



BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

How community participation in water and sanitation interventions impacts human health, WASH infrastructure and service longevity in low- and middle-income countries: a realist review

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-053320
Article Type:	Original research
Date Submitted by the Author:	15-May-2021
Complete List of Authors:	Nelson, Sarah; The University of Sydney, School of Public Health Drabarek, Dorothy; The University of Sydney, School of Public Health Jenkins, Aaron; The University of Sydney, School of Public Health; Edith Cowan University, School of Science Negin, Joel; The University of Sydney, School of Public Health Abimbola, Seye; The University of Sydney, School of Public Health
Keywords:	PUBLIC HEALTH, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Tropical medicine < INFECTIOUS DISEASES

SCHOLARONE™
Manuscripts








I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1 How community participation in water and sanitation interventions impacts human health, WASH
2 infrastructure and service longevity in low- and middle-income countries: a realist review

3
4 Sarah Nelson^{1*}, Dorothy Drabarek¹, Aaron Jenkins^{1,2}, Joel Negin¹, Seye Abimbola¹

5 1: School of Public Health, University of Sydney, Fisher Road, Camperdown, NSW 2006, Australia

6 2: School of Science, Edith Cowan University, Joondalup Drive, Joondalup, WA 6027, Australia

7
8 *Corresponding author

9 Email: s.a.nelson@live.com

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

11 **Abstract**

12

13 **Objective:** To understand how, and under what circumstances community participation in water and

14 sanitation interventions impacts availability (of safe water and sanitation), change in health status or

15 behaviour, and longevity (of resources and services).

16 **Design:** Realist review

17 **Data sources:** PubMed, Web of Science and Scopus databases to identify studies from low- and

18 middle-income countries from 2010 to 2020.

19 **Eligibility criteria for selecting studies:** Broad inclusion criteria were developed for studies to be

20 included. The contribution each paper was assessed based on relevance and rigour (e.g., can it

21 contribute to context, mechanism or outcome, and is the method used to generate that information

22 credible).

23 **Analysis:** Inductive and deductive coding was used to generate context–mechanism–outcome

24 configurations.

25 **Results:** 73 studies conducted in 29 countries were included. We identified five mechanisms that

26 explain availability, change and longevity outcomes: 1) accountability (policies and procedures to hold

27 communities responsible for their actions and outcomes of an intervention), 2) diffusion (spread of an

28 idea or behaviour by innovators over time through communication amongst members of a

29 community), 3) market (the interplay between demand and supply of a service or resource), 4)

30 ownership (sense of possession and control of the service or resource), and 5) shame (a feeling of

31 disgust in one’s behaviour or actions). Contextual elements identified include community dynamics

32 (such as community leadership and communication), technical skills and knowledge, resource access

33 and dependency, committee activity and practices (such as the presence of rules and management

34 plans), location, and level of community participation.

35

36 **Conclusions:** The findings highlight five key mechanisms, impacted by 19 contextual factors that

37 explain the outcomes of community-based water and sanitation interventions. Policymakers, program

38 implementers, and institutions need to consider community dynamics, location, resources, committee

39 activity, and practices, and level of community participation, before the introduction of community-

40 based water and sanitation interventions.

41

42 **Strengths and limitations**

43 • The size of the review allowed for diverse CMOs to be explored and understood from a range

44 of contexts from 29 countries.

- The paper identified 19 contextual factors that explain the outcomes of community-based water and sanitation interventions.
- The papers selected for this review were limited to those available in English, peer-reviewed and available online through a database search but did not include grey literature.
- Most of the papers identified only focused on outcomes over a short time period, with only a few looking over five years. The short time frames are usually insufficient for behaviour change or resource/service longevity to be observed.
- The paper did not include papers that looked at communities' natural resource management and interventions, it only included papers where an external party such as NGO or government was involved in the natural resource management and interventions.

Keywords: Context-mechanism-outcome configuration, low- and middle-income countries, realist review, communities

Introduction

Access to water and sanitation is fundamental for human health (1). Water, sanitation and hygiene (WASH) interventions continue to be implemented to improve availability and services, especially in low- and middle-income countries (LMICs). WASH interventions include hardware interventions such as toilets and water points, and their operation and maintenance, or software intervention such as education programmes and training. But the literature shows mixed effects of these interventions – some display positive impacts, with others showing no impact on health (2,3). In an effort to understand why WASH interventions fail, an expanding body of research seeks to examine the contexts (environmental, socio-cultural, institutional, economic) into which they are introduced (4–7). This emphasises the importance of understanding the influence of context on the success (or failure) of community-based WASH interventions and highlights that no single strategy can be successful in all contexts and circumstances (1,8,9).

WASH interventions are designed to take into account a broad range of factors such as cultural traditions (10,11), resource dependency (12), service quality and satisfaction (13), and rules and procedures used by the community (14). Further, the resources required for long term maintenance of interventions are often limited in LMICs, leading to their failure (1). It is difficult for cities, especially in LMICs, to improve sanitation and expand potable water access while keeping up with population growth and migration (15). Failure of interventions can occur for several reasons, such as lack of

1
2
3 79 community participation in design (16,17), lack of ownership (18,19), abuse of funds or poor financial
4
5 80 management (20), lack of willingness of community members to contribute (19–21), lack of
6
7 81 communication and connectedness (22) and no ongoing support and acknowledgement of behaviour
8
9 82 change (23–25).

10 83
11 84 Current literature shows multiple benefits of community participation; e.g., it allows cultural exchange
12
13 85 and the building of knowledge between the implementing partners, and it can ensure interventions
14
15 86 are more relevant to local priorities (7,26). Also, communities (particularly Indigenous communities),
16
17 87 have developed knowledge structures by place, space, and relationality over generations that are
18
19 88 passed from one generation to the next, providing information on how to use resources to promote
20
21 89 their longevity (7). It can also cause issues as communities may have beliefs that do not align with the
22
23 90 intervention (27). Lack of community participation is often seen as a hindrance in collaborative action
24
25 91 (28). The definition and manifestation of community participation in WASH interventions vary
26
27 92 significantly across articles and studies (4). In rural areas, community participation involves the active
28
29 93 engagement of users in water services management (4). Community participation can also mean the
30
31 94 involvement of community members in the planning, construction, decision-making, and ongoing
32
33 95 management of their water system (29). Community participation also refers to enabling communities
34
35 96 to initiate project ideas, make decisions about technology type and facility location that best suits
36
37 97 their needs (20). In the context of this paper, community participation is defined as community
38
39 98 members having a role in planning, design, construction, decision-making or management (including
40
41 99 financial and operations and maintenance) of WASH interventions (4,20,26,29).

42 100
43 101 Understanding the impact of contextual factors is important for designing and implementing long-
44
45 102 lasting WASH services within communities, given the vast heterogeneity of community contexts (6).
46
47 103 Some literature reviews have been conducted to examine the impact of specific contextual factors or
48
49 104 a single water or sanitation intervention (4,6). Our realist review attempts to address this gap in the
50
51 105 literature. The aim is to answer how and under what circumstances does community participation in
52
53 106 water and sanitation interventions impact availability of safe water and sanitation, change in health
54
55 107 status or WASH behaviour, and longevity of water resources, infrastructure and services.

56 108
57 109 **Materials and Methods**
58
59 110 *Rationale for using a realist approach to review*
60
61 111 The realist approach was chosen as it aims to understand and unpack the mechanisms through which
62
63 112 an intervention works or fails in different contexts and settings (30). It is a theory-driven approach

that can help explain why an intervention works in one setting and not in another (30). The realist approach begins with the understanding that interventions are complex because of their reliance on the interpretation, reasoning and actions of social agents to bring about change (31,32) and that the human agency of these social agents are in turn influenced by the socioeconomic, geographical, institutional structures in which they exist (i.e. context) (30). In realist synthesis, an outcome of an intervention is shaped by the interaction between these contextual factors and the intervention, which triggers some kind of action (or not) among social agents as determined by their reasoning, which then results in some kind of change (or not). Context-Mechanism-Outcome (CMO) configurations summarise explanations of how contextual factors (C), influence the production of outcomes (O), by triggering human agency in the form of mechanisms (M). 'Mechanism' refers to the combination of reasoning and resources that influence the actions of participants and stakeholders in an intervention. The mechanism may be activated under the right contextual conditions (33). Therefore, WASH interventions may change how a community receives or responses to this intervention, and this is dependent on the context in which they live.

Search strategy

In preparation for the realist review, we conducted preparatory sessions by reading a variety of WASH literature. This helped us identify possible outcomes, contexts, and mechanisms to guide the literature research and the best keywords to use. We conducted preliminary searches to see what type of papers were identified, and the breadth and depth of WASH interventions covered. This process helped guide the final review question as it highlighted gaps in documented knowledge, and in turn shaped the interventions we focused on i.e. "new" interventions, endogenous or exogenous in origin.

Two literature searches of PubMed, Web of Science and Scopus was conducted to identify peer-reviewed papers on how community participation in water and sanitation interventions impact availability of safe water and sanitation, change in health status or behaviour, and longevity of water resources and services outcomes in LMICs. The search terms used were 'water', 'WASH', 'water resource', 'hygiene', 'sanitation', 'community participation', 'demand driven', 'community led', 'community engage*', 'community based', 'community manage', 'sustain*' and 'health'. The search strategy was developed with the assistance of a research librarian. Filters were applied to exclude reviews. Only English papers were considered. Only articles from 01-01-2010 to 03-04-2019 were considered in the first search conducted in April 2019. Only articles from 01-01-2019 to 31-12-2020 were considered in the second search conducted in March 2021. Papers were identified and exported into Zotero. Duplicates were identified and removed. In conducting and reporting this realist synthesis

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

we followed the synthesis production and quality standards (RAMESES) (34) and training materials (35) and other examples of reviews (31,36).

After screening the abstracts, full papers were assessed on the intervention, the outcome of interest, community role, study type and location. The intervention may be endogenous or exogenous in origin. The intervention had an intended outcome linked to water, sanitation, health or resource/service longevity. The community had to participate in one or more of the following ways were included: a) community had full authority in decision-making and autonomy of the management of water resource or intervention, b) community had the majority of authority in decision-making and/or management of water resource or intervention, whether the latter is endogenous or exogenous in origin, c) community members (e.g. leaders, community health workers) were involved in the design and/or delivery of an intervention by an external agent. Community members may have varying degrees of autonomy in their work and decision-making power and d) community had a role through participation, consultation or engagement in activities and actions of an intervention by an external agent. Levels of decision-making power of community members may vary and may be as low as being easily overruled by an external agent. Only studies conducted in countries considered to be LMICs according to World Bank definitions were included (37).

