday life: Thought, emotion, and action. *Journal of Personality and Social Psychology*, 83(6): 1281-1297.

Appendices

Appendix 1: Authorship of this report

Details of Advisory Group membership

Tom Clasen, London School of Hygiene and Tropical Medicine (LSHTM)

Rob Quick, Centers for Disease Control and Prevention (CDC)

Julia Rosenbaum, FHI360

Almud Weitz, World Bank's Water and Sanitation Programme (WSP)

Details of Review Group membership

Kristyna Hulland, Department of International Health, The Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Robert Dreibelbis, School of Civil Engineering and Environmental Science and Department of Anthropology, Oklahoma University, Norman, Oklahoma, USA

Julia DeBruicker Valliant, Department of International Health, The Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Luke MacDonald, Department of Environmental Health, The Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Farhana Sultana, International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b), Dhaka, Bangladesh

Kellogg Schwab, Department of Environmental Health, The Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Peter Winch, Department of International Health, Social and Behavioral Interventions Program, The Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Contact details

kristynasolawetz@gmail.com, +1 203-609-3960

This report should be cited as:

Hulland K, Martin N, Dreibelbis R, DeBruicker Valliant J, Winch P (2015) *What factors affect sustained adoption of safe water, hygiene and sanitation technologies? A systematic review of literature*. London: EPPI-Centre, Social Science Research Unit, UCL Institute of Education, University College London.

ISBN: 978-1-907345-77-7

Acknowledgements

We would like to thank several individuals who have contributed to the success of this report, including Peggy Gross and the informationists at Welch Medical Libraries for their guidance in the design and conduct of the search strategy. We thank Luke MacDonald and Kellogg Schwabb for their assistance in the development and implementation of the protocol.

We also acknowledge the work of Nina Martin, Andrew Andrada, Meg Glancey and Farhana Sultana for their participation in data collection and management as well as colleagues at icddr,b for administrative support for our collaboration.

We wish to thank Caitlin Kennedy and Virginia Fonner for their guidance on the systematic review process.

Conflicts of interest

The authors declare no conflicts of interests.

Funding

Funding for this report was provided by 3ie.

Appendix 2: Search strategy in electronic databases for three concepts captured in the review

Concept 1 WASH Terms	**1A - WASH specific terminology** “toilet facilities” [mesh] OR “sewage” [mesh] OR “sewage” [tiab] OR “latrines”[tiab] OR “latrine”[tiab] OR “toilets”[tiab] OR “toilet”[tiab] OR “ecosan”[tiab] OR “biogas”[tiab] OR “sewer”[tiab] OR “sewers”[tiab] OR “waste management”[tiab] OR “waste management”[mesh] OR “hygiene”[mesh] OR “hygiene”[tiab] OR “hand washing”[tiab] OR “handwashing”[tiab] OR “hand disinfection”[mesh] OR “soap”[tiab] OR “soaps”[mesh] OR "tippy taps"[text word] OR “drinkwater”[tiab] OR “hand cleansing”[tiab] OR “handscrubbing”[tiab] OR “hand scrubbing”[tiab] OR “sanitation”[tiab] OR “sanitation”[mesh] OR “sanitizer”[tiab] OR “sanitiser”[tiab] OR “sanitary”[tiab] OR “sanitary engineering”[mesh] OR “excreta”[tiab] OR “feces”[tiab] OR “faeces”[tiab] OR “waste disposal”[tiab] OR “wastewater treatment” OR "water treated"[tiab] OR "treated water"[tiab] OR "Water Quality"[Mesh] OR “water purification”[mesh] OR “water supply”[mesh] OR "Water Quality"[tiab] OR “water purification”[tiab] OR “water supply”[tiab] OR "water treatment"[tiab] OR “point of use water”[tiab] OR
	1B - Terms combined with water terminology (“disinfection”[tiab] OR “disinfecting”[tiab] OR "Disinfectants"[Mesh] OR "Disinfectants"[tiab] OR "Disinfectant"[tiab] OR "Disinfection"[Mesh] OR “disinfection”[tiab] OR “sterilization”[tiab] OR “sterilisation”[tiab] OR "kiosk”[tiab] OR "kiosks”[tiab] OR “truck”[tiab] OR “trucks”[tiab] OR "boil”[tiab] OR "boiling”[tiab] OR “untreated”[tiab] OR “standpipes” OR "systems”[tiab] OR "system”[tiab] OR "systems”[tiab] OR "purification”[tiab] OR “treatment”[tiab] OR "treated"[tiab] OR “storage”[tiab] OR “safe”[tiab] OR “contamination”[tiab] OR “contaminated”[tiab] OR “microbiology”[tiab] OR “quality”[tiab] OR “quantity”[tiab] OR “improved”[tiab] OR “drinking”[tiab] OR “storage”[tiab] OR “source”[tiab] OR “supplies”[tiab] OR “inactivation”[tiab] OR “point of use”[tiab] OR “filtration”[tiab] OR “filter”[tiab] OR “filters”[tiab] OR “filtering”[tiab] OR “flocculation”[tiab] OR “SODIS”[tiab] OR "Environmental health"[tiab] OR "access"[tiab] OR "resources"[tiab] OR "Sanitary engineering"[tiab] OR “potable”[tiab] OR "distribution”[tiab] OR “management”[tiab] OR “chlorine”[tiab] OR “chlorination”[tiab] OR “filtration”[tiab] OR filter*[tiab] OR "sodium hypochlorite"[MeSH Terms] OR “sodium hypochlorite”[tiab] OR “Moringa oleifera seeds”[tiab] OR “Moringa oleifera seed”[tiab] OR "troclosene" [Supplementary Concept] OR “aquatabs”[tiab] OR “tubewells”[tiab] OR “tubewell”[tiab] OR “tube wells”[tiab] OR “tube well”[tiab] OR “tube wells”[tiab] OR “borewell”[tiab] OR “bore well”[tiab] OR “borewells”[tiab] OR “bore wells”[tiab] OR “biofilter”[tiab] OR “biofilters”[tiab] OR “catchment”[tiab] OR “hypochlorite sodium”[tiab]) AND ("Drinking Water"[Mesh] OR "Fresh Water"[Mesh] OR "water"[mesh:noexp] OR “water purification”[mesh] OR “water supply”[mesh] OR "Water Quality"[Mesh] OR water[tiab]))

Concept 2 Adoption/ Behaviour Terms	**Behaviour change terms** (“adaptive behaviour”[Tiab] OR “adaptive behaviour”[tiab] OR "adaptation, psychological"[MeSH Terms] OR “Adaptation”[tiab] OR “Adoption”[tiab] OR “Adopting”[tiab] OR "rejection"[tiab] OR "rejecting"[tiab] OR "facilitating"[tiab] OR "facilitate"[tiab] OR "facilitates"[tiab] OR "facilitator"[tiab] OR "facilitators"[tiab] OR “behaviour”[Tiab] OR “behaviours”[Tiab] OR “behavioural”[Tiab] OR “behaviour"[Tiab] OR “behaviours"[Tiab] OR “behavioural"[Tiab] OR "behaviour"[MeSH Terms] OR “coping”[tiab] OR “uptake”[tiab] OR “practices”[tiab] OR “practice”[tiab] OR “determinants”[tiab] OR “usability”[tiab] OR “feasibility”[tiab] OR “adherence”[tiab] OR “sustainability”[tiab] OR “sustain”[tiab] OR “sustained”[tiab] OR “attitude”[MeSH] OR “attitude”[tiab] OR “attitudes”[tiab] OR "psychology"[tiab] OR "psychological"[tiab] OR "psychosocial"[tiab] OR "sociological"[tiab] OR change[tiab] OR "social factors"[tiab] OR "sociocultural"[tiab] OR "socio cultural"[tiab] OR "Decision-making"[tiab] OR "Decision making"[tiab] OR "Decision making"[MeSH] OR "implementing"[tiab] OR “Motivation”[MeSH] OR "Motivation"[tiab] OR "Motivations"[tiab] OR "influences"[tiab] OR "influence"[tiab] OR "predictor"[tiab] OR "predictors"[tiab] OR "participation"[tiab] OR “behaviour and behaviour mechanisms”[MeSH] OR “adaptations”[tiab] OR “observance”[tiab] OR “conformity”[tiab] OR "compliance"[tiab] OR "diffusion"[tiab] OR "process evaluation"[tiab]))
Concept 3 LMIC Terms	**Lower and Middle Income Countries (LMIC) terminology** ("developing country"[tiab] OR "developing countries"[tiab] OR "developing nation"[tiab] OR "developing nations"[tiab] OR "developing population"[tiab] OR "developing populations"[tiab] OR "developing world"[tiab] OR "less developed country"[tiab] OR "less developed countries"[tiab] OR "less developed nation"[tiab] OR "less developed nations"[tiab] OR "less developed population"[tiab] OR "less developed populations"[tiab] OR "less developed world"[tiab] OR "lesser developed country"[tiab] OR "lesser developed countries"[tiab] OR "lesser developed nation"[tiab] OR "lesser developed nations"[tiab] OR "lesser developed population"[tiab] OR "lesser developed populations"[tiab] OR "lesser developed world"[tiab] OR "under developed country"[tiab] OR "under developed countries"[tiab] OR "under developed nation"[tiab] OR "under developed nations"[tiab] OR "under developed population"[tiab] OR "under developed populations"[tiab] OR "under developed world"[tiab] OR "underdeveloped country"[tiab] OR "underdeveloped countries"[tiab] OR "underdeveloped nation"[tiab] OR "underdeveloped nations"[tiab] OR "underdeveloped population"[tiab] OR "underdeveloped populations"[tiab] OR "underdeveloped world"[tiab] OR "middle income country"[tiab] OR "middle income countries"[tiab] OR "middle income nation"[tiab] OR "middle income nations"[tiab] OR "middle income population"[tiab] OR "middle income populations"[tiab] OR "low income country"[tiab] OR "low income countries"[tiab] OR "low income nation"[tiab] OR "low income nations"[tiab] OR "low income population"[tiab] OR "low income populations"[tiab] OR "lower income country"[tiab] OR "lower income countries"[tiab] OR "lower income nation"[tiab] OR "lower income nations"[tiab] OR "lower income population"[tiab] OR "lower income populations"[tiab] OR "underserved country"[tiab] OR "underserved countries"[tiab] OR "underserved nation"[tiab] OR "underserved nations"[tiab] OR "underserved population"[tiab] OR "underserved populations"[tiab] OR "underserved world"[tiab] OR "under served country"[tiab] OR "under served countries"[tiab] OR "under served nation"[tiab] OR "under served nations"[tiab] OR "under served population"[tiab] OR "under served populations"[tiab] OR "under served world"[tiab] OR "deprived country"[tiab] OR "deprived countries"[tiab] OR "deprived nation"[tiab] OR "deprived nations"[tiab] OR "deprived population"[tiab] OR "deprived populations"[tiab] OR "deprived world"[tiab] OR "poor country"[tiab] OR "poor countries"[tiab] OR "poor nation"[tiab] OR "poor nations"[tiab] OR "poor population"[tiab] OR "poor populations"[tiab] OR "poor world"[tiab] OR "poorer country"[tiab] OR "poorer countries"[tiab] OR "poorer nation"[tiab] OR "poorer nations"[tiab] OR "poorer

	population"[tiab] OR "poorer populations"[tiab] OR "poorer world"[tiab] OR "developing economy"[tiab] OR "developing economies"[tiab] OR "less developed economy"[tiab] OR "less developed economies"[tiab] OR "lesser developed economy"[tiab] OR "lesser developed economies"[tiab] OR "under developed economy"[tiab] OR "under developed economies"[tiab] OR "underdeveloped economy"[tiab] OR "underdeveloped economies"[tiab] OR "middle income economy"[tiab] OR "middle income economies"[tiab] OR "low income economy"[tiab] OR "low income economies"[tiab] OR "lower income economy"[tiab] OR "lower income economies"[tiab] OR "low gdp"[tiab] OR "low gnp"[tiab] OR "low gross domestic"[tiab] OR "low gross national"[tiab] OR "lower gdp"[tiab] OR "lower gnp"[tiab] OR "lower gross domestic"[tiab] OR "lower gross national"[tiab] OR lmic[tiab] OR lmics[tiab] OR "third world"[tiab] OR "lami country"[tiab] OR "lami countries"[tiab] OR "transitional country"[tiab] OR "transitional countries"[tiab] OR Africa[tiab] OR Asia[tiab] OR Caribbean[tiab] OR “West Indies”[tiab] OR “South America”[tiab] OR “Latin America”[tiab] OR “Central America”[tiab] OR "Atlantic Islands"[tiab] OR "Commonwealth of Independent States"[tiab] OR "Pacific Islands"[tiab] OR "Indian Ocean Islands"[tiab] OR "Eastern Europe"[tiab] OR Afghanistan[tiab] OR Albania[tiab] OR Algeria[tiab] OR Angola[tiab] OR Antigua[tiab] OR Barbuda[tiab] OR Argentina[tiab] OR Armenia[tiab] OR Armenian[tiab] OR Aruba[tiab] OR Azerbaijan[tiab] OR Bahrain[tiab] OR Bangladesh[tiab] OR Barbados[tiab] OR Benin[tiab] OR Byelarus[tiab] OR Byelorussian[tiab] OR Belarus[tiab] OR Belorussian[tiab] OR Belorussia[tiab] OR Belize[tiab] OR Bhutan[tiab] OR Bolivia[tiab] OR Bosnia[tiab] OR Herzegovina[tiab] OR Hercegovina[tiab] OR Botswana[tiab] OR Brasil[tiab] OR Brazil[tiab] OR Bulgaria[tiab] OR “Burkina Faso”[tiab] OR “Burkina Fasso”[tiab] OR “Upper Volta”[tiab] OR Burundi[tiab] OR Urundi[tiab] OR Cambodia[tiab] OR “Khmer Republic”[tiab] OR Kampuchea[tiab] OR Cameroon[tiab] OR Cameroons[tiab] OR Cameron[tiab] OR Camerons[tiab] OR “Cape Verde”[tiab] OR “Central African Republic”[tiab] OR Chad[tiab] OR Chile[tiab] OR China[tiab] OR Colombia[tiab] OR Comoros[tiab] OR “Comoro Islands”[tiab] OR Comores[tiab] OR Mayotte[tiab] OR Congo[tiab] OR Zaire[tiab] OR “Costa Rica”[tiab] OR “Cote d'Ivoire”[tiab] OR “Ivory Coast”[tiab] OR Croatia[tiab] OR Cuba[tiab] OR Cyprus[tiab] OR Djibouti[tiab] OR “French Somaliland”[tiab] OR Dominica[tiab] OR “Dominican Republic”[tiab] OR “East Timor”[tiab] OR “East Timur”[tiab] OR “Timor Leste”[tiab] OR Ecuador[tiab] OR Egypt[tiab] OR “United Arab Republic”[tiab] OR “El Salvador”[tiab] OR Eritrea[tiab] OR Estonia[tiab] OR Ethiopia[tiab] OR Fiji[tiab] OR Gabon[tiab] OR “Gabonese Republic”[tiab] OR Gambia[tiab] OR Gaza[tiab] OR “Georgia Republic”[tiab] OR “Georgian Republic”[tiab] OR Ghana[tiab] OR “Gold Coast”[tiab] OR Greece[tiab] OR Grenada[tiab] OR Guatemala[tiab] OR Guinea[tiab] OR Guam[tiab] OR Guiana[tiab] OR Guyana[tiab] OR Haiti[tiab] OR Honduras[tiab] OR Hungary[tiab] OR India[tiab] OR Maldives[tiab] OR Indonesia[tiab] OR Iran[tiab] OR Iraq[tiab] OR “Isle of Man”[tiab] OR Jamaica[tiab] OR Jordan[tiab] OR Kazakhstan[tiab] OR Kazakh[tiab] OR Kenya[tiab] OR Kiribati[tiab] OR Korea[tiab] OR Kosovo[tiab] OR Kyrgyzstan[tiab] OR Kirghizia[tiab] OR Kyrgyz Republic[tiab] OR Kirghiz[tiab] OR Kirgizstan[tiab] OR "Lao PDR"[tiab] OR Laos[tiab] OR Latvia[tiab] OR Lebanon[tiab] OR Lesotho[tiab] OR Basutoland[tiab] OR Liberia[tiab] OR Libya[tiab] OR Lithuania[tiab] OR Macedonia[tiab] OR Madagascar[tiab] OR “Malagasy Republic”[tiab] OR Malaysia[tiab] OR Malaya[tiab] OR Malay[tiab] OR Sabah[tiab] OR Sarawak[tiab] OR Malawi[tiab] OR Nyasaland[tiab] OR Mali[tiab] OR Malta[tiab] OR “Marshall Islands”[tiab] OR Mauritania[tiab] OR Mauritius[tiab] OR “Agalega Islands”[tiab] OR "Melanesia"[tiab] OR Mexico[tiab] OR Micronesia[tiab] OR “Middle East”[tiab] OR Moldova[tiab] OR Moldovia[tiab] OR Moldovian[tiab] OR Mongolia[tiab] OR Montenegro[tiab] OR Morocco[tiab] OR Ifni[tiab] OR Mozambique[tiab] OR Myanmar[tiab] OR Myanma[tiab] OR Burma[tiab] OR Namibia[tiab] OR Nepal[tiab] OR “Netherlands Antilles”[tiab] OR “New Caledonia”[tiab] OR Nicaragua[tiab] OR Niger[tiab] OR Nigeria[tiab] OR

	“Northern Mariana Islands”[tiab] OR Oman[tiab] OR Muscat[tiab] OR Pakistan[tiab] OR Palau[tiab] OR Palestine[tiab] OR Panama[tiab] OR Paraguay[tiab] OR Peru[tiab] OR Philippines[tiab] OR Philipines[tiab] OR Phillipines[tiab] OR Phillippines[tiab] OR Poland[tiab] OR Portugal[tiab] OR “Puerto Rico”[tiab] OR Romania[tiab] OR Rumania[tiab] OR Roumania[tiab] OR Russia[tiab] OR Russian[tiab] OR Rwanda[tiab] OR Ruanda[tiab] OR “Saint Kitts”[tiab] OR “St Kitts”[tiab] OR Nevis[tiab] OR “Saint Lucia”[tiab] OR “St Lucia”[tiab] OR “Saint Vincent”[tiab] OR “St Vincent”[tiab] OR Grenadines[tiab] OR Samoa[tiab] OR “Samoan Islands”[tiab] OR “Navigator Island”[tiab] OR “Navigator Islands”[tiab] OR “Sao Tome”[tiab] OR “Saudi Arabia”[tiab] OR Senegal[tiab] OR Serbia[tiab] OR Montenegro[tiab] OR Seychelles[tiab] OR “Sierra Leone”[tiab] OR “Sri Lanka”[tiab] OR Ceylon[tiab] OR “Solomon Islands”[tiab] OR Somalia[tiab] OR Sudan[tiab] OR Suriname[tiab] OR Surinam[tiab] OR Swaziland[tiab] OR Syria[tiab] OR Syrian[tiab] OR Tajikistan[tiab] OR Tadzhikistan[tiab] OR Tadjikistan[tiab] OR Tadzhik[tiab] OR Tanzania[tiab] OR Thailand[tiab] OR Togo[tiab] OR “Togolese Republic”[tiab] OR Tonga[tiab] OR Tunisia[tiab] OR Turkey[tiab] OR Turkmenistan[tiab] OR Turkmen[tiab] OR Tuvalu[tiab] OR Uganda[tiab] OR Ukraine[tiab] OR Uruguay[tiab] OR USSR[tiab] OR Soviet Union[tiab] OR “Union of Soviet Socialist Republics”[tiab] OR Uzbekistan[tiab] OR Uzbek[tiab] OR Vanuatu[tiab] OR New Hebrides[tiab] OR Venezuela[tiab] OR Vietnam[tiab] OR Viet Nam[tiab] OR West Bank[tiab] OR Yemen[tiab] OR Yugoslavia[tiab] OR Zambia[tiab] OR Zimbabwe[tiab] OR Rhodesia[tiab] OR “Developing Countries”[Mesh] OR Africa[Mesh:NoExp] OR “Africa, Northern”[Mesh:NoExp] OR “Africa South of the Sahara”[Mesh:NoExp] OR “Africa, Central”[Mesh:NoExp] OR “Africa, Eastern”[Mesh:NoExp] OR “Africa, Southern”[Mesh:NoExp] OR “Africa, Western”[Mesh:NoExp] OR Asia[Mesh:NoExp] OR “Asia, Central”[Mesh:NoExp] OR “Asia, Southeastern”[Mesh:NoExp] OR “Asia, Western”[Mesh:NoExp] OR “Caribbean Region”[Mesh:NoExp] OR “West Indies”[Mesh:NoExp] OR “South America”[Mesh:NoExp] OR “Latin America”[Mesh:NoExp] OR “Central America”[Mesh:NoExp] OR "Atlantic Islands"[Mesh:NoExp] OR "Commonwealth of Independent States"[Mesh:NoExp] OR "Pacific Islands"[Mesh:NoExp] OR "Indian Ocean Islands"[Mesh:NoExp] OR "Europe, Eastern"[Mesh:NoExp] OR Afghanistan[Mesh] OR Albania[Mesh] OR Algeria[Mesh] OR “American Samoa”[Mesh] OR Angola[Mesh] OR "Antigua and Barbuda"[Mesh] OR Argentina[Mesh] OR Armenia[Mesh] OR Azerbaijan[Mesh] OR Bahrain[Mesh] OR "Baltic States"[Mesh] OR Bangladesh[Mesh] OR Barbados[Mesh] OR Benin[Mesh] OR "Republic of Belarus"[Mesh] OR Belize[Mesh] OR Bhutan[Mesh] OR Bolivia[Mesh] OR “Bosnia-Herzegovina”[Mesh] OR Botswana[Mesh] OR Brazil[Mesh] OR Bulgaria[Mesh] OR “Burkina Faso”[Mesh] OR Burundi[Mesh] OR Cambodia[Mesh] OR Cameroon[Mesh] OR “Cape Verde”[Mesh] OR “Central African Republic”[Mesh] OR Chad[Mesh] OR Chile[Mesh] OR China[Mesh] OR Colombia[Mesh] OR Comoros[Mesh] OR Congo[Mesh] OR “Costa Rica”[Mesh] OR “Cote d'Ivoire”[Mesh] OR Croatia[Mesh] OR Cuba[Mesh] OR Cyprus[Mesh] OR Djibouti[Mesh] OR "Democratic Republic of the Congo"[Mesh] OR "Democratic People's Republic of Korea"[Mesh] OR Dominica[Mesh] OR “Dominican Republic”[Mesh] OR “East Timor”[Mesh] OR Ecuador[Mesh] OR Egypt[Mesh] OR “El Salvador”[Mesh] OR Eritrea[Mesh] OR Estonia[Mesh] OR Ethiopia[Mesh] OR "Equatorial Guinea"[Mesh] OR Fiji[Mesh] OR "French Guiana"[Mesh] OR Gabon[Mesh] OR Gambia[Mesh] OR "Georgia (Republic)"[Mesh] OR Ghana[Mesh] OR Greece[Mesh] OR Grenada[Mesh] OR Guatemala[Mesh] OR Guinea[Mesh] OR “Guinea-Bissau”[Mesh] OR Guam[Mesh] OR Guyana[Mesh] OR Haiti[Mesh] OR Honduras[Mesh] OR Hungary[Mesh] OR "Independent State of Samoa"[Mesh] OR India[Mesh] OR Indonesia[Mesh] OR Iran[Mesh] OR Iraq[Mesh] OR Jamaica[Mesh] OR Jordan[Mesh] OR Kazakhstan[Mesh] OR Kenya[Mesh] OR Korea[Mesh] OR Kyrgyzstan[Mesh] OR Laos[Mesh] OR Latvia[Mesh] OR Lebanon[Mesh] OR Lesotho[Mesh] OR Liberia[Mesh] OR Libya[Mesh] OR

	Lithuania[Mesh] OR "Macedonia (Republic)"[Mesh] OR Madagascar[Mesh] OR Malawi[Mesh] OR Malaysia[Mesh] OR Mali[Mesh] OR Malta[Mesh] OR Mauritania[Mesh] OR Mauritius[Mesh] OR "Melanesia"[Mesh] OR Mexico[Mesh] OR Micronesia[Mesh] OR "Middle East"[Mesh:NoExp] OR Moldova[Mesh] OR Mongolia[Mesh] OR Montenegro[Mesh] OR Morocco[Mesh] OR Mozambique[Mesh] OR Myanmar[Mesh] OR Namibia[Mesh] OR Nepal[Mesh] OR "Netherlands Antilles"[Mesh] OR "New Caledonia"[Mesh] OR Nicaragua[Mesh] OR Niger[Mesh] OR Nigeria[Mesh] OR Oman[Mesh] OR Pakistan[Mesh] OR Palau[Mesh] OR Panama[Mesh] OR "Papua New Guinea"[Mesh] OR Paraguay[Mesh] OR Peru[Mesh] OR Philippines[Mesh] OR Poland[Mesh] OR Portugal[Mesh] OR "Puerto Rico"[Mesh] OR "Republic of Korea"[Mesh] OR Romania[Mesh] OR Russia[Mesh] OR "Russia (Pre-1917)"[Mesh] OR Rwanda[Mesh] OR "Saint Kitts and Nevis"[Mesh] OR "Saint Lucia"[Mesh] OR "Saint Vincent and the Grenadines"[Mesh] OR Samoa[Mesh] OR "Saudi Arabia"[Mesh] OR Senegal[Mesh] OR Serbia[Mesh] OR Montenegro[Mesh] OR Seychelles[Mesh] OR "Sierra Leone"[Mesh] OR Slovenia[Mesh] OR "Sri Lanka"[Mesh] OR Somalia[Mesh] OR "South Africa"[Mesh] OR Sudan[Mesh] OR Suriname[Mesh] OR Swaziland[Mesh] OR Syria[Mesh] OR Tajikistan[Mesh] OR Tanzania[Mesh] OR Thailand[Mesh] OR Togo[Mesh] OR Tonga[Mesh] OR "Trinidad and Tobago"[Mesh] OR Tunisia[Mesh] OR Turkey[Mesh] OR Turkmenistan[Mesh] OR Uganda[Mesh] OR Ukraine[Mesh] OR Uruguay[Mesh] OR USSR[Mesh] OR Uzbekistan[Mesh] OR Vanuatu[Mesh] OR Venezuela[Mesh] OR Vietnam[Mesh] OR Yemen[Mesh] OR Yugoslavia[Mesh] OR Zambia[Mesh] OR Zimbabwe[Mesh]))))
	Additional parameters: Date (published after 1990), Language (published in English, French, Spanish, Portuguese)

Appendix 3: Additional description of methodology

Searching databases: search string used

We employed a three-part search term using Boolean indicators to find WASH literature from low- and middle-income countries that also included a behaviour change component to encompass the three concepts related to our research questions **Concept 1 – WASH technologies:** includes terms for water treatment, sanitation and hygiene. To reduce the number of non-relevant results, Concept 1 consists of two parts:

- Concept 1A refers to stand-alone terms included in our search.
- Concept 1B consist of terms that are combined with water and hygiene terms using the Boolean indicator AND.