Only studies with primary data were included. Formal quality appraisal was not carried out for individual papers could contribute to a different element of CMO configurations and exclusion reduces the validity of the findings (30). The contribution of any section of each paper was assessed based on relevance (i.e. whether it can contribute to emerging CMO configurations); and rigour (i.e. whether the method used to generate each piece of data relevant to the CMO configurations is credible).

Data extraction and categorisation

The first database searches found 595 entries from PubMed, 1,010 from Web of Science and 1,449 from Scopus (Figure 1). The searches from each database were merged, and 1,346 duplications were removed. A further 30 publications were removed based on their format, as they were a book or a review. After review of the remaining titles and abstracts, 1,523 were excluded reducing the selection to 155 publications. These 155 papers were read and assessed according to the inclusion and exclusion criteria by reviewers (SN and DD, in consultation with SA) on their relevance and rigour. Judgements on inclusion and exclusion were based upon two criteria: relevance (does the paper contribute to the understanding of how community participation in WASH interventions impacts any outcome of interest) and rigour (whether the method used to generate the data is credible e.g., not using primary

data). The second database searches found 739 entries from PubMed, 460 from Web of Science and 528 from Scopus (Figure 1). The same data extraction and categorisation steps were carried out in second search. A final 73 papers were included in the review.

[INSERT FIGURE 1 AROUND HERE]

We followed the stepwise approach used by Abimbola et al (31) (Table 1). Five papers were randomly selected, and iterative data extraction was conducted independently by three of the authors (SN, DD and SA) to determine the categories into which data will be extracted and the consistency of the extraction process across authors. Data from the papers were extracted into an excel spreadsheet into the following categories: study population, country, community role, intervention, water, sanitation or hygiene linkage, study type, and context, mechanism, and outcome components. The extraction process guided the initial development of preliminary understandings of what was involved in behaviours, actions, social phenomena, reasonings that connected outcomes with contexts in each paper. These preliminary understandings contributed to the creation of mechanisms. It was not always possible to extract data about the outcome, context, and mechanism from each paper.

By synthesising the information in each paper, we identified five mechanisms that explain the outcomes from the studies: accountability, diffusion, market, ownership, and shame. Papers had multiple mechanisms. Across the five mechanisms three sets of outcomes were identified:

- (1) Availability (of resources and services such as clean water, and sanitation) at an individual or community level,
- (2) Behaviour change (to prevent disease, such as a reduction in open defecation and increase the use of handwashing) or change in health status (e.g. reduction in disease levels, reduction in health status such as diarrheal rates) at individual or community level,
- (3) Longevity (of water and sanitation infrastructure, services, and resources, including factors that impact on their long-term use, such as the technical capacity to repair, operate and maintain infrastructure, resource, or service).

We identified factors (socioeconomic, geographical, institutional) that enabled or hindered outcomes, and these were categorised as context. Concurrently, a list of potential midrange theories that could help explain our interpretations of relationships between identified contexts, WASH interventions and outcomes of interest was drawn from the literature and team discussions. The list was refined until

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

214 five theories could coherently explain the identified outcomes of community participation in WASH
215 interventions.
216

For peer review only

217 Table 1: Steps taken in the realist analysis

Step	Process
Step 1: Identifying outcomes (description)	This involved reading and re-reading the papers, first to gain familiarity with the studies and second to identify outcomes which occur because of community WASH initiatives e.g., how community engagement in water and sanitation interventions impact access (to safe water and sanitation), change (in health status or behaviour), and longevity (of these resources).
Step 2: Identifying contextual components of outcomes (abduction)	This involved further reviewing of papers to identify (enablers and hindered) of the identified outcomes. These included skills and knowledge (including financial capabilities and technical abilities to for operations and maintenance), social cohesion and connectedness, communication, willingness to pay, leadership and diverse involvement in the intervention (of women and at different stages of design, planning and implementation), and community characteristics and location.
Step 3: Theoretical redescription (abduction)	<p>This step involved exploring the selected outcomes and their contextual components within the theories to better understand what they represent. Five theories informed our analysis.</p> <ol style="list-style-type: none"> 1) Social accountability holds people in place to achieve actions because of fear of exposure, professional or public reprisal or cost of reputation leads to responsiveness by following a certain behaviour or idea (36). We adapted this idea to include formal accountability mechanisms such as policies, procedures and rules to hold communities and committees responsible for their actions and outcomes of an initiative. 2) Diffusion of innovation theory is the spread or adaption of an idea or a behaviour through a process which people adopt over time (38). The idea or behaviour spreads through innovators (those who try an idea or behaviour first), and early adopters (opinion leaders who enjoy leadership roles and embrace change opportunities) who influence and change ideas or behaviours throughout the community (38). We utilised this theory for leaders and key people in the community to be the innovators to shape and influence WASH behaviours within the community. 3) Demand theory is an economic theory that is the interplay between demand and supply of a good or service (it is a balanced supply and the price that people are willing to pay for it (39). There is an important dynamic to ensure the system market does not fail, because of changes in price or demand. This theory is adapted to focus on the supply and demand for water resources, and a community's or individuals' willingness to pay for them and other factors that influence the supply and demand balance. 4) Arnstein's ladder of participation proposes that increased meaningful community participation correlates with more power in the decision-making process and thus more control over the change it may bring, leading to a sense of ownership (40). With this mechanism, we focused on how a sense of ownership within resources or service related to WASH such as water can help build a sense of value, and lead communities or individuals to manage the resources

	<p>or service better. The idea being a stronger sense of ownership than they are more likely to protect it and use it effectively.</p> <p>5) Social comparison theory is where humans need to compare themselves and evaluate their opinions and abilities to themselves, and that people evaluate their abilities and opinions through comparing themselves with other people (41). The influence of social comparison, and desire to fit into a specific situation can cause changes in verbal and nonverbal behaviour to fit the situation. Comparison can have negative impacts on behaviours. We adapted this theory to focus on the element of shame as a form of social comparison, for people to conform to appropriate socially accepted WASH behaviours</p>
Step 4: Identifying mechanisms (retroduction)	<p>This step involves examining the identified outcomes with their hindering or enabling contextual factors with the aiming of creating processes and systems that resulted from observed patterns across LMICs. This involved moving back and forth between primary data theories created in this review to develop explanations for the outcome and contextual linkages.</p>

220

221

222 Theoretical framing

223 We used retroductive analysis to identify the mechanisms underlying our O-C pairings (Step 4). This
224 was done by reading and rereading papers and reviewing the extracted data concurrent to
225 undertaking a close reading of the theory. This, along with team discussions, led to the exploration of
226 the wider literature. And in a process of deductive and inductive reasoning, we identified five theories
227 that informed our analysis (Step 3 for details). The first theory, *social accountability* explains how
228 people are held accountable for a certain behaviour or idea because of fear of exposure, professional
229 or public reprisal, or damaged reputation for not fulfilling it (36). The second theory, *diffusion of*
230 *innovation*, explains the pattern of the spread and adoption of a new idea, technology or behaviour
231 over time in social systems (38). It proposes that a population is made up of innovators, early adopters,
232 early majority, late majority and laggards who follow a predictable pattern of adoption that is
233 cumulative over time (38). Thirdly, demand theory is an economic theory that explains the relationship
234 between the supply and demand of a service or good, and its price (39). Typically, when a good or
235 service becomes more readily available and supply increases, prices tend to fall, and when the price
236 of a good or service increases demand tend to fall (39). Fourthly, *Arnstien's Ladder of Citizen's*
237 *Participation* provides a framework for understanding the impact of the extent to which a community
238 contributes to, is involved in, and owns community interventions (40). The level of participation has
239 implications for power and control a community can exert (40). Lastly, *social comparison* theory
240 explains that people shape ideas and behaviours in comparison to those surrounding them and they
241 change their ideas or behaviours to conform to those around them (41).

242

243 These five theories are broad in their potential application. For this reason, they are only a starting
244 point for the development in the CMO configurations. Through a process of retroductive analysis, the
245 five theories produced five mechanisms: 'social accountability' became the 'accountability' (e.g.
246 policies and procedures to hold communities and committees responsible for their actions and
247 outcomes of an intervention), 'diffusion of innovation' became the 'diffusion' (e.g. the spread or
248 adoption of the behaviour or action due to leaders or influential community members making the
249 change earlier), 'demand theory' became 'market' (the interplay between demand and supply of a
250 service or resource to ensure availability or longevity), 'Arnstein's Ladder' became 'ownership' (e.g.
251 the level of individual or community participation became impacts the degrees of control and sense
252 of possession over a service or resource impacted the outcomes of interest), and lastly 'social

1
2
3 253 comparison' became 'shame' (e.g. a feeling of disgust in one's behaviour or actions as they are not
4
5 254 seen as desired or comply with other people's behaviours in the community).
6
7 255

8 256 **Results**
9

10 257 Overall, 73 papers were identified, and presented data from 29 countries (Figure 2), with different
11
12 258 WASH intervention focus (Figure 3). We identified five mechanisms made possible by WASH
13
14 259 interventions: 'accountability', 'diffusion', 'market', 'ownership' and 'shame'. The analysis focused on
15
16 260 mechanisms, rather than the country as we were focused on community-based interventions and each
17
18 261 community intervention and context builds to a piece of the mechanism development. The analysis
19
20 262 did also not look at the type of intervention as the outcomes identified can be linked to WASH
21
22 263 interventions. As the country and the type of intervention were not specifically named in the finding
23
24 264 a separate table has been created in the Supplementary Appendix.
25
26 265

25 266 [INSERT FIGURE 2 AROUND HERE]

26 267 [INSERT FIGURE 3 AROUND HERE]
27
28 268

29
30 269 The next section describes each mechanism in detail, followed by a description of each based on the
31
32 270 individual outcome, and key contextual factors highlighted as identified through the literature review.
33
34 271 See Table 2 for a summary.
35
36 272

273 **Table 2: Enabling context-mechanism-outcome configurations**

Context	Mechanism	Outcome
<ul style="list-style-type: none"> • Easily accessible community (e.g., size and location) to allow access for monitoring visits. • Having opportunities to share information (e.g., meetings) between users and committee members for internal monitoring. • Having active and functional community committees for internal monitoring • Committees with clear responsibilities, rules and management plans that are followed and understood (e.g., written working plans for system breakdowns). • Having consequences for not conforming to change (e.g., fines). 	Accountability	<ul style="list-style-type: none"> • Availability of a service or a resource e.g., to ensure that sanitation facilities are in place or to assess the levels of groundwater. • Changes in behaviour or health outcomes e.g., reduction of open defecation, improvements in children's height and weight. • Sustainability of water resources and services.
<ul style="list-style-type: none"> • Having strong leaders or committees to help share the spread of ideas and initiate change. • Having higher levels of social cohesion and connectedness in small rural and remote communities to help create supportive environment for change and influence new social norms. • Having regular communication among peers to build and share knowledge. 	Diffusion	<ul style="list-style-type: none"> • Availability of resources or services e.g. latrines, handwashing facilities and water. • Changes in behaviour or health outcomes e.g. reduction of open defecation, water purification and waterborne diseases. • Maintenance and sustainability of latrines and water access/systems.
<ul style="list-style-type: none"> • Having strong leaders or committees to help share the spread of ideas and initiate change. • Having higher levels of social cohesion and connectedness in small rural and remote communities to help create supportive environment for change and influence new social norms. • Having regular communication among peers to build and share knowledge. 	Market	<ul style="list-style-type: none"> • Availability of resources e.g., water. • Sustainability of water services or latrine quality.
<ul style="list-style-type: none"> • Having community or committee knowledge or skills e.g. technical - the ability to repair hardware. • Having resource dependency to ensure community investment in supply and ongoing maintenance and operational costs. • Community involvement (including women) in the design, planning or implementation to promote accessibility, equitable access and the desire to maintain the resource. • Having opportunities to communicate about the state of the resource or service to help maintenance. 	Ownership	<ul style="list-style-type: none"> • Availability of resources or services e.g., water and latrines. • Sustainability of the water system or service.
<ul style="list-style-type: none"> • Small, cohesive, and isolated communities with high social cohesion and connectedness helps the conformity of behaviour. 	Shame	<ul style="list-style-type: none"> • Availability of resources e.g., individual or household ownership of latrines and handwashing facilities.

<ul style="list-style-type: none">• Having community involvement allows understanding of the impacts of the behaviour and the benefits of change.• Shame initiated by leaders and people known within the community helps acceptance, monitoring and enforcement.• Community technical or financial capabilities allows the ability to conform to change.• Ongoing support and acknowledgement of change for community motivation to maintain changes.		<ul style="list-style-type: none">• Change in behaviour or health outcomes e.g., reduction in open defecation, hand washing with soap, reduction in roundworm infestation and stunting.
---	--	---

274
275

276

277 ACCOUNTABILITY

278 The accountability mechanism is built on the idea of social accountability where one party holds
279 another accountable for something, such as an action. The accountability mechanism we propose is a
280 formal mechanism is triggered by the rules, procedures, and policies to hold committees, communities
281 and households responsible for decisions and actions. These can include monitoring and fines to help
282 ensure actions and decisions taken are appropriate to promote availability, behaviour change and
283 resource longevity. Accountability is more likely to be achieved when there the community is easily
284 accessible, opportunities are present to share information and there is a strong and functional
285 committee as it is easier to uphold and enforce rules, procedures, and policies. The three outcomes
286 identified were availability, change and longevity.

287

288 Availability

289 Triggered by internal or external monitoring, accountability may result in improved community
290 availability to a resource or service. The focus of such monitoring may be progress towards achieving
291 a goal. The goal may be about the availability of a service – e.g., to ensure that sanitation facilities are
292 in place (10,23,42–48), that facilities meet the needs of people with disabilities (49), or that water is
293 accessible (50,51). The goal may also be resource preservation (safety and/or accessibility) so that
294 water is available to be accessed as desired – e.g., to check water samples for faecal or arsenic
295 contamination (16,52–55), or to assess the level of groundwater available for agriculture throughout
296 the year (56). Internal monitoring can be conducted by a chief or village headman (10,23,42), locally
297 trained volunteers (52), community members (44,56) or by the community's health, water or
298 community—total led sanitation committee (46–48,50–53). External monitoring can be conducted by
299 NGO facilitators (44,49), health workers (43,46,57) or political leaders and council officials (48).

300

301 Opportunities and platforms for regular communication and meetings between community members,
302 service users and health or water committees help build a sense of trust and connection between all
303 parties and helps to hold them accountable (49,52,55). This is reinforced where community leadership
304 is transparent and has open channels for communicating with community members (10,23,42,51),
305 communities make plans to change i.e. display of stickers to show the commitment to build latrines
306 (45) and the use of technology allows up to date monitoring (42,53). Government guidelines can
307 reinforce safe standards and monitoring of resources e.g. water (48,58). Accountability is also
308 strengthened where there is a functional, long-standing water or health committee whose members
309 are active, motivated and committed, and have clear roles and responsibilities (50,51). These can be

1
2
3 310 reinforced through committee trainings (53). A gender-balanced committee opens up the space for
4
5 311 accountability, as more opinions and views are considered on what factors are important and need to
6
7 312 be considered (47,50,51,54,59,60). Despite of a gender-balanced committee, there can be challenges
8
9 313 in accepting the involvement of women (47).

10 314
11
12 315 **Change**

13 316 Ongoing external monitoring can hold communities accountable for changing their health, hygiene
14
15 317 and sanitation behaviours (44,46–49,57,61,62), leading to improved health of children as seen in
16
17 318 height and weight changes and diarrhoea occurrence (47,62). Without ongoing internal or external
18
19 319 monitoring, loss of momentum for change can occur, halting behaviour change progress (24,48).
20 320 Ongoing monitoring is enabled by regular meetings and sharing of information to enforce behaviour
21
22 321 change (26,47,52). However, limited availability to communities due to a remote location, inadequate
23
24 322 or unreliable transport, violence, and large community size and layout, understaffed organisations are
25
26 323 barriers to ongoing external monitoring (48,51,62). Accountability can also influence behaviour
27
28 324 change when triggered by fines (e.g. money, goat, or chicken) imposed as a penalty for not conforming
29
30 325 to the desired behaviour. For example, penalties can be used to enforce standards for latrines (26),
31
32 326 for not constructing a latrine, and for open defecation (10,48), and fines for not respecting water use
33
34 327 limits (55). Trust is an essential contextual factor for such penalties – tensions arise when a community
35
36 328 does not trust the person or committee collecting the fines and what they will do with the fines
37
38 329 (19,26). Trust depends on the person or committee’s record of financial management, and whether
39
40 330 they have clear rules about the use of such penalties. Lack of trust from external organisations can
41
42 331 also prevent change in communities’ behaviours (55).

43 332
44 333 **Longevity**

45 334 Accountability within community committees can facilitate their continued activities, therefore
46
47 335 promoting the longevity of resources and services for which they are responsible. This requires that
48
49 336 committees have internal feedback systems, take minutes and set agendas with written working
50
51 337 plans, reflecting high self-organising capabilities, and a sense of obligation among committee
52
53 338 members to attend meetings and take action to manage and maintain resources, thus contributing to
54
55 339 the longevity of water and sanitation interventions (18,26,50,52,58,63). Accountability to government
56
57 340 entities (e.g., water boards) for reports and abiding by government policies can promote longevity as
58
59 341 it can hold committees and communities responsible for funds to maintain resources and services
60
342 (16,18,58,64,65). Communication with the broader community holds committees accountable for
343 their roles and responsibilities concerning water and sanitation infrastructure in a community

(18,29,65). Communication can help enable the diffusion of efforts to change the landscape of governance within local communities, check the progress of actions and the enforcement of rules (10,21,55).

Committee accountability is enabled when committees have clear roles, responsibilities, rules and procedures (which they understand) on responding to system breakdowns, and managing ongoing maintenance and missing parts, with direct implications for the longevity of water availability and WASH infrastructure (22,26,50,53,58,66). The longevity of resources and services is facilitated by a committee's ability to make funds available or having bank accounts for operational and maintenance costs, and by it having rules and procedures for funds management (e.g., having a well-educated treasurer who manages and collects funds within the community), or by having the community participate actively in monitoring committee finances (16,20,22,50,55). However, where there are known instances of abuse of funds or poor financial management, community members are less willing to contribute, leading to low longevity of resources or services (19–21). Transparency in committee activities and community trust can help address this (55). Committee activity and social participation play key roles in managing maintenance and operation of water and sanitation systems and assist in the management of funds ensuring continued service provision (17,59,66–68). This can promote good governance and practice (17). While committee activity and social participation is an enabling factor, this alone is not enough to ensure the longevity of community water and sanitation infrastructure (69).

DIFFUSION

This mechanism captures the processes by which an idea, technology or behaviour that is perceived as new (i.e. they are considered innovations in a community) spreads and is adopted by individuals or a community. Our interpretation of how the diffusion of innovation theory works to bring about change was guided by the LMICs contexts from which we drew our review data. Diffusion of ideas in communities was observed as mostly unplanned, horizontal, peer-mediated spread (32), however in cases where the innovation was endogenous it was more likely that adoption was actively promoted (60), this difference can be explained by the effect of sense of ownership, which is explained in the mechanism ownership below.

The diffusion mechanism underscores that strong and stable social relations are essential for wide and sustained adoption of WASH interventions in communities, and illustrates the importance of *who* introduces new ideas, behaviours or technologies (exogenous WASH interventions) or champions

1
2
3 378 homegrown new ideas, behaviours or technologies (endogenous WASH interventions). These people
4
5 379 are identified as “innovators” (i.e. individuals who are the first to develop and try out new ideas) and
6
7 380 “early adopters” (i.e. opinion leaders who enjoy leadership roles and embrace change opportunities)
8
9 381 who over time through their influence, existing relationships and communication amongst members
10
11 382 of a community (38,71) can encourage adoption of new ideas, both passively and actively. Innovators
12
13 383 and early adopters in a community include teachers (72,73), leaders (10,23,42,48,71–75), healthcare
14
15 384 workers (57,72,73,76–78), and community committees (22,63,70,79). This mechanism is therefore
16
17 385 triggered primarily by contexts of strong social relations, and our analysis resulted in availability,
18
19 386 change, and longevity.
20
21 387

20 388 **Availability**

21
22 389 In communities lacking provision of basic WASH infrastructure by governments, availability to services
23
24 390 can be obtained through external agencies such as NGOs or by internal innovation. In both cases
25
26 391 availability of services is not instantaneous and depends on motivation, organisation and negotiation,
27
28 392 the successes of which are in turn shaped by the character of social relations within a community, the
29
30 393 more cohesive the better. In this way, availability of resources such as latrines
31
32 394 (8,11,42,45,46,48,63,74,75,80–82), water infrastructure such as pipes (29,70,83,84) and handwashing
33
34 395 facilities (46,48,81,82) can be driven by diffusion; when these facilities or the idea of them are new,
35
36 396 the collective action necessary to build or obtain them depends on the extent to which appreciation
37
38 397 for their value spreads in the community.
39
40 398

41
42 399 Additionally, information on community-led interventions that reflect the needs of the community
43
44 400 takes root more readily than interventions introduced by external sources which more often do not
45
46 401 address community needs accurately or at all. Information about the need for the WASH infrastructure
47
48 402 or service can diffuse more readily where people have similar experiences of need and importantly
49
50 403 high levels of social cohesion and sense of connectedness. Social cohesion and connectedness refer
51
52 404 to the extent of ongoing interaction and linkages in communities, and cooperation as people engage
53
54 405 and work together. Meaning that people may be more concerned about others, may be more likely
55
56 406 to cooperate, communicate and work with one another, and agree on community priorities and goals.
57
58 407 Attainment of resources is made easier if a significant number of people believe in its benefit and
59
60 408 value. Social cohesion helps to promote infrastructure or resource attainment and ultimately change
409
410 in access to WASH, as without it ‘early adopters’ would not be able to build the necessary momentum,
411
412 enthusiasm and confidence (8,45,63,80). In communities of high social cohesion, innovators can draw
413
414 on the existing influence of leaders to set new social norms (11,42,45,74), and early adopters draw on

the existing skills within the community to work on a resource or intervention (29,42,63,70). The success, respect and acceptance of the early adopters can provide the rest of the community confidence to adopt the new social norm (45,48). Diffusion can also within sections of the community such as among women and other community groups, as within these smaller groups they may have different sets of social norms and acceptable behaviours (11,70). Locally accessible resources enable availability (46,48).