Concept 2 - Behaviour/sustained adoption: includes terms reflecting sustained adoption of a behaviour/use of a technology, behaviour change and adherence.
Concept 3 – Lower- and middle-income countries (LMIC): because we are specifically interested in determining successful interventions in countries with low existing rates of clean water, sanitation and hygiene, the included terms and countries are limited to LMIC only.

This search string was combined in the following manner: (Concept 1A OR Concept 1B) AND Concept 2 AND Concept 3. Our initial search term yielded results that were highly sensitive (our database search resulted in over 170,000 titles) that were highly non-specific (a very low proportion, about 1/200, were related in any way to WASH research).

Databases searched

With guidance from a team of informationists (Davidoff and Florance, 2000, Plutchak, 2000) from the medical and public health library divisions at Johns Hopkins University and feedback from our review Advisory Panel, we selected a number of databases to retrieve relevant literature. This method was intended to capture the range of disciplines represented in the field of water, sanitation and hygiene. Our database search strategy included articles published in the following databases:

- PubMed
- Embase
- PsycINFO
- Web of Science
- Global Health – OVID
- Global Health – WHO (Including: LILACS and REPIDISCA)
- Africabib
- Bioline
- JSTOR
- Scopus
- IBSS
- Anthropology Plus
- JOLIS

Journals included in the hand search

Based on the results of this search, we expanded the list of journals to hand search included in our protocol. We consulted a list of 50 WASH-specific journals provided by IRC International Water and Sanitation Center and added the following:

- Development in Practice
- Environmental Science and Technology
- International Journal of Water Governance
- Journal of Applied Phytotechnology in Environmental Sanitation
- Journal of Applied Sciences in Environmental Sanitation
- Journal of Applied Technology in Environmental Sanitation
- Journal of Water Reuse and Desalination
- Sustainable Sanitation Practice
- Water Practice and Technology
- Water Utility Management International
- Waterlines

For each journal, we examined coverage in the major databases included in this search to inform our database, grey literature and hand search strategies.

Websites and databases consulted for the grey literature search

Table 16: Grey literature source locations

Grey literature source	**Website**
USAID Development Experience Clearinghouse and programme evaluations	DEC: https://dec.usaid.gov/dec/home/Default.aspx Project evaluation: http://www.usaid.gov/results-and-data/progress-data/evaluations
OECD	http://www.oecd-ilibrary.org/search/advanced
DFID R4D	http://r4d.dfid.gov.uk/Search/SearchResearchDatabase.aspx
World Bank / WSP	http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/0,,menuPK:577938~pagePK:64165265~piPK:64165423~theSitePK:469372,00.html
WaterAid	http://www.wateraid.org/international/what_we_do/documents_and_publications/4939.asp
CARE	http://www.care.org/careswork/searchwork.asp
Water.org	http://www.water.org
IRC International Water and Sanitation Centre	http://www.washdoc.info/
WHO	http://search.who.int/
CDC	http://www.cdc.gov/Publications/
Health Management Information Consortium (HMIC) database	http://www.ovid.com/site/catalog/databases/99.jsp

Grey literature source	Website
British Library of Development Studies Catalogue	http://bldscat.ids.ac.uk/
Bangladesh Rural Advancement Committee (BRAC)	http://research.brac.net/new/
UNICEF	http://www.unicef.org/publications/index_pubs_wes.html
Water Engineering and Development Centre	https://wedc-knowledge.lboro.ac.uk/refine-search.html
NGO Forum for Public Health	http://www.ngof.org/resource/publications
RDRS Bangladesh	http://www.rdrsbangla.net/
WSP	http://www.wsp.org/library
ELDIS	http://www.eldis.org/
icddr,b	Personal communication

Improving the specificity of searches and eliminating duplicates

Balancing sensitivity and specificity in systematic reviews

In conducting a systematic review of the literature, one of the key targets is to capture all of the available literature on a given topic. Researchers in one field may not necessarily be aware of the full *scope* and *extent* of the literature published in distinct but relevant fields.

In order to craft a relevant search, we employed a number of databases and broad descriptive terminology. We sought to strike a balance between sensitivity and specificity to result in a high number of topic-specific articles.

After conducting an initial search, we made several modifications to enhance specificity (citations relevant to our research question). To revise our search, we worked collaboratively with informationists at Johns Hopkins University in order to improve the 'signal-to-noise' ratio of our results.

First, we conducted an exercise with the research team to complete initial screening of titles and abstracts of 200 studies in five major databases. In this exercise, we screened for topic relevance (WASH-related research or programme evaluations), but did not apply full inclusion and exclusion criteria. The results of the initial searches and initial screening exercise are demonstrated in Figure 2. Screening was performed independently, and then compared during group meetings to ensure uniform understanding and application of the inclusion and exclusion criteria.

After this, we noted problematic terms by isolating particular search terms and combining them with other components in the search. For example, using a single term from concept 1 – WASH terms AND the complete concept 2 (terms indicating sustained adoption) AND the complete concept 3 – (LMIC terms), we were able to look at the types of articles and relevance that these terms contributed to the search. This process revealed a number of terms that yielded extraneous information, unrelated to the objectives of this review. The

following list provides examples of such terms, and why they were eliminated from the search:

- sewage, sewer, sewers: 'sewage' terms often indicate municipal-level systems; factors at this level are outside the scope of this study
- 'systems(s)' resulted in too broad a search as a stand-alone term. It was included as the term 'water system(s)'
- 'change' was much too broad for this search. We modified this term so that it was always associated with a descriptive term, such as 'behaviour', 'attitude' or 'use'.

Table 17: Initial assessment of relevance of database searches

Database	Total search results	Initial no. screened	% Relevant*
PubMed	7,860	200	3.5
Embase	9,100	200	8.5
Scopus	40,082	200	1.5
PsycINFO	850	200	3
Web of Science	~71,000	200	1

We also specified additional limits on the search in Scopus and Web of Science, the two databases with the highest number of results and lowest relevance. We limited subject areas in Scopus to:

- Biology-BIOC
- Business, Management and Accounting-BUSI
- Chemical Engineering-CENG
- Chemistry-CHEM
- Decision Sciences-DECI
- Earth and Planetary Sciences-EART
- Economics, Econometrics and Finance-ECON
- Engineering-ENGI
- Environmental Science-ENVI
- Immunology and Microbiology-IMMU
- Materials Science-MATE
- Medicine-MEDI
- Nursing-NURS
- Pharmacology, Toxicology and Pharmaceutics-PHAR
- Psychology-PSYC
- Social Sciences-SOCI
- Health Professions-HEAL
- Multidisciplinary-MULT

We limited the search in Web of Science to:

- Science Citation Index Expanded (SCI-EXPANDED) - 1900-present
- Social Sciences Citation Index (SSCI) - 1900-present

- Book Citation Index– Science (BKCI-S) - 2005-present

Exclusion criteria: full-text screening

Exclusion criteria were applied to full reports of articles whose titles and/or abstracts did not provide sufficient information to judge whether inclusion was warranted. Exclusion criteria were (in order of application):

1) **WASH focus**:
   i. Not about a WASH intervention, WASH behaviours and/or WASH behaviour change.
   ii. Study focuses on vector control or oviposition. An example is: Seng CM et al. (2008) Community-based use of the larvivorous fish *Poecilia reticulata* to control the dengue vector *Aedes aegypti* in domestic water storage containers in rural Cambodia. *Journal of Vector Ecology,* 33(1): 139-144.
2) **Population and study scope**: Study conducted in a health facility, school, day care centre, restaurant or other public or private sector institutional setting and/or primarily focused on the behaviours of healthcare workers, teachers or other employees of an institution or business.
3) **Date**: Study published before 1990. Given that WASH policies and programming are tied to the Millennium Development Goals, this criterion ensures that the research reflects relevant and contemporary WASH strategies.
4) **Geographical location**: Study not conducted in a lower- or middle-income country. For a list of included countries, see Appendix 2.
5) **Outcomes**:
   i. does NOT report on behavioural outcomes associated with a specific WASH technology (e.g. reports of microbial efficacy of WASH technologies), or
   ii. reports on behavioural outcomes but does NOT report on **at least one** of the following:
      - Knowledge, attitudes or beliefs (i.e.: 'views') of primary users of specific WASH technologies
      - Specific individual/population characteristics (socio-demographic, behavioural or psychological) associated with use or adoption of specific WASH technologies
      - Outcome and/or process evaluations of interventions which include behavioural outcomes of adoption or sustained adoption of WASH technologies either as an end-goal or as part of a larger health/development impact study.
6) **Language**: Study published in a language other than English, French, Spanish or Portuguese.
7) Types of data reported:
   i. Study does not report on primary data (editorials, policy documents, review articles etc.)
   ii. Study is an in-depth case study of a single individual.

Appendix 4: Supplemental tables

Table 18: Codebook for Research Question 1: IBM WASH framework codes

	Code	Description
Contextual	**Contextual factors** are characteristics encompassing the physical and social contexts in which individuals reside. They may be measured as background characteristics of the setting, individual, or environment. These characteristics may not be modified in the intervention; however, they exert significant influence on the adoption of specific products or behaviours.	
	Access to markets and resources	Access to markets, resources and products in the community to ensure that water is available for drinking, washing and toileting and that replacement parts or materials are available to maintain WASH behaviours. Use this code if market access is defined or explored.
	Household structure	The household structure refers to building materials or aspects of the household's built environment which determine access to WASH resources.
	Household income/wealth	Household income, wealth or another proxy measure (such as socio-economic status). Use this code if measures of wealth are reported as part of the study.
	Level of education	Level of education refers to years of schooling or level of education achieved (i.e. completion of primary school, secondary school etc.)
	Income generation/work patterns	This code refers to occupation, income generation activities or work and the associated demands on time. Apply this code if such factors are identified as participant characteristics or if work patterns influence WASH access in the home.
	Religion	Religion is reported as a participant characteristic or a factor that potentially modifies behaviour.
	Ethnicity	Ethnicity is reported as a participant characteristic or a factor that potentially modifies behaviour.
	Opportunity for repetition of behaviour	An opportunity for repetition of behaviour refers to the habitual/behavioural-level factors such as ready access to WASH infrastructure in a reliable, convenient location for frequent use.
Psychosocial	**Psychosocial factors** encompass the social and psychological determinants of a behaviour or adoption of a new behaviour. These factors may be modified as part of the intervention or may be mentioned as influential factors.	
	Descriptive norms	Descriptive norms include perceptions about what behaviours are commonly performed in the community or what one perceives others to be doing.
	Injunctive norms	Injunctive norms include perceptions of what behaviours are typically approved or disapproved of as well as what one thinks others expect them to be doing.

	Subjective norms	Subjective norms describe an individual's perceptions of behaviour which is influenced by the judgement of others.
	Nurture	Nurture includes aspects of caretaking and parenthood. Include this code if care for one's family members is influential in determining behaviour.
	Knowledge	Knowledge factors relate WASH behaviours to expected health outcomes, such as: mode of transmission of diarrhoea, other WASH-related diseases, toxins (such as heavy metals or other environmental contaminants), etc.
	Perceived susceptibility	Perceived susceptibility refers to a person's perception that their health may be affected if a given behaviour is adopted or continued.
	Perceived severity	Perceived severity refers to a person's perceptions of the consequences of a disease and the level of severity influencing decision making and behavioural adoption.
	Perceived benefits/barriers	Perceived benefits or barriers refer to expectations of the individuals that influence the positive or negative aspects of using a WASH technology or continuing a WASH behaviour. This could include social (prestige) or physical (bad taste) benefits or barriers.
	Disgust	Disgust refers to a negative reaction to contamination, usually contact with faeces or faecal contamination associated with poor WASH practices.
	Self-efficacy	Self-efficacy refers to an individual's belief in their ability to complete behaviours and achieve desired results.
	Behavioural cues	Behavioural cues include verbal or visual reminders that incite an individual to practise a behaviour.
Technology	**Technology factors** include attributes of a product, device, or technology that influences the user interaction and facilitates WASH behaviours.	
	Local manufacturing	Local manufacturing means that a product or replacement parts or materials can be made and available locally.
	Distribution, Importing, or procurement of the technology	These factors refer to networks essential to accessing the product with ease for the consumer. These can include distribution, importing or procurement aspects of the supply chain which enable the user to maintain a consistent supply of needed items e.g. replacement parts, soap, chlorine)
	Feasibility	Feasibility refers to the aspects of the technology that render its use possible over time given resource constraints.

	Status	This code refers to the product's ability to increase the status of the user household because of access to novel or sophisticated technology.
	Cost	Cost refers to the price of using or maintaining the technology or associated products. Use this code if cost is a factor related to adoption or continued use.
	Installation	Installation refers to the site, location, and accessibility of the technology. Use this code if aspects of the installation influence how often a product is used, the desirability of the location, or the convenience of access.
	Maintenance	Maintenance includes the efforts needed to maintain the technology to facilitate frequent, sustained use. This can include regular cleaning, refilling with water, pumping of latrine pits, replacing broken parts, and the time it takes to conduct such maintenance.
	Ease/effectiveness	The ease or effectiveness of routine use refers to behavioural-level factors facilitating easy product use. This code could include the ability to easily refill a water treatment container, or the effectiveness of a soap sudsing agent to remove soil from hands.

Table 19: Codebook for Research Question 2: Process evaluations and programme characteristics

Code	**Description**
Description of target population	Provided demographic information on the study population
External factors	Similar to 'contextual factors' in the IBM WASH framework, this refers to factors outside of a programme that affect uptake. This could include availability of stocks or the diffusion of ideas through a community
Implementation study	Assesses the effectiveness of intervention delivery channels (e.g. different communication strategies, or supply chains) to bring technologies to users
Level of impact	Quantification of WASH use at the time of the survey (e.g. percentage of respondents who report treating water)
Microbial effectiveness	Presents results on water quality assays or reduction of microbial content. Almost exclusively in water treatment literature
Monitoring methods	Utilised or expressed an objective to establish a monitoring and evaluation system within the project
Policy implications	Discusses the impact of the intervention design and findings with respect to current policy
Post-intervention sustainability	Explicitly measures adoption of WASH technology use at least six months after the start of a project. Includes both 'maintained' and 'sustained' adoption studies.