Change

Diffusion can occur through communication among peers, which leads to shared understanding, therefore reinforcing the adoption of new behaviour at an individual or community level (42,63,72,83). Examples of diffusion influencing behaviour change include reduction of open defecation (10,46,48,61,64,71,73,82,85), water purification (83), disposal of rubbish and care of animals (61), and sanitation and hygiene behaviours e.g. handwashing and safe disposal of faecal material (47,70,75,82), which may lead to improved health outcomes such as a reduction in diarrhoea rates, waterborne diseases and respiratory infections (47,48,57,70,78). Behaviour change is enabled by diffusion in communities with high levels of social cohesion and connectedness by enabling communication among peers, to build and share knowledge i.e. through community and marketing events or radio shows (46,48,63,78,81,82), and as highly regarded leaders influence the spread of new behaviour and create new social norms through their endorsement (11,21,71,73,82). Higher levels of social cohesion in small rural and remote communities can also help sustain long-term behaviour change (e.g., reduction in open defecation), especially where people stick together to create a supportive environment for long-lasting change. In these contexts, the focus is on behaviour change at the community rather than at an individual's level (61,73). Increased latrine quality and cleanliness can reinforce the behaviour change (46,47).

Longevity

The longevity of resources such as water pumps or piping infrastructure or has often been difficult to achieve in LMICs where resources and technical expertise required for their maintenance are not easily available. However, if the value of the resource, through demonstrated health benefit for example has diffused and taken root in a community, this may assist in the mobilisation of efforts to maintain the resource or service. Strong social bonds between community members characterised shared goals and trust help facilitate the spread of information about the benefit of new ideas and encourage their adoption (29,63,72,74). The perceived need to collectively mobilise resources to address water or sanitation problems is shared by committees and within committees

1
2
3 446 (29,79,83,86,87). The willingness of community members to help one another further allows the
4 447 diffusion to lead to longevity of resources such as latrines (8,81) and water access (79,83), through the
5 448 maintenance of the resources (29). Gender-balanced committees or the active involvement of women
6 449 facilitates the spread of ideas within the community, especially about resources such as water systems
7 450 that women are particularly involved in using and managing daily (21,22,50,56,70).
8
9
10
11
12

13 451
14 452 **MARKET**
15 453 The market mechanism operates through the dynamic relations between demand and supply which
16 454 determines the price of a good or service. It is a mechanism allowing the distribution of resources. The
17 455 market mechanism is a dynamic balance between supply and demand, and can easily be thrown out
18 456 of balance, and lead to failure. Typically, when a good or service becomes more readily available and
19 457 supply increases, prices tend to fall, and when the demand for a good or service reduces, prices tend
20 458 to increase. The continued presence of a market system is important as it also a way that communities
21 459 and people support themselves. Supply and demand of resources, especially in relation to WASH is
22 460 influenced by contextual factors such as community or committee knowledge or skills, resource
23 461 dependency and use in the community, ability to access resources for operation and maintenance,
24 462 and a weather resilience system. These factors influence the want and need for services and
25 463 resources. Market systems need to be resilient and adaptable to address fluctuations in supply and
26 464 demand to ensure that there are continued resource or service availability and longevity for
27 465 communities.
28
29
30
31
32
33
34
35
36
37

38 467 **Availability**
39 468 Knowledge mediates relations between supply and demand, lack of knowledge results in imbalances
40 469 between supply and demand. Without knowledge, the availability of a resource or service may remain
41 470 low, even when it is available at an affordable price. Hence, to lead to improved use, efforts to increase
42 471 and improve the quality of supply (e.g. through training to increase the skills of local artisans on well
43 472 design), require complementary efforts to increase household knowledge (e.g. through social media
44 473 and public demonstrations) (88). The greater the level of community dependence on a resource (e.g.
45 474 high levels of need for clean, safe, drinkable water for domestic purposes), the more likely it is that
46 475 the community will invest in its supply (e.g. by promoting local development of skills required to
47 476 maintain hardware), thus, helping to maintain or increase the availability of water (17,20,52,59,70,79).
48
49
50
51
52
53
54
55
56

57 478 **Longevity**
58
59
60

Varying levels of demand for a resource or service due to seasonality can have an important influence on longevity. For example, water kiosk services are viable during the dry season when people are willing to pay for water because of limited rain and availability of water. However, market failure of water kiosks occurs (and they become unviable in the long term) due to continued supply during the wet season in settings where there is increased availability of water due to cheaper options linked to rains then becomes unviable in the long term (67). Willingness to pay for a water system (18–20,22,67) and community-based water supply projects costs (53,68,69) often determines a system's reliability or longevity, and this is linked to demand, affordability and financial capacity in a community. The ability to access resources and funding is important when communities lack knowledge and skills, and the ability to pay for such skills lacking (52).

User fees are often imposed when there is limited internal or external financial support, and the resource or service requires ongoing maintenance and operational costs. User fees can also help to regulate demand and promote the responsible use of resources, promoting longevity (52,58,68), although this requires enforcement to pay fees (55). Low levels of willingness to pay (sometimes reflecting low levels of need or capacity to pay) can become a barrier to operation and maintenance and longevity of the water service and latrine quality (17,20,22,52,68). Where willingness exists in conjunction with the inability to access funds and, resources or need from external funding availability to water and latrines is compromised (22,58,85). Willingness to pay may also depend on satisfaction with and quality of the service, which in turn depends on how well it is operated or maintained (20).

OWNERSHIP

Endogenous interventions (interventions initiated by community members) are far better at reflecting and meeting a community's needs compared to interventions that are brought into the community by external agents with minimal or without community consultation and involvement. These are two extremes of a spectrum of community involvement captured in Arnstein's Ladder of Citizen Participation (40), which proposes that increased meaningful community participation correlates with more power in the decision-making process and thus more control over the change it may bring. Control of an object, process or idea is considered a key characteristic of the phenomenon of ownership (89). Examples of total ownership may be rare in the literature, but not rare at all in day-to-day practice within communities. However, well-planned collaboration between communities and external agents, which engage communities in co-planning, co-production, and co-management (90) or maintenance can achieve 'citizen control' and build an effective sense of ownership while overcoming barriers of access posed by lack of resources. Meaningful participation as co-production

1
2
3 513 is important as people often feel that they own something they create, shape or produce (89). A secure
4
5 514 sense of ownership over a water resource, water infrastructure or hardware is crucial as it promotes
6
7 515 investment and commitment to its preservation at individual and community levels. Community
8
9 516 involvement and inclusion, power and control are all necessary for an individual or community to feel
10
11 517 a sense of ownership over WASH infrastructure, and this sense of ownership has significant impact on
12
13 518 shaping outcomes availability and longevity of WASH interventions.
14

15 519
16
17 520 **Availability**

18 521 The need for the resource can help promote ownership, as the communities have a dependency on it
19
20 522 and take greater steps to ensure the availability of resources such as water and latrines (48,54–
21
22 523 56,81,91). Ownership can be initiated by need or want of a resource: such that as a community plays
23
24 524 a role in obtaining an intervention, their sense of ownership can be increased when the intervention
25
26 525 is in place, thus creating a self-reinforcing loop between availability and ownership. The extent to
27
28 526 which community members feel a sense of ownership towards a resource can influence whether they
29
30 527 seek external or draw on internal technical and financial support to ensure that the resources (e.g.,
31
32 528 water and sanitation facilities) are in place (22,29,47,52,63,73,92). High levels of social cohesion and
33
34 529 connectedness is an enabler of efforts to access external funds or mobilise community resources
35
36 530 (22,29,55,63,92). Access to loans and grants can help promote ownership (47,55). The involvement of
37
38 531 a broad range of community members in water and sanitation interventions can promote a collective
39
40 532 sense of ownership, which, in turn, can facilitate social cohesion and connectedness by providing
41
42 533 opportunities for a community to share a common goal (8,93,94). By promoting community ownership
43
44 534 of a resource, involving community members in capacity building (e.g. in managing the resource) can
45
46 535 promote availability (42,48,56,81), and involving women, leaders and people with disabilities (e.g., in
47
48 536 decision-making) can ensure that access is equitable and safe (49,50,55,65,72,93,95). Ownership by a
49
50 537 range of community members, including those who are often underrepresented in positions of power
51
52 538 and control, can increase availability for these community members as with ownership comes the
53
54 539 opportunity for people to alter what they own, therefore satisfying their needs (89).
55
56 540

57 541 **Longevity**

58 542 Ownership is enabled by involving communities in the co-design, co-planning and co-implementation
59
60 543 of hardware, increasing the likelihood that the resource reflects community needs (16,94), the costs
544 are appropriate and affordable (17,20), the community has the appropriate information for operations
545 and maintenance (20,53,66,96), and the community is willing and able to commit to bear hardware
546 costs and ongoing operational and maintenance costs (17,64,97,98), thus becoming self-sufficient

(17,20,92). In the absence of this, a community may need to rely on external sources for the longevity of resources (19,54,68,96,98). Ownership is enabled when communities are allowed or granted decision-making authority in operations and have responsibility for the maintenance of hardware (19,99). Taking ownership requires a leader or committee to champion action (18,36,52,53,92), especially when a leader or committee has to manage the hardware (e.g. in terms of speed and adequacy of repair), and to raise and manage funds necessary to maintain the hardware (e.g. their water system) in the long term (50,52,53,60,66,79,84,92). Financial management ability, can be hampered when communities have low budget resources or communities are unable to afford the service and the committee receives limited funds to maintain a water system, impacting the longevity of the water service (16,52,54).

The capacity to manage the hardware can promote a sense of ownership (18,22,53,56,68,94). Therefore, retention of human resources and committee members can lead to resource/service longevity as knowledge and skills are retained in communities (22,51,66). Having a broad range of members (including women) on such committees can promote buy-in from the community, and diverse voices in decisions leading to a greater sense of ownership, and desire to maintain the resource (17,20,26,29,50,51,54). Involvement of women is important as they use water regularly and have a great need for water, and in some cases, their sense of ownership can be sufficiently strong to enable them to independently fund, plan, build and maintain water systems (70), allowing them to gain status, take on leadership roles and support younger women in the community (17,70). Women communicate with the committees about system breakdowns and without whom, such information sharing that lead to repair may not occur (29). Such active communication reflects ownership and indicates a willingness to work together and build connections within the community which promotes longevity by facilitating ongoing response to maintenance issues (22,56,79,83). Lack of ownership of hardware can occur in communities with low socioeconomic status as they may have other priorities, or where the need for the hardware is limited, which in turn limits commitment to its maintenance (18).

SHAME

Shame is based on the theory of social comparison where others compare themselves to those around them to determine their own self-worth and can trigger disgust, disappointment, or embarrassment in one's behaviour or actions. It is activated by individuals comparing themselves to each other where the shame of not conforming to the appropriate or undesirable WASH behaviours such as open defecation, leads communities or individuals to change their behaviour or action to become more

1
2
3 581 socially acceptable. Shame can be leveraged as a feature of interventions that seek to reset
4
5 582 community norms, so community members view open defecation and not washing hands as
6
7 583 disgusting and as harmful to the whole community. Comparison between individuals, between
8
9 584 households and between communities, can lead to shame as it brings out elements of competition
10
11 585 and can result in shame from the loss. This may manifest by introducing incentives (e.g. in the form of
12
13 586 prizes and rewards) to motivate communities to achieve a water or sanitation goal in comparison to
14
15 587 one another (10,42,43,51,62,81). Contextual factors such as socioeconomic status, location,
16
17 588 leadership, resources, and social capital enable and reinforce the appropriate and desired behaviour
18
19 589 or action. Availability and behaviour change are the two outcomes associated with the shame
20
21 590 mechanism.
22

23
24 591
25 592 **Availability**
26
27 593 Without external support, shame can promote availability of and individual/household ownership of
28
29 594 latrines (23,42,44–46,48,49,73,75,76,81,82,85,95,100–102) and handwashing facilities
30
31 595 (43,46,48,72,81,82). These outcomes are limited in communities and households with financial and
32
33 596 technical challenges (25,48,62,80,85,95,102). Enablers include initiating shame by leaders and people
34
35 597 known within the community, which helps the acceptance, monitoring and enforcement of new
36
37 598 norms (23,42,44,73,75,76,81,82,100). Smaller homogenous communities with effective leadership,
38
39 599 are more likely to achieve universal sanitation coverage because people have closer relationships and
40
41 600 are more mindful of the impact of their behaviours on others, therefore change in social norms occur
42
43 601 more readily (42).
44
45 602

46
47 603 Social cohesion and connectedness are important enablers of household latrine construction because
48
49 604 a level of cooperation and collective action it promotes can help overcome the inequality in resources
50
51 605 and skills necessary to build latrines (11,24,48,63,71,72,74,80). Together they promote friendship and
52
53 606 community respect, and an appreciation of social benefit of private goods that may help reduce open
54
55 607 defecation (81). Social cohesion and connectedness also enable ‘shame’ to be transmitted throughout
56
57 608 a community. However, when communities lack technical or financial capabilities (25,85,95),
58
59 609 availability may be compromised by the lack of privacy, safety and construction of low standard
60
61 610 latrines (95), although when the new social norm is sufficiently established, communities may seek to
62
63 611 repair or rebuild such latrines (73,85). The shame of losing in a competition can have a negative effect
64
65 612 on the non-winners who may be demotivated as a result (81). Improvements in the availability of
66
67 613 latrines and handwashing facilities (43,81) may occur as a result of the motivation of winning prizes

(e.g., motorcycles) or simply the right of a leader to claim they 'won' by their community being first to become open defecation free (42,43).

Change

Efforts to avoid shame can result in a change in sanitation behaviour (i.e. reduction in open defecation, increase latrine use, appropriate disposal of excreta material and clean facilities) (10,11,25,42,44,48,51,62,71,72,75,82,85,88,100–103) and an increase in levels of overall hygiene behaviour, including handwashing (25,26,82,101) and safe drinking water and storage (i.e. lower *E. coli* levels) (25,75). These changes impact health outcomes such as a reduction in childhood diarrheal disease, roundworm infestation and stunting (42,62,75,80,85,100). Behaviour change is limited where prior beliefs about the negative impact of open defecation are weak (100), where open defecation solves a cultural problem such as men and women not being allowed to share a toilet (10,11), where there is a focus on latrine construction over utilisation (101), where there is a lack of water for latrine cleaning and hand washing facilities close to latrines (85) and the latrine is full (102). Shame is more effective for behaviour change in small, cohesive, and isolated total communities with similar views, as people want to fit in and conform to social norms (88), where effective leadership and community involvement help reinforce change in social norms (10,44,72,85), and where high social cohesion and connectedness makes people more likely to conform for the benefit and social wellbeing of the community (8,48,80), especially as social pressure mounts and community tolerance for undesirable behaviour decreases (11,23,80). Latrine quality and cleanliness can help ensure people utilise it and feel safe (44). Increased respect and social acceptance for latrine ownership can help the shift social norms (48). Celebration by village members and local media coverage of open defecation free status can reinforce the undesirable behaviour and shame of those not conforming to the social norm (44).

Effective leadership is an important enabler of reduced levels of open defecation in communities, as it helps reinforce changes in social norms (10,72,82,85). High rates of latrine ownership and availability, can indicate a change in social norms and the acceptance of the new behaviour (73). Communities that have a lead role in an intervention, allows them to identify the impacts of their behaviour and helps them understand the importance of change in behaviour leading to a paradigm shift to promote sanitation facilities and stop open defecation (85). However, an increase in latrine ownership does not always guarantee their sustained use, increase in handwashing or reduction in open defecation (10,25,73,85). Without ongoing support, acknowledgement of change and loss of

1
2
3 647 messaging impact, behaviour change is unlikely to be sustained as there is a tendency for fatigue or
4
5 648 loss of motivation within communities (23–25,102).
6
7 649

8 650 **Discussion**
9

10 651 In this realist review, we investigated how (mechanisms) and under what circumstances (context)
11 652 community efforts and decisions regarding WASH interventions promote health and resource/service
12 653 longevity (outcomes) in LMICs. To our knowledge, this is the first realist review to do so. We identified
13 654 five mechanisms: accountability, diffusion, market, ownership, and shame. The five theories we
14 655 identified five theories that acted as foundations for the mechanisms. We also identified contextual
15 656 factors that lead to positive and negative outcomes for availability, behaviour change, health, and
16 657 resource/service longevity in both external and internal interventions in a community setting.
17
18
19
20
21
22 658

23 659 Our study identified 19 contextual factors that need to be considered before interventions start
24 660 including community location, communities with similar characteristics, communication, leadership,
25 661 fines/penalties, seasonality, resource dependency, access to resources and funding, community
26 662 financial and technical skills and knowledge, leadership, ongoing support and acknowledgement of
27 663 change, community connectedness and social cohesion, community willingness to pay, committees
28 664 with followed and understood responsibilities, rules and management plans, active committees that
29 665 include women and community/committee involvement in the design, planning or implementation of
30 666 the intervention. Different combinations of these factors lead to different outcomes. Amongst the
31 667 mechanisms, overlapping contextual factors were identified including social cohesion and
32 668 connectedness, skills and knowledge (including financial capabilities and technical abilities for
33 669 operations and maintenance), willingness to pay, communication, communities with similar
34 670 characteristics and views often in a remote location, leadership and diverse involvement in the
35 671 intervention (of women and at different stages of design, planning and implementation). Of these
36 672 contextual factors, social cohesion and connectedness, leadership, and diverse involvement in the
37 673 intervention (including of women and at different stages of design, planning and implementation)
38 674 stood out as being common across successful interventions.
39
40
41
42
43
44
45
46
47
48
49
50 675

51 676 Our findings have some similarities with the realist reviews by Loevinsohn et al (5) and Stefanelli et al
52 677 (7) showing community cohesion and connectedness, community involvement and skills and
53 678 knowledge as enabling factors. Further, Loevinsohn et al (5) found organisations made the decisions
54 679 of where and when to intervene, but they had limited transparency and accountability which can lead
55 680 to inequalities in services. This reflects the need for key contextual factors we identified to be
56
57
58
59
60

considered such as leadership and diverse involvement in the intervention. Other evidence shows issues with co-management of water resources, the need to redevelop current water governance practices and barriers to implementation such as difficulties engaging Indigenous participants (7). Other evidence highlights flaws in much existing WASH interventions aimed at reducing infections and suggest the need for greater intensity (e.g. through frequent contact between promoters and community members) to facilitate behaviour change. These studies indicate a need focus on broader strategies to reduce contamination in the household environment (e.g. through the complete separation of animal faeces from people's living environments), rather than only behaviour change (104).

Also, other literature reviews have been conducted to explore contextual factors impacting WASH outcomes and interventions. While Jiménez et al (4) categorised their outcomes differently (the legitimacy of the process, increased awareness from the population, participant empowerment, better management and accountability and improved sustainability), their findings resonant with ours. Like our CMO configurations, Jiménez et al developed procedural elements and contextual factors that influence rural drinking water, rural sanitation and urban drinking water and sanitation. Further, other factors such as access to adequate and timely information were identified (4). What our paper adds, is what factors have positive and negative outcomes. In their systematic review, Novotný et al (6) provide a health-outcome nexus assessing how contextual factors impact different sanitation outcomes. Again, similar outcomes and contextual factors were identified, but with a broader range of community and individual socioeconomic factors (6).

Monitoring is a major component of the accountability mechanism, and it can be conducted through multiple forms including reports and follow up visits. However, the downside of ongoing monitoring is that it is expensive, time-consuming, labour and resource-intensive, and increased frequency can induce reactivity from subjects (105,106). Outsider reporting of activities and changes may also not be accurate (105). The length of time involved in monitoring and observation may be inconvenient for households and communities and may change their routines (106). Higher social economic households show greater responses to monitoring or observation, and may not reflect the population (107).