Predictors of use/disuse	Conducts statistical analyses to determine associations between potential predictors and behavioural outcomes
Technology attributes	Description of the WASH technology in detail

Table 20: Studies examining multiple WASH technologies

Handwashing and water treatment	11	Whiteford et al., 1996; Bolt et al., 2003; Bendahmane, 2004; Parker et al., 2006; Academy for Educational Development Inc, 2007; Unicef, 2008; Arnold et al., 2009; Abt Associates Inc, 2010; Sijbesma et al., 2011a; Bowen et al., 2013
Handwashing and sanitation	23	Whiteford et al., 1996; Bolt et al., 2003; Bendahmane 2004; Cairncross and Shordt 2004; SEUF, 2004; Shordt and Cairncross 2004; Torres 2004; Cairncross et al., 2005; Shordt 2005; Choudhury and Hossain 2006; Development Alternatives Inc., 2006b; Academy for Educational Development Inc, 2007; Govindan, 2007; Kamal and Kumar, 2007;Unicef, 2008; Wicken et al., 2008; Akter et al., 2011; Sijbesma et al., 2011a; Whaley and Webster 2011; Kapur, 2012; Beyene and Hailu, 2013
Water treatment and sanitation	10	Bahardjo and O'Brien 1994; Niewoehner and Afonso, 1995; Whiteford et al., 1996; Bolt et al., 2003; Bendahmane, 2004; Academy for Educational Development Inc, 2007; Unicef, 2008; Fuchs and Mihelcic, 2011; Sijbesma et al., 2011a;
ALL 3	7	Whiteford et al., 1996; Bolt et al., 2003; Bendahmane, 2004; Academy for Educational Development Inc, 2007; Unicef, 2008; Sijbesma et al., 2011a;

Table 21: Studies assessed in individual syntheses

Domain	**Citation**	**Synthesis**				
		RQ1: Measuring sustained adoption (n=21)	**RQ1: Behavioural factors**			**RQ2: Programme factors (n=14)**
			Psychosocial (n=36)	**Contextual (n=29)**	**Technological (n=33)**	
Hand-washing	Cairncross and Shordt, 2004			✓		✓
	Bowen et al., 2013	✓				
	Devine and Koita, 2010		✓	✓	✓	✓
	Whaley and Webster, 2011		✓	✓	✓	✓
	Shordt and Cairncross,			✓		✓

Domain	Citation	Synthesis				
		RQ1: Measuring sustained adoption (n=21)	RQ1: Behavioural factors			RQ2: Programme factors (n=14)
			Psychosocial (n=36)	Contextual (n=29)	Technological (n=33)	
	2004					
	O'Brien and Favin 2012			✓	✓	✓
	Parker et al., 2006	✓	✓		✓	✓
	Cairncross et al., 2005	✓		✓		
	Wilson and Chandler, 1993	✓	✓			✓
	SEUF, 2004	✓	✓	✓	✓	✓
Water Treatment	Altherr et al., 2008		✓		✓	
	Arnold et al., 2009	✓	✓		✓	
	Christen et al., 2011		✓	✓		
	DuBois et al., 2010	✓	✓	✓	✓	
	Parker 1997	✓	✓	✓	✓	✓
	Peletz et al., 2012	✓	✓		✓	
	Brown et al., 2007	✓	✓	✓	✓	
	Aiken et al., 2011	✓	✓	✓	✓	
	Brown et al., 2009		✓	✓	✓	
	Casanova et al., 2012	✓	✓	✓	✓	
	Freeman et al., 2012		✓	✓	✓	
	Mosler et al., 2013	✓	✓		✓	✓

Domain	Citation	Synthesis				
		RQ1: Measuring sustained adoption (n=21)	RQ1: Behavioural factors			RQ2: Programme factors (n=14)
			Psychosocial (n=36)	Contextual (n=29)	Technological (n=33)	
	Mosler and Kraemer, 2012		✓			
	Kraemer and Mosler 2012		✓		✓	✓
	Tamas et al., 2009	✓	✓	✓		
	Wood et al., 2012		✓	✓	✓	
	Tamas and Mosler, 2011		✓	✓	✓	
	Wheeler and Agha, 2013	✓	✓		✓	✓
	Ngai et al., 2007	✓	✓		✓	
	Hoque et al., 2004		✓	✓	✓	
	Kraemer and Mosler, 2011		✓			
	Inauen et al., 2013		✓	✓		
Sanitation	Eder et al., 2012	✓			✓	
	Barnard et al., 2013	✓	✓	✓	✓	
	Choudhury and Hossain, 2006		✓	✓	✓	
	Diallo et al., 2007	✓	✓		✓	
	Waterkeyn and Cairncross,		✓	✓	✓	

Domain	Citation	Synthesis				
		RQ1: Measuring sustained adoption (n=21)	RQ1: Behavioural factors			RQ2: Programme factors (n=14)
			Psychosocial (n=36)	Contextual (n=29)	Technological (n=33)	
	2005					
	Kullman and Ahmed, 2011	✓	✓	✓	✓	✓
	Simms et al., 2005			✓	✓	
	Roma et al., 2010		✓	✓	✓	
	Ross et al., 2011		✓	✓	✓	✓
	Malebo, 2012		✓	✓	✓	
	Qutub et al., 2008	✓		✓	✓	
	Devine and Sijbesma, 2011		✓			

Table 22: Stated behavioural objectives of studies included in RQ1: Measuring sustained adoption synthesis

Author, Year	Objectives	Summary
Bowen et al., 2013	To evaluate handwashing behaviour five years after a handwashing intervention	Post-intervention sustainability
Devine and Koita 2010	To apply innovative promotional approaches to behaviour change to generate widespread and sustained improvements in handwashing with soap at scale among women of reproductive age and primary school-aged children. To create an environment to awaken, fortify and support intentions to wash hands	Predictors of use/disuse Implementation study
Parker et al., 2006	To promote use of safe water systems through a clinic-based intervention	Post-intervention sustainability Implementation methods
Cairncross et al., 2005	To study the degree to which induced changes in hygiene behaviour have been sustained	Post-intervention sustainability Level of impact
Wilson and Chandler, 1993	To explore impressions of a hand soap intervention after two years	Post-intervention sustainability

Author, Year	Objectives	Summary
SEUF, 2004	To assess the level of sustainability of behavioural change 1-3 years after a hygiene promotion intervention; develop a methodology for cost-effective longitudinal monitoring of behavioural changes; get insight into the relationships between project approaches and external conditions and sustainability of changes in hygiene behaviour; determine policy and programming indications and influence policy; develop an active network in the field of hygiene promotion	Post-intervention sustainability Level of impact Monitoring methods External factors Policy implications
Arnold et al., 2009	To revisit households to assess water treatment behaviour, basic hygiene knowledge and practices and child health six months after the conclusion of the intervention	Post-intervention sustainability
DuBois et al., 2010	To assess usage patterns and use prevalence of 1) socially marketed sodium hypochlorite, 2) flocculent disinfectant	Post-intervention sustainability Description of target population Predictors of use/disuse
Parker, 1997	1) To supply water to rural villages 2) To set up an operational and maintenance system to increase self-reliance of villagers 3) To strengthen national systems	Post-intervention sustainability Implementation study Level of impact
Peletz et al., 2012	To assess the following components of a gravity filter/safe storage intervention: 1) use of HWTS 2) microbial performance of the intervention 3) health impact on prevalence of diarrhoea 4) increased ownership and responsibility of villagers for hardware	Post-intervention sustainability Microbial effectiveness Level of impact
Brown et al., 2007	To examine continued use of the filters in households and identify predictors of long-term use; independently evaluate the microbiological effectiveness and health impacts of the Cambodian water filter programmes	Post-intervention sustainability Predictors of use Microbial effectiveness
Aiken et al., 2011	To assess the overall performance and sustainability of previously implemented biosand filters in the Dominican Republic approx. one year after initial installation To assess performance effectiveness and continued use To assess the long-term health impact on diarrhoea	Post-intervention sustainability Microbial effectiveness Level of impact
Casanova et al., 2012	To determine the factors associated with filter disuse and evaluate the quality of household drinking water after a tsunami	Predictors of use Microbial effectiveness
Mosler et al., 2013	To use a psychological theory of behavioural change to measure and interpret the effectiveness of different promotional strategies for achieving long-term usage of a household water treatment and safe storage (HWTS)	Predictors of use Post-intervention sustainability

Author, Year	Objectives	Summary
Wheeler and Agha, 2013	To determine any significant differences in key behavioural or intermediate programmatic indicators over the project period; determine if there are any associations between exposure to Certeza interventions and behaviours relating to water treatment	Predictors of use Level of impact
Ngai et al., 2007	To describe a framework for a water filter design and implementation	Post-intervention sustainability
	To discuss a pilot of three technologies	Microbial effectiveness
	To evaluate the Kanchan arsenic filter	Level of impact
	To collaborate with Environment and Public Health Organization (ENPHO) Nepal staff for field research, development and implementation of HWTS	Technology attributes
Eder et al., 2012	To assess the impact and sustainability of health, water and sanitation interventions in Bolivia six years post-project	Post-intervention sustainability
Barnard et al., 2013	To explore the impact of an RCT that introduced India's Total Sanitation Campaign (TSC) (latrine coverage and use) over a longer period (3+ years)	Post-intervention sustainability
Diallo et al., 2007	To assess household latrine use and maintenance, and the acceptability of a household latrine promotion project one year after implementation in rural Niger	Post-intervention sustainability
Kullman and Ahmed, 2011	To understand positive factors of sustainability and factors that might work against the sustainability of rural sanitation in Bangladesh	Predictors of use/disuse
Qutub et al., 2008	To assess whether sanitation and health benefits of the Quetta Katchi Abadis Environment Management Programme (QKAEMP) project were being sustained at household and community levels	Post-intervention sustainability Predictors of use/disuse
	To investigate what other effects could be attributed to the programme (innovations, costs)	

Additional outcome measurement tables assessing sustained adoption post-project period

Guide to Tables 23-25:

1. These tables present data from all studies or evaluations where the level of adoption was measured six months or longer after the end of the WASH project or programme.
2. A variety of indicators of sustained adoption were used both in terms of the behaviour measured, and the method of measurement (self-report, demonstration of the behaviour to the interviewer, spot check and pocket voting).
3. Only **three** studies conducted measurements at two different time points after the end of the project: SEUF, 2004, Parker et al., 2006 and Bowen et al., 2013.
4. Most studies did not publish data obtained both during and after an intervention together, so it is difficult to ascertain changes in the level of adoption over time. In studies that did report time series data, there was generally a static or decreasing trend in use over time.
5. Abbreviations used:

a. HWS = Handwashing station
b. HW = Handwashing
c. SODIS = Solar disinfection of water

Table 23: Handwashing outcomes measured

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post intervention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont. Obs.	Demo.	Spot check	Pocket voting				
Wilson and Chandler, 1993	Cross-sectional survey	Handwashing with soap	✓		✓			once	2 years	No data provided	**94%** claim to use soap when washing hands
SEUF, 2004	Two separate cross-sectional surveys *Longitudinal panel survey (one study site included in both surveys)	Handwashing practice Handwashing technique Presence of soap/ handwashing station			✓		✓	twice*	1-5 years	No data provided	At first follow up: • **87%** could demonstrate proper handwashing • **97%** rubbed hands with both soap and water (districts with longer interventions showed increased practice) • Water and soap were available near latrines in **80% and 93%** of homes in two **intervention** districts, compared with **0% in the control** district At second follow up: • **75%** reported always washing hands with soap

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post intervention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont. Obs.	Demo.	Spot check	Pocket voting				
Cairncross et al., 2005	Cross-sectional survey	Handwashing practice Handwashing technique	✓		✓			once	2-9 years	No data provided	**57%** women report always washing with soap (any time) • 81% demonstrate correct technique Less common among men and children: • 55.2% girls, 47.7% boys, 40% men reported handwashing Odds of correct technique **13.4 times higher** (CI 6.3-28.3) in households where all the women reported the practice
Parker et al., 2006	Longitudinal cohort study	Handwashing technique (six-step criteria)			✓			twice	2 weeks 1 year	No data provided on current use	*2 weeks post*: **44%** correctly performed all six HW steps; **91-93%** had wash basins and soap *1 year post*: **34%** were able to demonstrate all six HW steps; **100%** had wash basins and soap

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post intervention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont. Obs.	Demo.	Spot check	Pocket voting				
Arnold et al., 2009	Cross-sectional survey	Presence of soap/ handwashing station with soap Handwashing practice	✓			✓		once	1 year	No data provided	**90%** households had soap present No difference between diarrhoea prevalence between intervention and control groups
Eder et al., 2012	Cross-sectional survey	Handwashing practice	✓					once	6 years	No data provided	87+% households used soap or detergent
Bowen et al., 2013**	Longitudinal cohort survey	Presence of soap/ handwashing station with soap Handwashing technique	✓		✓	✓		twice	20 months 5yrs	No data provided (original study only reported diarrhoea prevalence)	After 20 months: • Presence of HWS with soap and water: 53% (control); 79% (handwashing); 64% (handwashing station + water treatment) After 5 years: • Intervention households **14 times more likely** to rub both hands at least three times • HWS with soap and water: **26%** (control); **99%** (handwashing); **96%** (handwashing station + water treatment)

*This study conducted two separate follow-up assessments: the first in three villages, and the second a year later in ten villages. We considered this a longitudinal panel survey, rather than two separate cross-sectional surveys, as one village contributed to the results of both assessments.