Diffusion of innovation has been widely identified as a mechanism in public health, for example in the adoption of new health policies and technologies, and the use of new drugs (108). In using this mechanism, there is a growing push to highlight the psychological and physical health benefits of what is being adopted (109). New behaviours may need to be adapted to meet the cultural needs of the

1
2
3 715 target population (108,109) before adoption. A downside of the diffusion mechanism is that blame
4
5 716 can be put on an individual and on those of lower social-economic status who are unable to conform
6
7 717 or adopt an innovation or new behaviour due to financial barriers (109).
8
9 718
10 719 The market mechanism builds on the economic theory of demand. For this mechanism to be sustained
11
12 720 there needs to be a delicate balance between supply, demand and pricing on the resource (39). The
13
14 721 downside of markets is that they may not be sensitive to the cultural and social dimensions involved
15
16 722 in the use of water and sanitation services or resources (110,111). Further, the market mechanism
17
18 723 does not take into consideration the effects of climate change and the changing population demands
19
20 724 (110,111). Research in the United Kingdom highlighted the difficulty of using the market mechanism
21
22 725 to predict underlying patterns to sustain WASH interventions (110).
23
24 726
25 727 Ownership can be broken into several components, including 1) process (who has a voice and whose
26
27 728 voice is heard), 2) outcome (who influences the decisions and from what effort), and 3) distribution
28
29 729 (who is affected by the process and outcome) (112). Ownership can be difficult to achieve, especially
30
31 730 equally and fairly within a community, especially as a privilege and socioeconomic status are involved
32
33 731 in who has a voice, whose voice listened to, who has the power or influence within the community to
34
35 732 be involved in decision-making, and who has the power or influence to be involved in negotiations
36
37 733 (112). The literature that was used to inform the development of the ownership mechanisms, with a
38
39 734 focus on co-production was based on examples in high-income contexts where priorities and power
40
41 735 of communities and individuals are very different. A systematic review found ownership a key
42
43 736 component for health intervention sustainability within Sub-Saharan Africa (113).
44
45 737
46 738 Shame as a mechanism has been widely used in sanitation, tobacco control and obesity interventions
47
48 739 (114–116). Shame has been employed by community-led total sanitation since the 1990s (116).
49
50 740 However, there are recent arguments in global health that shame should never be employed as a
51
52 741 mechanism to drive improved health outcomes (117), because it can lead to psychological harm
53
54 742 especially among poor households who cannot afford to make the change, and because it can be a
55
56 743 direct attack on a person’s identity or concept of self and be detrimental to their self-esteem
57
58 744 (21,118,119). The shame mechanism is woven into many behaviour change sanitation interventions.
59
60 745 Before using this mechanism, detailed discussions need to occur to highlight the potential downsides
746 of focusing on shame.
747

Further work is needed to validate our five proposed mechanisms and CMO configurations in empirical studies. We recognise that there are alternative theories that can be used to explain the outcomes in the identified studies. For example, nudge theory provides an alternative explanation to accountability where positive nudges within the community such as monitoring or meetings, act as a positive reinforcement for their behaviour change or actions of the community. Ongoing meetings and monitoring may also be seen as positive nudges for people to perform the socially acceptable behaviour or action being nudged. On the other hand, fines for defaulting act as negative nudges and reinforce the appropriate actions and behaviours (120). The transtheoretical (or “stages of change”) model also offers an alternative explanation for behaviour change at the community level with a key contextual factor being the selection of natural leaders who can help guide and influence communities through the stages of behaviour change (121). The transtheoretical model can also be linked to shame, as actions are taken to provide information about others approval for a behaviour such as a walk of shame to indicate open defaecation behaviour in a community (121). Indeed, shame itself may represent a negative nudge. Persuasion theory is yet another theory that could explain changes in behaviour around water use and open defecation (122). In smaller communities, monitoring, strong leadership, and communication in the community can be used to persuade people to change their behaviour as they understand the consequences. Greater knowledge and understanding of the impact of the change and social influence can persuade people to achieve a more desirable behaviour. These three theories offer alternative explanations but were not chosen as the initial guiding theories as they do not include the diversity of contextual factors and were mainly linked to behaviour change outcomes. The five guiding theories that were selected flexible, and well-studied in the literature, so this allowed us to build a detailed understanding, and how they relate specifically to the WASH sector.

Strengths and limitations

This review involved a thorough detailed search, which identified 73 papers, from 29 countries for inclusion. The size of the review allowed for diverse CMOs to be explored and understood. Only one paper from Small Island Developing States (SIDS) matched our inclusion criteria that matched our inclusion criteria was located. Most papers included in the study were from the African and Asian LMICs. Due to this, it is unreasonable to generalise the findings to all contexts, we would need to include papers from a wider range of contexts and varied locations. This is an important factor to consider as SIDS have different priorities and challenges for water and sanitation in comparison to Asian and African countries. Research should be conducted within SIDS to further refine the CMO configurations identified in this review and to develop new CMO configurations which can be used to

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

781 explain multiple outcomes around water and sanitation interventions in these settings, as the
782 literature has tended to only look at one or the other.

783
784 The papers selected for this review were limited to those available in English, peer-reviewed and
785 available online through a database search. We also only looked at published articles and did not
786 include grey literature such as NGO and government reports. Most of the papers identified only
787 focused on outcomes over a short time period, with only a few looking over five years (20,79). The
788 short time frames are usually insufficient for behaviour change or resource/service longevity to be
789 observed. In the Māori population of New Zealand, a frame of less than 50 years is not appropriate as
790 it does not consider, the ‘mokopuna of the mokopuna’ [grandchild of the grandchild] (123). Among
791 the papers included in our study, it was hard to identify ‘physical’ and ‘social’ contextual factors, as
792 very limited information was often provided on these, and details were not deemed relevant
793 information for the paper. If more information was available, then the types of contextual factors may
794 have been found to play a bigger role than we identified. Lastly, we did not include papers that looked
795 at communities’ natural resource management and interventions, we only included papers where an
796 external party such as NGO or government was involved in the natural resource management and
797 interventions. Further research needs to be conducted to identify the mechanisms involved in such
798 intervention.

799
800 Based on our findings, the diverse involvement of communities to assess the design and plan of an
801 intervention is one of the most important enabling factors for resource/service longevity and
802 behaviour change. For water resource-focused interventions where the goal is to promote availability
803 or longevity of the resource then the accountability, market and ownership mechanisms seem to be
804 particularly important, but these mechanisms depend more on a broad range of community-level
805 contextual factors. For behaviour change, mechanisms shame and diffusion of innovation seem to be
806 particularly effective, but they are most effective in smaller homogenous communities. Before starting
807 any intervention, it is important to understand the contextual factors within each community and to
808 tailor the intervention accordingly. For example, interventionists who want to consider using the
809 "accountability" mechanism to achieve desired outcomes will do well to ask themselves if the
810 communities in which they seek to intervene have the necessary contextual factors (e.g. easily
811 accessible community to allow access for monitoring visits, community-level platforms that facilitate
812 internal monitoring etc) as shown in Table 2. And if not, whether to consider another mechanism or
813 support their target communities to develop such favourable contextual factors before or while
814 introducing an intervention.

Conclusion

This study brings together the knowledge generated from 73 water and sanitation interventions in LMICs where communities are involved. Health, infrastructure and resource/service longevity-related outcomes are influenced by five mechanisms. The mechanisms are, 1) accountability (policies and procedures to hold communities and committees responsible for their actions and outcomes of an intervention), 2) diffusion (spread of an idea or behaviour by innovators over time through communication amongst members of a community), 3) market (the interplay between demand and supply of a service or resource), 4) ownership (sense of possession and control of the service or resource), and 5) shame (a feeling of disgust in one's behaviour or actions). We identified 19 individual contextual factors that impact these mechanisms. These contextual factors can be utilized by policymakers, program designers and implementers and NGOs in the development of interventions. They can also help improve the likelihood of success for targeted outcomes and infrastructure and service longevity. The results also provide a framework for analysing and understanding the performance of WASH interventions retrospectively.

Abbreviations:

LMICs – Low-and-middle income countries

NGO – Nongovernmental organisation

SIDS - Small Island Developing States

WASH – Water, sanitation, and hygiene

Data availability statement

Data sharing is not applicable to this article as no datasets were generated or analysed during this current study.

Patient and Public Involvement

No patient involved

Competing interests

The authors have declared that no competing interests exist.

Funding

1
2
3 848 This work was supported by the Stronger Systems for Health Security grant scheme by the Indo-Pacific
4 849 Centre for Health Security, Department of Foreign Affairs and Trade Australia (Grant No: SSHS 74427),
5 850 and Bloomberg Philanthropies Vibrant Oceans Initiative (Grant No: 53006). The funders had no role in
6 851 the study design, data collection and analysis, decision to publish or preparation of this manuscript.
7
8
9

10 852
11 853 Authors' contributions
12
13 854 Conceptualization: Sarah Nelson, Joel Negin, Seye Abimbola
14
15 855 Data Curation: Sarah Nelson, Dorothy Drabarek
16
17 856 Formal analysis: Sarah Nelson, Dorothy Drabarek, Seye Abimbola
18
19 857 Funding acquisition: Aaron Jenkins, Joel Negin, Seye Abimbola
20
21 858 Investigation: Sarah Nelson, Dorothy Drabarek
22
23 859 Methodology: Sarah Nelson, Dorothy Drabarek, Seye Abimbola
24
25 860 Supervision: Aaron Jenkins, Joel Negin, Seye Abimbola
26
27 861 Validation: Sarah Nelson, Seye Abimbola
28
29 862 Visualisation: Sarah Nelson, Seye Abimbola
30
31 863 Writing – original draft preparation: Sarah Nelson, Dorothy Drabarek
32
33 864 Writing – review & editing: Sarah Nelson, Dorothy Drabarek, Aaron Jenkins, Joel Negin, Seye Abimbola
34
35 865
36 866

35 867 References
36
37 868 1. Humphrey JH. Reducing the user burden in WASH interventions for low-income countries.
38 869 *Lancet Glob Health*. 2019;7(9):e1158–9.
39
40
41 870 2. Garn JV, Sclar GD, Freeman MC, Penakalapati G, Alexander KT, Brooks P, et al. The impact of
42 871 sanitation interventions on latrine coverage and latrine use: A systematic review and meta-
43 872 analysis. *Int J Hyg Environ Health*. 2017;220(2):329–40.
44
45
46
47 873 3. Bhutta ZA, Gaffey MF, Crump JA, Steele D, Breiman RF, Mintz ED, et al. Typhoid Fever: Way
48 874 Forward. *Am J Trop Med Hyg*. 2018; 6;99(3_Suppl):89–96.
49
50
51 875 4. Jiménez A, LeDeunff H, Giné R, Sjödin J, Cronk R, Murad S, et al. The enabling environment for
52 876 participation in water and sanitation: a conceptual framework. *Water*. 2019;11(2):308.
53
54
55
56 877 5. Loevinsohn M, Mehta L, Cuming K, Nicol A, Cumming O, Ensink JHJ. The cost of a knowledge
57 878 silo: A systematic re-review of water, sanitation and hygiene interventions. *Health Policy*
58 879 *Plan*. 2015;30(5):660–74.
59
60