**The results presented here are an aggregation of data from two related publications: Luby et al. (2009), which reports the data at 20 months after the end of the intervention, and Bowen et al. (2013), which reports data at five years after the end of the intervention.

Table 24: Water treatment outcomes measured

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post-inter-vention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont.Obs.	Demo.	Spot Check	Pocket vote				
Parker, 1997	Cross-sectional survey	Continued use of technology						once	4 years	No data provided	**20/22** wells operational Preventative maintenance in only 1/15 villages visited
Parker et al., 2006	Longitudinal cohort study	Purchase of technology	✓			✓		twice	2 weeks 1 year	*Immediately after intervention*: **85%** received any WASH info; **80%** received info on HW; **76%** received info on HW and SWS No data on current use provided	*2 weeks post*: **53%** received any WASH info; **68%** had detectable chlorine residual; **44%** correctly performed all six HW steps; **91-93%** had wash basins and soap *1 year post*: **71%** had detectable chlorine residuals; **34%** able to demonstrate all six HW steps; **100%** had wash basins and soap
Ngai et al., 2007	Longitudinal panel study	Water treatment	✓					once	2-3 years	No data provided	**83%** reported that they used arsenic filters everyday (started at least one year prior)

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post-inter-vention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont.Obs.	Demo.	Spot Check	Pocket vote				
Brown et al., 2007	Cross-sectional survey Longitudinal cohort study	Water treatment	✓					once	1-4 years	No data provided	**31%** use ceramic filters regularly at follow up Use decreased as length of time from intervention increased **65% of non-users** cited breakage of filter as limiting factor **46%** decreased risk of diarrhoeal disease
Arnold et al., 2009	Cross-sectional survey	Water treatment	✓			✓		once	6-8 months	**70%** reported treating water	**37%** overall reported treatment at follow-up 6 months after the programme **33%** intervention vs **21%** control reported any method of water treatment **8.7%** intervention and **3.3**% control confirmed water treatment (E. coli count)

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post-inter-vention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont.Obs.	Demo.	Spot Check	Pocket vote				
DuBois et al., 2010	Cross-sectional survey Longitudinal cohort study	Water treatment Water quality	✓			✓		once	2 years	**8%** (8/104) used flocculant-disinfectant in last week **48%** (50/104) reported treating water with some method in last week **11%** had detectable residual chlorine	Use of chlorine: **37%** ever, **15%** in last week Use of flocculant disinfectant: **7%** ever, **1%** in last week Use of any treatment: **38%** ever, **16%** in last week
Aiken et al., 2011	Cross-sectional survey	Water treatment Water quality Continued functionality of technology	✓			✓		once	1 year	Assessment unsure; No data provided	**90%** reported use of biosand filter. **89%** of filters were functional at time of survey A longer time since installation was associated with continued use (filters installed earlier were more often used than those installed later) **75%** of samples had WHO-level safe water

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post-inter-vention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont.Obs.	Demo.	Spot Check	Pocket vote				
Tamas et al., 2009	Longitudinal panel survey	Water treatment	✓					once	7 months	**95-100%** households had heard about SODIS **48-73%** used SODIS (depending on promotion method); **29%** use in control areas	Use of SODIS dropped to **39-47%** seven months after intervention ended, compared to **20%** in control groups
Casanova et al., 2012	Cross-sectional survey	Water treatment Continued functionality of technology	✓			✓		once	1-2 years	No data provided	Filters worked **98%** of the times they were used
Peletz et al., 2012	RCT	Water treatment	✓			✓		once	1 year	Measured but not reported. Provides aggregate for **all** and **final** visits	At final visit: • **96%** were reported as 'users' (had filter and storage vessel, and used filter recently) • **92%** users confirmed (water quality test) • Mothers reporting exclusive use **92%**

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post-inter-vention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont.Obs.	Demo.	Spot Check	Pocket vote				
Mosler et al., 2013	Longitudinal panel survey	Water treatment	✓			✓		once	26 months	Household promoter visits, persuasion, public commitment, and memory aids produce most users	**At least 65%** who received household visits reported use during and up to 6 months post intervention end. SODIS practice declined in all groups 6 months after all intervention activities ceased Mean difference 1.3% between observed and actual use: self-report is fairly accurate. Behaviour declined over time, after promotion ended
Wheeler and Agha, 2013	Longitudinal panel survey	Water treatment	✓					once	6 years	**27%** reporting any treatment of water **14%** using any chlorine product; **11%** using Certeza	**38%** reporting any treatment of water **25%** using any chlorine product; **22%** using Certeza **48%** report chlorination is easy

Table 25: Sanitation outcomes measured

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post-intervention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont.Obs.	Demo.	Spot Check	Pocket vote				
SEUF, 2004	Two separate cross-sectional surveys *Longitudinal panel survey (one study site included in both surveys)	Latrine use Latrine functionality				✓	✓	twice	1-5 years	No data provided	At end of first follow up: • **93-98%** reported always using a good latrine (pocket vote) • **52-81%** had functioning latrines At second follow up: • **92%** reported latrine use • **51%** had functioning latrines Overall: • Women had higher use of latrines than men • Reported frequency of use was higher in districts with longer-term interventions • Possibly affected by participation in hygiene classes
Cairncross et al., 2005	Cross-sectional survey	Latrine use					✓	once	2-9 years	No data provided	**89.5%** women surveyed indicate they use a 'good latrine' at home

Citation	Study design	Outcome measured	Measurement method					Freq.	Length of time to follow-up (post-intervention)	Level of adoption at last intervention survey (during intervention)	Level of adoption achieved at follow up (after end of intervention)
			Self-report	Cont.Obs.	Demo.	Spot Check	Pocket vote				
Diallo et al., 2007	Cross-sectional survey	Latrine use Latrine ownership	✓			✓		once	1 year	No data provided	**92.5%** adults reported always use **55%** children under 10 reported always using it **100%** households had a latrine, **86%** of those inspected were functional
Qutub et al., 2008	Cross-sectional survey	Latrine ownership	✓					once	4 years	No data provided	**90%** reported having a latrine installed during programme
Kullman and Ahmed, 2011	Cross-sectional survey	Latrine use Latrine ownership	✓					once	54 months	Study sites were declared open-defecation free prior to 2005 by government	**89.5%** households owned or shared an improved latrine Households reporting exposure to promotion visits were more likely to have an improved/shared latrine
Eder et al., 2012	Cross sectional survey	Presence of a latrine	✓			✓		once	6 years	No data provided	**73%** reported having a latrine **50%** actually had one
Barnard et al., 2013	Cross-sectional survey	Latrine use Presence of a latrine	✓					once	>3 years	No data provided	**72%** reported that at least one member used a latrine **47%** reported use 'all of the time' **38-95% (mean 72%)** reported presence of a latrine

Table 26: Summary of studies intending to assess sustained adoption (n=44)

Studies NOT looking at maintenance (during project period) (n=23)	Studies that DO assess sustained adoption (post project period) (n=21)
1. Cairncross and Shordt, 2004	1. Bowen et al., 2013
2. Devine and Koita 2010	2. Parker et al., 2006
3. Whaley and Webster, 2011	3. Cairncross et al., 2005
4. Shordt and Cairncross, 2004	4. Wilson and Chandler, 1993
5. O'Brien and Favin 2012	5. SEUF, 2004
6. Altherr et al., 2008	6. Arnold et al., 2009
7. Christen et al., 2011	7. DuBois et al., 2010
8. Brown et al., 2009	8. Parker 1997
9. Hoque et al., 2004	9. Peletz et al., 2012
10. Freeman et al., 2012	10. Brown et al., 2007
11. Mosler and Kraemer, 2011	11. Aiken et al., 2011
12. Tamas and Mosler, 2011	12. Casanova et al., 2012
13. Kraemer and Mosler 2012	13. Mosler et al., 2013
14. Wood et al., 2012	14. Tamas et al., 2009
15. Inauen et al., 2013	15. Wheeler and Agha, 2013
16. Choudhury and Hossain, 2006	16. Ngai et al., 2007
17. Waterkeyn and Cairncross, 2005	17. Eder et al., 2012
18. Simms et al., 2005	18. Barnard et al., 2013
19. Roma et al., 2010	19. Diallo et al., 2007
20. Ross et al., 2011	20. Kullman and Ahmed, 2011
21. Malebo, 2012	21. Qutub et al., 2008
22. Devine and Sijbesma, 2011	
23. Kraemer and Mosler, 2011	

Appendix 5: Data extraction form used in the mapping and keywording stage

Mapping criteria	Definition and categories
IDENTIFICATION OF DOCUMENT OR ARTICLE	
Title	Full title
Author	Last names of each author
Year	Year of publication
Journal Title	Name of Journal
Type of publication	1=Report 3=Book 4=Dissertation 5=Conference proceedings 9=Research project 10=Article in a periodical
STUDY POPULATION AND SCALE OF INTERVENTION IMPLEMENTATION	
Study type	1=Descriptive study 2=Intervention study 3=Programme evaluation 4=Other
Number of sites	1=Single methodology and single site 2=Single methodology and multiple sites geographically contiguous or close to each other 3=Single methodology and multiple geographically separated sites 4=Multiple methodologies and multiple sites
If multi-site, how many?	# of sites
If multi-site, which sites were reported on?	Name of sites reported 99=Not applicable
Scale of the study	1=One/several village(s) 2=Sub-district 3=District 4=Province or region 5=National
Approximate population	The approximate population covered in the study/intervention
Rationale for scale up	1=Yes 7=No
Region of the study	1=Latin America and Caribbean 2=Near East and North Africa 3=Sub-Saharan Africa 4=South Asia 5=East Asia 6=South-East Asia and Oceania
Country site for the study	Name of the country the study/evaluation was conducted in

Mapping criteria	Definition and categories
STUDY DESIGN/METHODOLOGY	
Sustained behaviour objective	1= Yes 7= No 99=Descriptive study only
Standard intervention methodology	1= Intervention does not have a standard name 2= Community-Led Total Sanitation (CLTS) 3=Other name (Specify) 99= Does not apply
Inter-group comparisons	Description of the inter-group comparisons made: 1=No inter-group comparisons. Comparisons made between individuals from the same area who did or did not receive the intervention 2=No inter-group comparisons. Single group of participants that received the routine/programmatic intervention that people in that area always receive 3=No inter-group comparisons were made. Single group of participants that received a new/different intervention 4=Intervention group vs. comparison (control) group. Allocation to intervention was non-random 5=Intervention group vs. comparison (control) group. Allocation to intervention was random.
Individual or group comparisons	Description of comparisons made between individuals: 1=No individual-level comparisons were made. Group-level comparisons were made 2=Individuals receiving the intervention were compared to those not receiving the intervention 3=Individuals receiving the intervention were compared to those not receiving the intervention, assignment was random 4=Individuals who have adopted and/or sustained behaviour of interest compared to individuals receiving the same intervention who have not adopted the behaviour
Behaviour comparisons	Description of comparisons made between behaviours, behavioural determinants or other variables at different points in time: 1=Cross-sectional study 2=Pre-post comparisons from a defined baseline to the end of the study or evaluation 3=Pre-post comparisons from a mass distribution to a later date 4=Pre-post comparisons from the start of a community mobilisation process to a later date 5=Pre-post comparisons from the onset of a complex humanitarian emergency to a later date

Mapping criteria	Definition and categories
	6=Pre-post comparisons from the conclusion of research study to a later date 7=Pre-post comparisons from the conclusion of a period of intensive implementation by government or NGO to a later date 8=Continuous monitoring 9=Panel design (cohort study)
Time from implementation	# of months 99=Not applicable
Time from implementation/ project/study end	# of months 99=Not applicable
Water quality and/or microbial contamination outcomes	Description of what water quality and/or microbiological contamination outcomes were assessed: 1=Presence of bacteria in drinking water 2=Presence of parasites in drinking water 3=Presence of arsenic in drinking water 4=Presence of fluoride in drinking water 5=Presence of other heavy metals in drinking water 6=H2S test on drinking water 7=Presence of pesticides or other agricultural chemicals in drinking water 8=Assessment of salinity of drinking water 9=Assessment of turbidity of drinking water 10=Other test on drinking water 99=No information provided
Biological/epidemiological outcomes	Types of biological or epidemiological outcome were assessed: 1=Prevalence of diarrhoea in young children 2=Incidence of diarrhoea in young children 3=Prevalence of parasitic infection e.g. Schistosomes, Ascariasis 4=Incidence of parasitic infection e.g. Schistosomes, Ascariasis 5=H2S test on drinking water 6=Measures of tropical enteropathy 7=Mortality e.g. under-five mortality rate, disease-specific mortality 8=Other outcomes

Mapping criteria	Definition and categories
	99=No information provided and/or no biological or epidemiological outcomes were assessed
Economic measure	1=Wealth, economic status 2=Willingness to pay for water treatment technologies 3=Actual expenditures on water treatment technologies 4=Willingness to pay for sanitation technologies 5=Actual expenditures on sanitation technologies 6=Other expenditures on technologies 7=Expenditures on care seeking and treatment 8=Other economic measures 99=No information provided and/or no economic measures were assessed
Detail of the study	1=Very general, characteristics of methodology and study design described in general terms 2=Some detail presented, but incomplete 3=Full detail typical of an article in a peer-reviewed journal
Detail of the study/evaluation results	1=Very general, very few numbers or tables, results described in general terms 2=Some detail presented, but incomplete 3=Full detail typical of an article in a peer-reviewed journal
Detail of the intervention content/components	1=Very general, very limited detail on characteristics of intervention, who delivered the intervention, and how it was delivered. It would be impossible to replicate intervention based on information provided. 2=Some detail presented, but incomplete 3=Full detail typical of an article in a peer-reviewed journal
Study type	1=Views study 2=Outcome/process evaluation
RIGOUR	
Explicit conceptual model or literature review	1=Not at all 2=Partially, and/or incomplete description 3=Fully, with complete description