- 880 6. Novotný J, Hasman J, Lepič M. Contextual factors and motivations affecting rural community
881 sanitation in low- and middle-income countries: a systematic review. *Int J Hyg Environ Health*.
882 2018;221(2):121–33.
- 883 7. Stefanelli RD, Castleden H, Harper SL, Martin D, Cunsolo A, Hart C. Experiences with
884 integrative indigenous and western knowledge in water research and management: a
885 systematic realist review of literature from Canada, Australia, New Zealand, and the United
886 States. *Environ Rev*. 2017;25(3):323–33.
- 887 8. Harter M, Mosch S, Mosler H-J. How does community-led total sanitation (CLTS) affect latrine
888 ownership? A quantitative case study from Mozambique. *BMC Public Health*. 2018;18(1):387.
- 889 9. Valcourt N, Walters J, Javernick-Will A, Linden K, Hailegiorgis B. Understanding rural water
890 services as a complex system: an assessment of key factors as potential leverage points for
891 improved service sustainability. *Sustainability*. 2020;12(3):1243.
- 892 10. Zimba R, Ngulube V, Lukama C, Manangi A, Tiwari A, Osbert N, et al. Chiengi District, Zambia
893 open defecation free after 1 year of community-led total sanitation. *Am J Trop Med Hyg*.
894 2016;95(4):925–7.
- 895 11. Mlenga DH, Baraki YA. Community led total sanitation for community based disaster risk
896 reduction: a case for non-input humanitarian relief. *Jambá J Disaster Risk Stud*. 2016;8(2).
- 897 12. Jennewein JS, Jones KW. Examining ‘willingness to participate’ in community-based water
898 resource management in a transboundary conservation area in Central America. *Water*
899 *Policy*. 2016;18(6):1334–52.
- 900 13. Garn JV, Sclar GD, Freeman MC, Penakalapati G, Alexander KT, Brooks P, et al. The impact of
901 sanitation interventions on latrine coverage and latrine use: a systematic review and meta-
902 analysis. *Int J Hyg Environ Health*. 2017;220(2):329–40.
- 903 14. McGinnis MD, Ostrom E. Social-ecological system framework: initial changes and continuing
904 challenges. *Ecol Soc*. 2014;19(2).
- 905 15. Bhutta ZA, Gaffey MF, Crump JA, Steele D, Breiman RF, Mintz ED, et al. Typhoid fever: way
906 forward. *Am J Trop Med Hyg*. 2018;99(Suppl 3):89–96.

- 1
- 2
- 3 907 16. Abedin MdA, Habiba U, Shaw R. Community perception and adaptation to safe drinking water
- 4 908 scarcity: salinity, arsenic, and drought risks in coastal Bangladesh. *Int J Disaster Risk Sci.*
- 5 909 2014;5(2):110–24.
- 6
- 7
- 8
- 9 910 17. Padawangi R. Community-driven development as a driver of change: water supply and
- 10 911 sanitation projects in rural Punjab, Pakistan. *Water Policy Oxf.* 2010;12(S1):104–20.
- 11
- 12
- 13 912 18. Klug T, Shields KF, Cronk R, Kelly E, Behnke N, Lee K, et al. Water system hardware and
- 14 913 management rehabilitation: qualitative evidence from Ghana, Kenya, and Zambia. *Int J Hyg*
- 15 914 *Environ Health.* 2017;220(3):531–8.
- 16
- 17
- 18
- 19 915 19. Jimenez-Redal R, Soriano J, Holowko N, Almandoz J, Arregui F. Assessing sustainability of rural
- 20 916 gravity-fed water schemes on Idjwi Island, D.R. Congo. *Int J Water Resour Dev.*
- 21 917 2018;34(6):1022–35.
- 22
- 23
- 24
- 25 918 20. Kwangware J, Mayo A, Hoko Z. Sustainability of donor-funded rural water supply and
- 26 919 sanitation projects in Mbire district, Zimbabwe. *Phys Chem Earth Parts ABC.* 2014;76–78:134–
- 27 920 9.
- 28
- 29
- 30
- 31 921 21. Jones S. Participation as citizenship or payment? A case study of rural drinking water
- 32 922 governance in Mali. *Water Altern.* 2011;4(1):18.
- 33
- 34
- 35
- 36 923 22. Madrigal-Ballesteros R, Naranjo MA. Adaptive capacity, drought and the performance of
- 37 924 community-based drinking water organizations in Costa Rica. *J Water Clim Change.*
- 38 925 2015;6(4):831–47.
- 39
- 40
- 41
- 42 926 23. Russpatrick S, Tiwari A, Markle L, Musonda E, Mutunda A, Osbert N, et al. Mobility up the
- 43 927 sanitation ladder following community-led total sanitation in rural Zambia. *J Water Sanit Hyg*
- 44 928 *Dev.* 2017;7(3):436–44.
- 45
- 46
- 47
- 48 929 24. Ogendo KN, Kihara AB, Kosgei RJ, Tweya H, Kizito W, Murkomen B, et al. Assessment of
- 49 930 community led total sanitation uptake in rural Kenya. *East Afr Med J.* 2016;5.
- 50
- 51
- 52 931 25. Woode PK, Dwumfour-Asare B, Nyarko KB, Appiah-Effah E. Cost and effectiveness of water,
- 53 932 sanitation and hygiene promotion intervention in Ghana: the case of four communities in the
- 54 933 Brong Ahafo region. *Heliyon.* 2018;4(10).
- 55
- 56
- 57
- 58 934 26. Madon S, Malecela MN, Mashoto K, Donohue R, Mubyazi G, Michael E. The role of
- 59 935 community participation for sustainable integrated neglected tropical diseases and water,
- 60

- 936 sanitation and hygiene intervention programs: a pilot project in Tanzania. *Soc Sci Med.*
 937 2018;202:28–37.
- 938 27. Nguyen TH, Ross A. Barriers and opportunities for the involvement of Indigenous knowledge
 939 in water resources management in the Gam river basin in North-East Vietnam. *Water*
 940 *Alternatives.* 2017;10(1):26.
- 941 28. Naiga R, Penker M. Determinants of users' willingness to contribute to safe water provision in
 942 rural Uganda. *Lex Localis.* 2014;12(3):695.
- 943 29. Kelly E, Lee K, Shields KF, Cronk R, Behnke N, Klug T, et al. The role of social capital and sense
 944 of ownership in rural community-managed water systems: qualitative evidence from Ghana,
 945 Kenya, and Zambia. *J Rural Stud.* 2017;56:156–66.
- 946 30. Pawson R, Greenhalgh T, Harvey G, Walshe K. Realist review - a new method of systematic
 947 review designed for complex policy interventions. *J Health Serv Res Policy.* 2005;10(Suppl
 948 1):21–34.
- 949 31. Abimbola S, Baatiema L, Bigdeli M. The impacts of decentralization on health system equity,
 950 efficiency and resilience: a realist synthesis of the evidence. *Health Policy Plan.*
 951 2019;34(8):605–17.
- 952 32. Greenhalgh T, Robert G, Bate P, Macfarlane F, Kyriakidou O. Diffusion of innovations in health
 953 service organisations: a systematic literature review. John Wiley & Sons; 2008.
- 954 33. Pawson R, Tilley N. Realistic evaluation. Sage; 1997.
- 955 34. Wong G, Greenhalgh T, Westhorp G, Buckingham J, Pawson R. RAMESES publication
 956 standards: realist syntheses. *BMC Med.* 2013;11(1):21.
- 957 35. Wong G, Westhorp G, Pawson R, Greenhalgh T. Realist synthesis - Rameses training materials.
 958 2013.
- 959 36. Lodenstein E, Dieleman M, Gerretsen B, Broerse JEW. Health provider responsiveness to
 960 social accountability initiatives in low- and middle-income countries: a realist review. *Health*
 961 *Policy Plan.* 2017;32(1):125–40.

1
2
3 962 37. World Bank. World Bank Country and Lending Groups [Internet]. [cited 2019 May 5].
4
5 963 Available from: [https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-](https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups)
6 964 [bank-country-and-lending-groups](https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups)
7
8
9 965 38. Rogers EM. Diffusion of Innovations, 5th Edition. Simon and Schuster; 2010.
10
11
12 966 39. Hicks JR. A Revision of Demand Theory [Internet]. Oxford University Press; 1986 [cited 2019
13 967 Nov 26]. Available from: <https://ideas.repec.org/b/oxp/obooks/9780198285502.html>
14
15
16 968 40. Arnstein SR. A Ladder Of Citizen Participation. *J Am Inst Plann.* 1969 Jul 1;35(4):216–24.
17
18
19 969 41. Festinger L. A theory of social comparison processes. *Hum Relat.* 1954;7(2):117–40.
20
21
22 970 42. Tiwari A, Russpatrick S, Hoehne A, Matimelo SM, Mazimba S, Nkhata I, et al. Assessing the
23 971 impact of leveraging traditional leadership on access to sanitation in rural Zambia. *Am J Trop*
24 972 *Med Hyg.* 2017;97(5):1355–61.
25
26
27 973 43. Mwakitalima A, Massa K, Seleman A, Kassile T. Scaling up rural sanitation in Tanzania:
28 974 evidence from the national sanitation campaign. *J Water Sanit Hyg Dev Lond.* 2018;8(2):290–
29 975 306.
30
31
32 976 44. Alzua ML, Djebbari H, Pickering AJ. A community-based program promotes sanitation. *Econ*
33 977 *Dev Cult Change.* 2020;68(2):357–90.
34
35
36
37 978 45. Harter M, Inauen J, Mosier H-J. How does Community-Led Total Sanitation (CLTS) promote
38 979 latrine construction, and can it be improved? A cluster-randomized controlled trial in Ghana.
39 980 *Soc Sci Med.* 2020;245:112705.
40
41
42
43 981 46. Okolimong CD, Ndejjo R, Mugambe RK, Halage AA. Effect of a community-led total sanitation
44 982 intervention on sanitation and hygiene in Pallisa District, Uganda. *Am J Trop Med Hyg.*
45 983 2020;103(4):1735–41.
46
47
48
49 984 47. Dey NC, Parvez M, Islam MR, Mistry SK, Levine DI. Effectiveness of a community-based water,
50 985 sanitation, and hygiene (WASH) intervention in reduction of diarrhoea among under-five
51 986 children: Evidence from a repeated cross-sectional study (2007-2015) in rural Bangladesh. *Int*
52 987 *J Hyg Environ Health.* 2019;222(8):1098–108.
53
54
55
56
57
58
59
60