Mapping criteria	Definition and categories
Aims and objectives clearly stated	1=Not at all 2=Partially, and/or incomplete description 3=Fully, with complete description
Clear description of context	1=Not at all 2=Partially, and/or incomplete description 3=Fully, with complete description
Clear description of sample and how it was recruited	1=Not at all 2=Partially, and/or incomplete description 3=Fully, with complete description
Clear description of methods used to collect/analyse data	1=Not at all 2=Partially, and/or incomplete description 3=Fully, with complete description
Attempts to establish reliability/validity of data analysis	1=Not at all 2=Partially, and/or incomplete description 3=Fully, with complete description
Inclusion of sufficient original data to mediate between evidence and interpretation	1=Not at all 2=Partially, and/or incomplete description 3=Fully, with complete description
STATEMENT OF BEHAVIOURAL OBJECTIVES	
Behavioural Objectives	Are the behavioural objectives stated or target behaviours for the study/evaluation? 1=Yes 7=No
Behaviour participant	Who is stated should practise the behaviour? 1=There is an explicit statement of who should practise the behaviour 2=You can infer who is intended to practise the behaviour but no explicit statement 3=Not made clear who should practise the behaviour 99=Not applicable
Behaviour frequency	Do the objectives state how often or when or the key times to practise the behaviour? 1=No description 2=Minimal description 3=Full description 99=Not applicable

Mapping criteria	Definition and categories
Objectives described elsewhere?	Was there a description, in the objectives or elsewhere, of how to practise the behaviour? 1=No description 2=Minimal description 3=Full description
Behaviour goal/target	Was there a statement about the goal/target for the level of behaviour change/adoption to be achieved by the end of the study? 1=Yes, explicit statement of goal/target 2=Goal/target can be inferred 3=No statement
BEHAVIOUR CHANGE INTERVENTIONS/ACTIVITIES	
Intervention components	Were the intervention components or activities described that were carried out to promote behaviour change/adoption of new behaviours? 1=Full and detailed description 2=Minimal description 3=No description
Interventions/activities description	What type of interventions/activities were described? 1=Hardware to improve accessibility, quality and reliability of water supply 2=Promotion of latrine or toilet construction by community 3=Education/communication through mass media/social marketing 4=Education/communication through youth clubs or school clubs or teachers 5=Education/communication through women's groups 6=Education/communication through community health workers or health promoters 7=Education/communication through facility-based health workers 8=Community-Led Total Sanitation 99=Not applicable, no interventions or activities described
Model/theory of behaviour change	Was the behaviour change intervention based on an explicit model/theory of behaviour change? 1=Yes 7=No 99=Unclear/unable to determine

Mapping criteria	Definition and categories
Modifying constructs of target behaviours	Did the behaviour change intervention attempt to modify or change specific constructs, factors or determinants related to the target behaviours? 1=Yes 7=No
Constructs, factors, and determinants	Description of the different constructs/factors/determinants mentioned, given a (1) if applicable: 1. No constructs, factors or determinants mentioned 2. Contextual determinants (sociodemographic) mentioned e.g. age, gender, level of education, income/wealth 3. Contextual determinants (environmental) mentioned e.g. climate, topography, soil 4. Contextual determinants (social and cultural) mentioned e.g. migration, ethnicity (but excluding psychosocial like knowledge, beliefs, traditional practices) 5. Psychosocial determinants mentioned e.g. knowledge, disgust, self-efficacy, social norms, outcome expectations, perceived susceptibility, perceived severity 6. Technology determinants mentioned e.g. suitability of the technology for the population, feasibility of regular use by the population, availability/distribution and cost of the technology
Phases	Was the behaviour change intervention implemented in a series of phases, each one building upon the previous one? 1=Yes 7=No
IMPLEMENTATION AND EVALUATION OF HANDWASHING INTERVENTIONS	
Promotion	Was handwashing promoted? 1=Yes 7=No
Enabling technology	Was some type of enabling technology installed, distributed, sold, promoted or identified as part of the intervention or programme? Given a (1) if applicable 1. Handwashing station with reservoir and tap 2. Place to wash hands at pump or other water source 3. Bar soap 4. Soapy water/soapy water bottle 5. Ash 6. Hand sanitiser 7. The study assessed whether soap, sanitiser or other enabling technology was present, but did not provide it or distribute or sell

Mapping criteria	Definition and categories
	it to people 8. Other 88. No enabling technology related to handwashing installed, distributed or sold 99. Enabling technology was part of intervention, but no information provided about it
Amount installed/distributed	If hardware was involved, was there a statement of the total number installed or distributed or sold over the entire project area? actual # of hardware 88. No handwashing intervention 99. Handwashing intervention implemented, but no information provided on this point
Household proportion	Statement of the proportion of households installing, receiving, or purchasing the hardware? Actual % 88. No handwashing intervention 99. Handwashing intervention implemented, but no information provided on this point
Functionality/maintenance	Was functionality/maintenance of the hardware assessed? 1. Yes 7. No 88. No handwashing intervention 99. Handwashing intervention implemented, but no information provided on this point
Assessment of intervention	Description of steps taken to assess the effect of the intervention to promote handwashing: Given a (1) if applicable: 1. Survey question: People were asked the key times to practise handwashing 2. Survey question: People were asked if they practise handwashing at all 3. Survey question: People were asked if they practise handwashing at key times 4. Observation of handwashing skills: One or more people from each household asked to demonstrate how to wash hands correctly. Observer notes amount of water used, soap or ash used to wash hands, both hands washed/rubbed 5. Pocket voting: Each person attending a meeting votes secretly in pocket chart on whether they always wash both hands with soap and water

Mapping criteria	Definition and categories
	6. Observation of availability of soap and water at place of handwashing 7. Survey question: Interviewee asked to bring soap used for handwashing 8. Motion detector in a bar of soap 9. Direct observation: Spot check to observe handwashing 10. Direct observation: Continuous observation in household to observe handwashing 77. Disease risk/germ theory related to handwashing 88. No handwashing intervention 99. Handwashing intervention implemented, but no information provided on this point
Observation	Were handwashing behaviours observed? 1. Yes 7. No 88. No handwashing intervention 99. Handwashing intervention implemented, but no information provided on this point
Reported results	Which results were reported related to the change in the handwashing measure in this study? Given a (1) if applicable: 1. Significant increase in handwashing during period of study/intensive implementation of programme 2. No or insignificant increase in handwashing during period of study/intensive implementation of programme 3. Maintenance of handwashing or very limited decline (non-significant) after end of study/intensive implementation of programme 4. Gradual decline in handwashing occurring over many months after end of study/intensive implementation of programme 5. Sharp decline in handwashing occurring immediately after end of study/intensive implementation of programme 6. Decrease in diarrhoea during period of study/intensive implementation 7. Maintenance of decrease in diarrhoea after end of study/intensive implementation of programme 8. Failure to maintain decrease in diarrhoea after end of study/intensive implementation of programme 77. Data reported are from a cross-sectional or single survey and changes overtime cannot be inferred from study design or description. 88. No handwashing intervention

Mapping criteria	Definition and categories
	99. Handwashing intervention implemented, but no information provided on this point
Presence of soap	Is there an increase in reported presence of soap near sink, toilet or handwashing station, and/or proportion of respondents able to produce a bar of soap when asked? Given a (1) if applicable: 1. Significant increase in availability of soap for handwashing 2. Non-significant increase in availability of soap for handwashing 3. No increase in availability of soap for handwashing 88. No handwashing intervention 99. Handwashing intervention implemented, but no information provided on availability of soap
IMPLEMENTATION AND EVALUATION OF WATER TREATMENT INTERVENTIONS	
Promotion	Was water treatment/POU promoted as part of this study or programme? 1=Yes 7=No
Boiling promotion	Was boiling of drinking water promoted? 1=Yes 7=No 88=No water treatment intervention

Mapping criteria	Definition and categories
Enabling technology	Description of enabling technology installed, distributed, sold or promoted as part of the intervention: 1. Ceramic filter 2. Biosand filter 3. Other kind of filter 4. Chlorine tablets 5. Chlorine dispenser 6. Solar water disinfection 7. Vessel to hold specific amount of water for chlorination 8. Vessel to protect water from recontamination by hands 9. Other 88. No enabling technology related to water treatment installed, distributed or sold 99. Enabling technology was part of intervention, but no information provided
Amount installed/distributed	Was there a statement of the total number installed or distributed or sold over the entire project area? actual # installed 88. No water treatment intervention 99. Water treatment intervention implemented, but no information provided on this point
Household proportion	Statement of the proportion of households installing, receiving, or purchasing the hardware: Actual % 88. No handwashing intervention 99. Handwashing intervention implemented, but no information provided on this point
Installation/receipt/purchase	Description of how the installation, receipt or purchase at the household level was measured 1. Confirmation at time of installation or delivery 2. Observation during a household survey 3. Question to the householder during a household survey 88. No water treatment intervention 99. Water treatment intervention implemented, but no information provided on this point
Functionality/maintenance	Was functionality/maintenance of the hardware assessed? 1. Yes 7. No

Mapping criteria	Definition and categories
	88. No handwashing intervention 99. Handwashing intervention implemented, but no information provided on this point
Assessment of intervention	Description of which of the following steps were taken to assess the effect of the intervention to promote water treatment: 1. Survey question: People were asked how and when to treat their water 2. Survey question: People were asked if they practise water treatment at all 3. Observation of skills: One or more people from each household asked to demonstrate how to treat water with the technology provided 4. Pocket voting: Each person attending a meeting votes secretly in pocket chart on whether they always treat their water 5. Observation of presence and functionality of the water treatment technology 6. Microbiological testing of drinking water samples 7. Testing of drinking water for Arsenic 8. Testing of drinking water for Fluoride 9. Testing of drinking water for other contaminants 10. H2S test on drinking water 11. Test of drinking water for chlorine 12. Other 77. Knowledge of germ theory / disease transmission related to water 88. No water treatment intervention 99. Water treatment intervention implemented, but no information provided on this point
Reported results	Description of the type of results reported: 1. Significant increase in water treatment during period of study/intensive implementation of programme 2. No or insignificant increase in water treatment during period of study/intensive implementation of programme 3. Maintenance of water treatment or very limited decline after end of study/intensive implementation of programme 4. Moderate decline in water treatment after end of study/intensive implementation of programme 5. Sharp decline in water treatment after end of study/intensive implementation of programme 6. Decrease in diarrhoea during period of study/intensive implementation

Mapping criteria	Definition and categories
	7. Maintenance of decrease in diarrhoea after end of study/intensive implementation of programme 8. Failure to maintain decrease in diarrhoea after end of study/intensive implementation of programme 77. Data reported are from a cross-sectional or single survey and changes overtime cannot be inferred from study design or description. 88. No water treatment intervention 99. Water treatment intervention implemented, but no information provided on this point
IMPLEMENTATION AND EVALUATION OF SANITATION INTERVENTIONS	
Sanitation promotion	Was sanitation promoted as part of this study or programme? 1=Yes 7=No
Enabling technology	Description of some type of enabling technology installed or distributed or sold or promoted as part of the intervention: 1. Materials for latrine construction provided free of charge to community 2. Materials for latrine construction sold to community 3. Community members trained in latrine construction 4. Private company or contractors construct latrines 5. Community constructs their own latrines, in traditional way 6. Other 88. No enabling technology related to sanitation installed, distributed or sold 99. Enabling technology was part of intervention, but no information provided about it
Amount installed/distributed	If hardware was involved, was there a statement of the total number installed or distributed or sold over the entire project area? actual # of hardware 88. No sanitation intervention 99. Sanitation intervention implemented, but no information provided on this point
Household proportion	Statement of the proportion of households installing, receiving, or purchasing the hardware: Actual % 88. No sanitation intervention 99. Sanitation intervention implemented, but no information

Mapping criteria	Definition and categories
	provided on this point
Installation/receipt/purchase	Description of how the installation, receipt or purchase at the household level was measured 1. Confirmation at time of installation or delivery 2. Observation during a household survey 3. Question to the householder during a household survey 88. No sanitation intervention 99. Sanitation intervention implemented, but no information provided on this point
Functionality/maintenance	Was functionality/maintenance of the hardware assessed? 1. Yes 7. No 88. No sanitation intervention 99. Sanitation intervention implemented, but no information provided on this point
Assessment of intervention	Description as to which of the following steps were taken to assess the effect of the intervention to promote sanitation: 1. Survey question: People were asked if they use the latrine 2. Survey question: People were asked if they help to maintain/clean the latrine 3. Pocket voting: Each person attending a meeting votes secretly in pocket chart on whether they always use the latrine 4. Direct observation: Observer visits latrine to see was a clear path to the pit, if there was excreta in the pit, and if surrounding environment is free of excreta. 5. Direct observation for cleanliness: Observer examines to see if latrine floor, the squat hole/pan and walls are free of excreta 6. Direct observation for maintenance: presence/lack of cover for hole in pit latrines, presence of holes in walls big enough to see through, whether the latrine has roof and door 7. Direct observation: Sites of open defecation in the community 8. Other method 77. Disease risk/knowledge of germ theory related to sanitation. 88. No sanitation intervention99. Sanitation intervention implemented, but no information provided on this point
Reported results	Description of which results were reported in this study: 1. Significant increase in latrine use during period of study/intensive implementation of programme 2. No or insignificant increase in latrine use during period of study/intensive implementation of programme

Mapping criteria	Definition and categories
	3. Maintenance of latrine use or very limited decline after end of study/intensive implementation of programme 4. Moderate decline in latrine use after end of study/intensive implementation of programme 5. Sharp decline in latrine use after end of study/intensive implementation of programme 6. Decrease in diarrhoea during period of study/intensive implementation 7. Maintenance of decrease in diarrhoea after end of study/intensive implementation of programme 8. Failure to maintain decrease in diarrhoea after end of study/intensive implementation of programme 77. Data reported are from a cross-sectional or single survey and changes overtime cannot be inferred from study design or description. 88. No sanitation intervention 99. Sanitation intervention implemented, but no information provided on this point
FACTORS AFFECTING UPTAKE OF THE BEHAVIOUR/ADOPTION OF THE BEHAVIOURAL RECOMMENDATIONS	
Association between contextual factors and behaviours/interest	Was the association between any of the following contextual factors and the behaviours or interest assessed? 1. Household income/wealth 2. Level of education of household members 3. Household structure 4. Income generation activities or work patterns of household members 5. Religion 6. Ethnicity 7. Other contextual factors 99. No contextual factors reported or described
Association between psychosocial factors and behaviours/interest	Was the association between any of the following psychosocial factors and the behaviours or interest assessed? 1. Knowledge of mode of transmission of diarrhoea 2. Knowledge of other WASH diseases 3. Knowledge of toxins (Arsenic, Fluoride, pesticides etc.) 4. Perceived susceptibility 5. Perceived severity 6. Perceived benefits 7. Perceived barriers

Mapping criteria	Definition and categories
	8. Social norms – Descriptive 9. Social norms – Injunctive 10. Subjective norms 11. Disgust 12. Self-efficacy 13. Behavioural cues 14. Other psychosocial factors 99. No psychosocial factors reported or described
Association between technology factors and behaviours/interest	Was the association between any of the following technology factors and the behaviours or interest assessed? 1. Feasibility of using the technology 2. Feasibility of routine/repeated use of the technology 3. Status for owner to been seen owning such a technology 4. Cost 5. Installation of the technology 6. Maintenance and/or difficulty maintaining in working order 7. Local manufacturing of technology 8. Importing or procuring the technology 9. Distribution of the technology 10. Other technology-related factors 99. No technology-related factors reported or described

Appendix 6: Mapping code book

Identification of document or article

ID 3-Digit ID

- 101-199 Handwashing
- 201-299 Water treatment/POU
- 301-399 Sanitation/latrines

101. Item ID, Internal (7 digits):
102. Title
103. Author last name
104. Year
105. Type of publication: Journal article Y/N

If not journal article, what type of publication is it?

1. Report
2. Book, Whole
3. Book, Chapter
4. Dissertation
5. Conference proceedings
6. Document from Internet site
7. Web Site
8. DVD, Video, Media
9. Research project
10. Article in a periodical
11. Interview
12. Generic

106. Journal title
107. Pages
108. URL
109. Volume
110. Issue
111. Publisher
112. Institution
113. City
114. Linked study ID:
115. Linked study ID:
116. Linked study ID:
117. Linked study ID:

118. Linked study ID:

119. Linked study ID:

Study population and scale of intervention implementation

201. Was this a descriptive study or an intervention study or a programme evaluation?

1. Descriptive study with no intervention introduced or promoted now or in the past or a study which reports on participants' views ideas
2. Intervention study: Intervention introduced or promoted under research conditions, where inputs available that are not normally available
3. Programme evaluation or implementation study: Intervention introduced or promoted under routine or programmatic conditions
4. Other

202. Was this a single site/country or multi-site/country study or evaluation?

1. Study or programme evaluation with single methodology and single site
2. Study or programme evaluation with single methodology and multiple sites that are geographically contiguous or very close to each other
3. Study or programme evaluation with single methodology and multiple geographically separated sites
4. Multiple studies or programme evaluations, each with its own methodology, reported in one article or report e.g. Bolt and Cairncross 2004 'Lessons learned on research methodologies and research implementation from a multi-country research study'.

203. If multi-site, how many sites were there in the study? __ __ sites 99=Not applicable

204. If multi-site/multi-country like Bolt and Cairncross 2004 , data from which of the sites is reported in this database entry?

1. All sites reported in this database entry
2. Only one of the sites is reported in this database entry

Name of site: _____

205. What was the scale of the study?

1. One village or several villages
2. Sub-district
3. District
4. Province or Region
5. National

206. What was the approximate population covered in the study/intervention?
_____

207. Did the authors mention or specify as part of the rationale for the study that this study/programme was attempting to implement at scale/scale up an intervention previously implemented at a small scale or as a pilot study?

1. Yes

7. No

208. What Region was the study/evaluation conducted in?

1. Latin America and Caribbean
2. Near East and North Africa
3. Sub-Saharan Africa
4. South Asia
5. East Asia
6. South-East Asia and Oceania

209. What country was the study/evaluation conducted in? _____

Study design/methodology

301. Was an explicit objective of study or evaluation to examine sustained behaviour change after an intervention or programme?

1. Yes

7. No

99. Descriptive study only, no implementation involved

302. Was the study or evaluation testing or evaluating an intervention methodology with a standard name? If yes, what was the name?

1. The intervention does not have a standard name
2. Community-Led Total Sanitation (CLTS)
3. Other name (Specify): _____(99 = DOES NOT APPLY)

303. What inter-group (between group) comparisons were made in the study?

1. No inter-group comparisons were made. Instead, comparisons were made between individuals from the same area who did or did not receive the intervention.
2. No inter-group (between group) comparisons were made. There was one single group of participants in the study, and this group received the routine/programmatic intervention that people in that area always receive.
3. No inter-group (between group) comparisons were made. There was one single group of participants in the study, and this group received a new or different intervention that was being pilot tested without any comparison group.
4. Intervention group vs. comparison (control) group. Allocation to intervention and comparison groups was non-random e.g. one group or area (neighbourhood, community, district) was already receiving the intervention, and another similar area was identified to serve as a comparison.
5. Intervention group vs. comparison (control) group. Allocation to intervention and comparison groups was random e.g. all of the groups or areas (neighbourhoods, communities, districts) eligible to receive the intervention were identified at the outset, then they were allocated to the intervention or comparison arm of the study through random selection.

304. Were comparisons made between individuals, rather than between groups (neighbourhoods, communities, districts)? What comparisons were made?

1. No individual-level comparisons were made. Group-level comparisons were made, and one of responses 2 through 5 in Q303 is applicable.
2. Individuals receiving the intervention were compared to individuals not receiving the intervention, but assignment of individuals to intervention or comparison arms of the study was not random.
3. Individuals receiving the intervention were compared to individuals not receiving the intervention, but assignment of individuals to intervention or comparison arms of the study was random, this was a randomised controlled trial (RCT).
4. Individuals who have adopted and/or sustained the behaviour of interest compared to individuals receiving the same intervention who have not adopted and/or discontinued the behaviour.

305. What comparisons were made between behaviours, behavioural determinants or other variables at different points in time? Check all that apply, as sometimes multiple types of comparisons are made.

1. No comparisons were at different points in time. This was a cross-sectional study, for example a single household survey or a single round of qualitative research.
2. Pre-post comparisons from a defined baseline to the end of the study or evaluation
3. Pre-post comparisons from a mass distribution to a later date
4. Pre-post comparisons from the start of a community mobilisation process (e.g. ignition phase of community-led total sanitation – CLTS) to a later date
5. Pre-post comparisons from the onset of a complex humanitarian emergency to a later date
6. Pre-post comparisons from the conclusion of research study to a later date
7. Pre-post comparisons from the conclusion of a period of intensive implementation by government or NGO (e.g. mass installation of latrines, mass drilling of boreholes) to a later date
8. Continuous monitoring
9. Panel design (cohort study)

306. How many months after implementation started were measurements made to assess sustainability?

__ __ months 99=Not applicable

307. How many months after implementation/project/study ended were measurements made to assess sustainability?

__ __ months 99=Not applicable

308. What water quality and/or microbiological contamination outcomes were assessed? Check all that apply:

1. Presence of bacteria in drinking water e.g. Vibrio cholerae, E. coli
2. Presence of parasites in drinking water e.g. Entamoeba histolyticum
3. Presence of arsenic in drinking water
4. Presence of fluoride in drinking water

5. Presence of other heavy metals in drinking water
6. H2S test on drinking water
7. Presence of pesticides or other agricultural chemicals in drinking water
8. Assessment of salinity of drinking water
9. Assessment of turbidity of drinking water
10. Other test on drinking water
99. No information provided

309. What types of biological or epidemiological outcome were assessed? Check all that apply:

1. Prevalence of diarrhoea in young children
2. Incidence of diarrhoea in young children
3. Prevalence of parasitic infection e.g. Schistosomes, Ascaris
4. Incidence of parasitic infection e.g. Schistosomes, Ascaris
5. H2S test on drinking water
6. Measures of tropical enteropathy
7. Mortality e.g. under-five mortality rate, disease-specific mortality
8. Other outcomes

99. No information provided and/or no biological or epidemiological outcomes were assessed.

310. What economic measures were assessed? Check all that apply:

1. Wealth, economic status
2. Willingness to pay for water treatment technologies
3. Actual expenditures on water treatment technologies
4. Willingness to pay for sanitation technologies
5. Actual expenditures on sanitation technologies
6. Other expenditures on technologies
7. Expenditures on careseeking and treatment
8. Other economic measures
99. No information provided and/or no economic measures were assessed.

311. In how much detail is the study or evaluation methodology and study design described?

1. Very general, characteristics of methodology and study design described in general terms
2. Some detail presented, but incomplete
3. Full detail typical of an article in a peer-reviewed journal

What is the rigour of the study?	**1=Not at all**	**2=Partially, and/or incomplete description**	**3=Fully, with complete description**
312. Does the study have an explicit conceptual model or literature review?			
313. Are the aims and objectives clearly stated?			
314. Is there a clear description of context?			
315. Is there a clear description of the sample and how it was recruited?			
316. Is there a clear description of the methods used to collect and analyse data?			
317. Are there attempts to establish the reliability and validity of data analysis?			
318. Is there inclusion of sufficient original data to mediate between evidence and interpretation?			

319. In how much detail are the study or evaluation results described?

1. Very general, very few numbers or tables, results described in general terms
2. Some detail presented, but incomplete
3. Full detail typical of an article in a peer-reviewed journal

320. In how much detail are the intervention content / intervention components described?

1. Very general, very limited detail on characteristics of intervention, who delivered the intervention, and how it was delivered. It would be impossible to replicate intervention based on information provided.
2. Some detail presented, but incomplete
3. Full detail typical of an article in a peer-reviewed journal

321. Study type

1. Study is a 'Views study', non-intervention, OR intervention study which focuses on factors that influence adoption and sustained adoption.
2. Study represents an outcome evaluation or process evaluation and discusses characteristics of interventions and their effectiveness.

Statement of behavioural objectives

401. Was there a statement of the behavioural objectives or target behaviours for the study or evaluation?

1. Yes

7. No

402. Cut and paste the behavioural objectives

403. Do the objectives state who should practise the behaviour?

1. Yes, there is an explicit statement 'the target group for the behaviour is X', or 'the intervention was targeted at X'

2. You can infer who is intended to practise the behaviour, but it is not stated explicitly
3. No, it is not made clear who should practise the behaviour
99. Not applicable – No objectives stated

404. Do the objectives state how often or when or the key times to practise the behaviour?

1. No description e.g. 'wash hands'
2. Minimal description e.g. 'wash hands before eating'
3. Full description e.g. 'wash hands at three key times: after going to the toilet, before eating and before food preparation'
99. Not applicable – No objectives stated

405. Is there a description, in the objectives or elsewhere, of how to practise the behaviour?

1. No description e.g. 'wash hands'
2. Minimal description e.g. 'wash hands with soap'
3. Full description e.g. 'wash both hands with soap until lather is produced, for 30 seconds or more'

406. Is there a statement about the goal/target for the level of behaviour change/adoption to be achieved by the end of the study? e.g. 'the study aimed to reached a 60% level of handwashing before meals'

1. Yes, there is an explicit statement of the goal or target
2. You can infer the goal or target, but it is not stated explicitly
3. No, there is no statement of the goal or target to be achieved

Behaviour change interventions/activities

501. Were the intervention components or activities described that were carried out to promote behaviour change / adoption of new behaviours?

1. Full and detailed description
2. Minimal description
3. No description

502. What interventions or activities are described? Check all that apply

1. Hardware to improve accessibility, quality and reliability of water supply
2. Promotion of latrine or toilet construction by community
3. Education/communication through mass media / social marketing
4. Education/communication through youth clubs or school clubs or teachers
5. Education/communication through women's groups
6. Education/communication through community health workers or health promoters
7. Education/communication through facility-based health workers
8. Community-Led Total Sanitation
99. Not applicable, no interventions or activities described

503. Was the behaviour change intervention developed based on an explicit model or theory of behaviour change?

1. Yes

7. No

99. Unclear or unable to determine

504. What model or theory of behaviour change was mentioned?

_____

99. Not applicable, unclear, or unable to determine

505. Did the behaviour change intervention attempt to modify or change specific constructs, factors or determinants related to the target behaviours?

1. Yes

7. No

506. What constructs, factors or determinants are mentioned? Use factors listed in the IBM Wash Framework, check all that apply

1. No constructs, factors or determinants mentioned
2. Contextual determinants (sociodemographic) mentioned e.g. age, gender, level of education, income/wealth
3. Contextual determinants (environmental) mentioned e.g. climate, topography, soil
4. Contextual determinants (social and cultural) mentioned e.g. migration, ethnicity (but excluding psychosocial like knowledge, beliefs, traditional practices)
5. Psychosocial determinants mentioned e.g. knowledge, disgust, self-efficacy, social norms, outcome expectations, perceived susceptibility, perceived severity
6. Technology determinants mentioned e.g. suitability of the technology for the population, feasibility of regular use by the population, availability/distribution and cost of the technology

507. Was the behaviour change intervention implemented in a series of phases, each one building upon the previous one?

1. Yes

7. No

Implementation and evaluation of handwashing interventions

601. Was handwashing promoted as part of this study or programme?

1. Yes => Continue

7. No => Skip this section and leave the rest of the questions blank. Go to Section 7.

602. Was some type of enabling technology installed, distributed, sold, promoted or identified as part of the intervention or programme? Check all that apply:

1. Handwashing station with reservoir and tap
2. Place to wash hands at pump or other water source
3. Bar soap

4. Soapy water/soapy water bottle
5. Ash
6. Hand sanitiser
7. The study assessed whether soap, sanitiser or other enabling technology was present, but did not provide it or distribute or sell it to people
8. Other

88. No enabling technology related to handwashing installed, distributed or sold

99. Enabling technology was part of intervention, but no information provided about it

603. If hardware was involved, was there a statement of the total number installed or distributed or sold over the entire project area?

_ _ # hardware

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

604. Was there a statement of the proportion of households installing, receiving, or purchasing the hardware?

_ _ %

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

605. How was installation, receipt or purchase at the household level measured?

1. Confirmation at time of installation or delivery
2. Observation during a household survey
3. Question to the householder during a household survey

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

606. Was functionality/maintenance of the hardware assessed?

1. Yes

7. No

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

607. Which of the following steps were taken to assess the effect of the intervention to promote handwashing? Check all that apply.

1. Survey question: People were asked the key times to practise handwashing
2. Survey question: People were asked if they practise handwashing at all
3. Survey question: People were asked if they practise handwashing at key times

4. Observation of handwashing skills: One or more people from each household asked to demonstrate how to wash hands correctly. Observer notes amount of water used, soap or ash used to wash hands, both hands washed/rubbed
5. Pocket voting: Each person attending a meeting votes secretly in pocket chart on whether they always wash both hands with soap and water
6. Observation of availability of soap and water at place of handwashing
7. Survey question: Interviewee asked to bring soap used for handwashing
8. Motion detector in a bar of soap
9. Direct observation: Spot check to observe handwashing
10. Direct observation: Continuous observation in household to observe handwashing

77. Disease risk / germ theory related to handwashing

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

608. Were handwashing behaviours observed?

1. Yes

7. No

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

609. How were handwashing behaviours observed?

77. Disease risk knowledge of germ theory related to X

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

610. Which results were reported related to the change in the handwashing measure in this study? Check all that apply.

1. Significant increase in handwashing during period of study/intensive implementation of programme
2. No or insignificant increase in handwashing during period of study/intensive implementation of programme
3. Maintenance of handwashing or very limited decline (non-significant) after end of study/intensive implementation of programme
4. Gradual decline in handwashing occurring over many months after end of study/intensive implementation of programme
5. Sharp decline in handwashing occurring immediately after end of study/intensive implementation of programme
6. Decrease in diarrhoea during period of study/intensive implementation
7. Maintenance of decrease in diarrhoea after end of study/intensive implementation of programme

8. Failure to maintain decrease in diarrhoea after end of study/intensive implementation of programme

77. Data reported are from a cross-sectional or single survey and changes over time cannot be inferred from study design or description.

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

611. Is there an increase in reported presence of soap near sink, toilet or handwashing station, and/or proportion of respondents able to produce a bar of soap when asked?

1. Significant increase in availability of soap for handwashing
2. Non-significant increase in availability of soap for handwashing
3. No increase in availability of soap for handwashing

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on availability of soap

612. What factors were associated with use/adoption of handwashing enabling technology

88. No handwashing intervention

99. Handwashing intervention implemented, but no information provided on this point

Implementation and evaluation of water treatment interventions

701. Was water treatment / POU promoted as part of this study or programme?

1. Yes => Continue

7. No => Skip this section and leave the rest of the questions blank. Go to Section 8.

702. Was boiling of drinking water promoted?

1. Yes

7. No

88. No water treatment intervention

703. Was some type of enabling technology installed or distributed or sold or promoted as part of the intervention? Check all that apply:

1. Ceramic filter
2. Biosand filter
3. Other kind of filter
4. Chlorine tablets
5. Chlorine dispenser
6. Solar water disinfection
7. Vessel to hold specific amount of water for chlorination
8. Vessel to protect water from recontamination by hands
9. Other

88. No enabling technology related to water treatment installed, distributed or sold

99. Enabling technology was part of intervention, but no information provided about it

704. If hardware was involved, was there a statement of the total number installed or distributed or sold over the entire project area?

_ _ # installed

88. No water treatment intervention

99. Water treatment intervention implemented, but no information provided on this point

705. Was there a statement of the proportion of households installing, receiving, or purchasing the hardware?

_ _ %

88. No water treatment intervention

99. Water treatment intervention implemented, but no information provided on this point

706. How was installation, receipt or purchase at the household level measured?

1. Confirmation at time of installation or delivery
2. Observation during a household survey
3. Question to the householder during a household survey

88. No water treatment intervention

99. Water treatment intervention implemented, but no information provided on this point

707. Was functionality/maintenance of the hardware assessed?

1. Yes

7. No

88. No water treatment intervention

99. Water treatment intervention implemented, but no information provided on this point

708. Which of the following steps were taken to assess the effect of the intervention to promote water treatment? Check all that apply.

1. Survey question: People were asked how and when to treat their water
2. Survey question: People were asked if they practise water treatment at all
3. Observation of skills: One or more people from each household asked to demonstrate how to treat water with the technology provided
4. Pocket voting: Each person attending a meeting votes secretly in pocket chart on whether they always treat their water
5. Observation of presence and functionality of the water treatment technology
6. Microbiological testing of drinking water samples
7. Testing of drinking water for Arsenic
8. Testing of drinking water for Fluoride

9. Testing of drinking water for other contaminants

10. H2S test on drinking water

11. Test of drinking water for chlorine

12. Other

77. Knowledge of germ theory / disease transmission related to water

88. No water treatment intervention

99. Water treatment intervention implemented, but no information provided on this point

709. Which results were reported in this study? Check all that apply.

1. Significant increase in water treatment during period of study/intensive implementation of programme
2. No or insignificant increase in water treatment during period of study/intensive implementation of programme
3. Maintenance of water treatment or very limited decline after end of study/intensive implementation of programme
4. Moderate decline in water treatment after end of study/intensive implementation of programme
5. Sharp decline in water treatment after end of study/intensive implementation of programme
6. Decrease in diarrhoea during period of study/intensive implementation
7. Maintenance of decrease in diarrhoea after end of study/intensive implementation of programme
8. Failure to maintain decrease in diarrhoea after end of study/intensive implementation of programme

77. Data reported are from a cross-sectional or single survey and changes over time cannot be inferred from study design or description.

88. No water treatment intervention

99. Water treatment intervention implemented, but no information provided on this point

710. What factors were associated with use/adoption of water treatment technology?

88. No water treatment intervention

99. Water treatment intervention implemented, but no information provided on this point

Implementation and evaluation of sanitation interventions

801. Was sanitation promoted as part of this study or programme?

1. Yes => Continue

7. No => Skip this section and leave the rest of the questions blank. Go to Section 9.

802. Was some type of enabling technology installed or distributed or sold or promoted as part of the intervention? Check all that apply:

1. Materials for latrine construction provided free of charge to community
2. Materials for latrine construction sold to community

3. Community members trained in latrine construction
4. Private company or contractors construct latrines
5. Community constructs their own latrines, in traditional way
6. Other

88. No enabling technology related to sanitation installed, distributed or sold

99. Enabling technology was part of intervention, but no information provided about it

803. If hardware was involved, was there a statement of the total number installed or distributed or sold over the entire project area?

88. No sanitation intervention

99. Sanitation intervention implemented, but no information provided on this point

804. Was there a statement of the proportion of households installing, receiving, or purchasing the hardware?

88. No sanitation intervention

99. Sanitation intervention implemented, but no information provided on this point

805. How was installation, receipt or purchase at the household level measured?

1. Confirmation at time of installation or delivery
2. Observation during a household survey
3. Question to the householder during a household survey

88. No sanitation intervention

99. Sanitation intervention implemented, but no information provided on this point

806. Was functionality/maintenance of the hardware assessed?

1. Yes

7. No

88. No sanitation intervention

99. Sanitation intervention implemented, but no information provided on this point

807. Which of the following steps were taken to assess the effect of the intervention to promote sanitation? Check all that apply.

1. Survey question: People were asked if they use the latrine
2. Survey question: People were asked if they help to maintain/clean the latrine
3. Pocket voting: Each person attending a meeting votes secretly in pocket chart on whether they always use the latrine
4. Direct observation: Observer visits latrine to see if there was a clear path to the pit, if there was excreta in the pit, and if surrounding environment is free of excreta.
5. Direct observation for cleanliness: Observer examines to see if latrine floor, the squat hole/pan and walls are free of excreta
6. Direct observation for maintenance: presence/lack of cover for hole in pit latrines, presence of holes in walls big enough to see through, whether the latrine has roof and door

7. Direct observation: Sites of open defecation in the community
8. Other method

77. Disease risk / knowledge of germ theory related to sanitation.

88. No sanitation intervention

99. Sanitation intervention implemented, but no information provided on this point

808. Which results were reported in this study? Check all that apply.

1. Significant increase in latrine use during period of study/intensive implementation of programme
2. No or insignificant increase in latrine use during period of study/intensive implementation of programme
3. Maintenance of latrine use or very limited decline after end of study/intensive implementation of programme
4. Moderate decline in latrine use after end of study/intensive implementation of programme
5. Sharp decline in latrine use after end of study/intensive implementation of programme
6. Decrease in diarrhoea during period of study/intensive implementation
7. Maintenance of decrease in diarrhoea after end of study/intensive implementation of programme
8. Failure to maintain decrease in diarrhoea after end of study/intensive implementation of programme

77. Data reported are from a cross-sectional or single survey and changes over time cannot be inferred from study design or description.

88. No sanitation intervention

99. Sanitation intervention implemented, but no information provided on this point

809. What factors were associated with use/adoption of sanitation technology

88. No sanitation intervention

99. Sanitation intervention implemented, but no information provided on this point

Factors affecting uptake of the behaviour/adoption of the behavioural recommendations

901. Is the association between any of the following contextual factors and the behaviours or interest assessed? Check all that apply:

1. Household income/wealth
2. Level of education of household members
3. Household structure
4. Income generation activities or work patterns of household members
5. Religion
6. Ethnicity
7. Other contextual factors => Q902

99. No contextual factors reported or described

902. Specify other contextual factors

99. No other contextual factors reported or described

903. Is the association between any of the following psychosocial factors and the behaviours or interest assessed? Check all that apply:

1. Knowledge of mode of transmission of diarrhoea
2. Knowledge of other WASH diseases
3. Knowledge of toxins (Arsenic, Fluoride, pesticides etc.)
4. Perceived susceptibility
5. Perceived severity
6. Perceived benefits
7. Perceived barriers
8. Social norms – Descriptive
9. Social norms – Injunctive
10. Subjective norms
11. Disgust
12. Self-efficacy
13. Behavioural cues
14. Other psychosocial factors=> Q904

99. No psychosocial factors reported or described

904. Specify other psychosocial factors:

99. No other psychosocial factors reported or described

905. Is the association between any of the following technology factors and the behaviours or interest assessed? Check all that apply:

1. Feasibility of using the technology
2. Feasibility of routine/repeated use of the technology
3. Status for owner to been seen owning such a technology
4. Cost
5. Installation of the technology
6. Maintenance and/or difficulty maintaining in working order
7. Local manufacturing of technology
8. Importing or procuring the technology
9. Distribution of the technology
10. Other technology-related factors => Q906

99. No technology-related factors reported or described

906. Specify other technology-related factors:

99. No other technology-related factors

The authors of this report were supported by the Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre) and the International Initiative for Impact Evaluation (3ie).

The Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre) is part of the Social Science Research Unit (SSRU), Institute of Education, University of London.

Since 1993, we have been at the forefront of carrying out systematic reviews and developing review methods in social science and public policy. We are dedicated to making reliable research findings accessible to the people who need them, whether they are making policy, practice or personal decisions. We engage health and education policy makers, practitioners and service users in discussions about how researchers can make their work more relevant and how to use research findings.

Founded in 1990, the Social Science Research Unit (SSRU) is based at the UCL Institute of Education, University College London. Our mission is to engage in and otherwise promote rigorous, ethical and participative social research as well as to support evidence-informed public policy and practice across a range of domains including education, health and welfare, guided by a concern for human rights, social justice and the development of human potential.

This material has been funded by the Department for International Development. However the views expressed do not necessarily reflect the department's official policies. The report was first published in 2015 by:

Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre)
Social Science Research Unit
Institute of Education, University of London
18 Woburn Square
London WC1H 0NR

Tel: +44 (0)20 7612 6397
http://eppi.ioe.ac.uk
http://www.ioe.ac.uk/ssru

ISBN: 978-1-907345-77-7

Cover image © Kristyna Hulland

The International Initiative for Impact Evaluation (3ie) works to improve the lives of people in the developing world by supporting the production and use of evidence on what works, when, why and for how much. 3ie is a new initiative that responds to demands for better evidence, and will enhance development effectiveness by promoting better informed policies. 3ie finances high-quality impact evaluations and campaigns to inform better program and policy design in developing countries. 3ie Systematic Reviews examine the range of available evidence regarding a particular intervention.

International Initiative for Impact Evaluations (3ie)
Tel: + 44(0)20 7958 8351/8350
http://www.3ieimpact.org

This document is available in a range of accessible formats including large print. Please contact the Institute of Education for assistance:
telephone: +44 (0)20 7947 9556 email: info@ioe.ac.uk