- 988 48. Safari J, Mohamed H, Dimoso P, Akyoo W, Odhiambo F, Mpete R, et al. Lessons learned from
989 the national sanitation campaign in Njombe district, Tanzania. *J Water Sanit Hyg Dev.*
990 2019;9(4):754–64.
- 991 49. Biran A, Danquah L, Chunga J, Schmidt W-P, Holm R, Itimu-Phiri A, et al. A cluster-randomized
992 trial to evaluate the impact of an inclusive, community-led total sanitation intervention on
993 sanitation access for people with disabilities in Malawi. *Am J Trop Med Hyg.* 2018;98(4):984–
994 94.
- 995 50. Anthonj C, Fleming L, Cronk R, Godfrey S, Ambelu A, Bevan J, et al. Improving monitoring and
996 water point functionality in rural Ethiopia. *Water.* 2018;10(11):1591.
- 997 51. Kema KM, Komwihangiro J, Kimaro S. Integrated community based child survival,
998 reproductive health and water and sanitation program in Mkuranga district, Tanzania: a
999 replicable model of good practices in community based health care. *Pan Afr Med J.*
1000 2012;13(Suppl 1).
- 1001 52. Roekmi RAK, Baskaran K, Chua LH. Community-based water supplies in Cikarang, Indonesia:
1002 Are they sustainable? *Nat Resour Forum.* 2018;42(2):108–22.
- 1003 53. Longwe B, Mganga M, Sinyiza N. Review of sustainable solar powered water supply system
1004 design approach by water mission Malawi. *Water Pract Technol.* 2019;14(4):749–63.
- 1005 54. Madrigal-Ballesteros R, Capitán T, Salas A, Córdoba D. Household and community responses to
1006 seasonal droughts in rural areas of Costa Rica. *Waterlines.* 2019;38(4):286–304.
- 1007 55. Azemzi H, Erraoui EH. Irrigation water management and collective action: understanding the
1008 shift from community management to participatory management in Souss-Massa (Morocco).
1009 *Euro-Mediterr J Environ Integr.* 2020;6(1):1.
- 1010 56. Maheshwari B, Varua M, Ward J, Packham R, Chinnasamy P, Dashora Y, et al. The role of
1011 transdisciplinary approach and community participation in village scale groundwater
1012 management: insights from Gujarat and Rajasthan, India. *Water.* 2014;6(11):3386–408.
- 1013 57. Gimaiyo G, McManus J, Yarri M, Singh S, Trevett A, Moloney G, et al. Can child-focused
1014 sanitation and nutrition programming improve health practices and outcomes? Evidence
1015 from a randomised controlled trial in Kitui County, Kenya. *BMJ Glob Health.* 2019;4(1).

- 1
- 2
- 3 1016 58. String GM, Singleton RI, Mirindi PN, Lantagne DS. Operational research on rural, community-
- 4 1017 managed water safety plans: case study results from implementations in India, DRC, Fiji, and
- 5 1018 Vanuatu. *Water Res.* 2020;170:115288.
- 6
- 7
- 8
- 9 1019 59. Sarkar S, Greenleaf JE, Gupta A, Ghosh D, Blaney LM, Bandyopadhyay P, et al. Evolution of
- 10 1020 community-based arsenic removal systems in remote villages in West Bengal, India:
- 11 1021 assessment of decade-long operation. *Water Res.* 2010;44(19):5813–22.
- 12
- 13
- 14
- 15 1022 60. Madziyauswa V. Assessing sustainability of community managed NGOs' WASH interventions
- 16 1023 in rural Zimbabwe: the case of Chivi district in Masvingo province. *J Water Sanit Hyg Dev.*
- 17 1024 2017;640–9.
- 18
- 19
- 20
- 21 1025 61. Keoprasith B, Kizuki M, Watanabe M, Takano T. The impact of community-based, workshop
- 22 1026 activities in multiple local dialects on the vaccination coverage, sanitary living and the health
- 23 1027 status of multiethnic populations in Lao PDR. *Health Promot Int.* 2013;28(3):453–65.
- 24
- 25
- 26
- 27 1028 62. Pickering AJ, Djebbari H, Lopez C, Coulibaly M, Alzua ML. Effect of a community-led sanitation
- 28 1029 intervention on child diarrhoea and child growth in rural Mali: a cluster-randomised
- 29 1030 controlled trial. *Lancet Glob Health.* 2015;3(11):e701–11.
- 30
- 31
- 32
- 33 1031 63. Dickin S, Bisung E, Savadogo K. Sanitation and the commons: the role of collective action in
- 34 1032 sanitation use. *Geoforum.* 2017;86:118–26.
- 35
- 36
- 37
- 38 1033 64. Opare S. Sustaining water supply through a phased community management approach:
- 39 1034 lessons from Ghana's "oats" water supply scheme. *Environ Dev Sustain.* 2011;13(6):1021–42.
- 40
- 41
- 42 1035 65. Morinville C, Harris LM. Participation, politics, and panaceas: exploring the possibilities and
- 43 1036 limits of participatory urban water governance in Accra, Ghana. *Ecol Soc.* 2014;19(3):art36.
- 44
- 45
- 46 1037 66. Dhoba L. Going to scale with rural water supply: a reflection on experiences from sustaining
- 47 1038 community managed piped water schemes in rural Zimbabwe. *J Water Sanit Hyg Dev.*
- 48 1039 2020;10(3):527–38.
- 49
- 50
- 51
- 52 1040 67. Kelly E, Shields KF, Cronk R, Lee K, Behnke N, Klug T, et al. Seasonality, water use and
- 53 1041 community management of water systems in rural settings: qualitative evidence from Ghana,
- 54 1042 Kenya, and Zambia. *Sci Total Environ.* 2018;628–629:715–21.
- 55
- 56
- 57
- 58 1043 68. Rout S. Institutional variations in practice of demand responsive approach: evidence from
- 59 1044 rural water supply in India. *Water Policy.* 2014;16(4):650–68.
- 60

- 1045 69. Ibrahim SH. Sustainability assessment and identification of determinants in community-based
1046 water supply projects using partial least squares path model. *J Sustain Dev Energy Water*
1047 *Environ Syst.* 2017;5(3):345–58.
- 1048 70. Aladuwaka S, Momsen J. Sustainable development, water resources management and
1049 women's empowerment: the wanaraniya water project in Sri Lanka. *Gend Dev.*
1050 2010;18(1):43–58.
- 1051 71. Crocker J, Abodoo E, Asamani D, Domapielle W, Gyapong B, Bartram J. Impact evaluation of
1052 training natural leaders during a community-led total sanitation intervention: A cluster-
1053 randomized field trial in Ghana. *Environ Sci Technol.* 2016;50(16):8867–75.
- 1054 72. Crocker J, Geremew A, Atalie F, Yetie M, Bartram J. Teachers and sanitation promotion: an
1055 assessment of community-led total sanitation in Ethiopia. *Environ Sci Technol.*
1056 2016;50(12):6517–25.
- 1057 73. Crocker J, Saywell D, Bartram J. Sustainability of community-led total sanitation outcomes:
1058 evidence from Ethiopia and Ghana. *Int J Hyg Environ Health.* 2017;220(3):551–7.
- 1059 74. Nunbogu AM, Harter M, Mosler H-J. Factors associated with levels of latrine completion and
1060 consequent latrine use in Northern Ghana. *Int J Environ Res Public Health.* 2019;16(6):920.
- 1061 75. Soboksa NE, Hailu AB, Gari SR, Alemu BM. Water supply, sanitation and hygiene interventions
1062 and childhood diarrhea in Kersa and Omo Nada districts of Jimma Zone, Ethiopia: a
1063 comparative cross-sectional study. *J Health Popul Nutr.* 2019;38(1):45.
- 1064 76. Zeleke DA, Gelaye KA, Mekonnen FA. Community-led total sanitation and the rate of latrine
1065 ownership. *BMC Res Notes.* 2019;12(1):14.
- 1066 77. Andrade EL, Bingenheimer JB, Edberg MC, Zoerhoff KL, Putzer EM. Evaluating the
1067 effectiveness of a community-based hygiene promotion program in a rural Salvadoran
1068 setting. *Glob Health Promot St-Denis Cedex.* 2019;26(1):69–80.
- 1069 78. Karinja M, Schlienger R, Pillai GC, Esterhuizen T, Onyango E, Gitau A, et al. Risk reduction of
1070 diarrhea and respiratory infections following a community health education program - a
1071 facility-based case-control study in rural parts of Kenya. *BMC Public Health.* 2020;20(1).
- 1072 79. Wardle C, Zakiriaeva N. Sustainability and long-term impact of community-managed water
1073 supply in rural Kyrgyzstan, Central Asia. *Waterlines.* 2018;37(2):118–31.

- 1074 80. Cameron L, Olivia S, Shah M. Scaling up sanitation: evidence from an RCT in Indonesia. *J Dev Econ*. 2019;138:1–16.
- 1075
- 1076 81. Whaley L, Webster J. The effectiveness and sustainability of two demand-driven sanitation and hygiene approaches in Zimbabwe. *J Water Sanit Hyg Dev*. 2011;1(1):20–36.
- 1077
- 1078 82. Yeboah-Antwi K, MacLeod WB, Biemba G, Sijenji P, Höhne A, Verstraete L, et al. Improving Sanitation and Hygiene through Community-Led Total Sanitation: The Zambian Experience. *Am J Trop Med Hyg*. 2019;100(4):1005–12.
- 1079
- 1080
- 1081 83. Chankova S, Hatt LE, Musange SF. A community-based approach to promote household water treatment in Rwanda. *J Water Health*. 2012;10(1):116–29.
- 1082
- 1083 84. Singh C. Is participatory watershed development building local adaptive capacity? Findings from a case study in Rajasthan, India. *Environ Dev*. 2018;25:43–58.
- 1084
- 1085 85. Tessema RA. Assessment of the implementation of community-led total sanitation, hygiene, and associated factors in Diretiyara district, Eastern Ethiopia. *PLOS ONE*. 2017;12(4):e0175233.
- 1086
- 1087
- 1088 86. Ganing A, Abu A, Harpenas, Muslimin I, Adam A. Community empowerment in management community-based total sanitation through health education in Majene. *Indian J Public Health Res Dev*. 2018;9(12):1466–71.
- 1089
- 1090
- 1091 87. Barrington D, Fuller K, McMillan A. Water safety planning: adapting the existing approach to community-managed systems in rural Nepal. *J Water Sanit Hyg Dev*. 2013;3(3):392–401.
- 1092
- 1093 88. Harvey PA. Zero subsidy strategies for accelerating access to rural water and sanitation services. *Water Sci Technol Lond*. 2011;63(5):1037–43.
- 1094
- 1095 89. Pierce JL, Kostova T, Dirks KT. Toward a Theory of Psychological Ownership in Organizations. *Acad Manage Rev*. 2001;26(2):298–310.
- 1096
- 1097 90. Van Eijk C, Steen T. Why engage in co-production of public services? Mixing theory and empirical evidence. *Int Rev Adm Sci*. 2016;82(1):28–46.
- 1098
- 1099 91. Tiwari A, Russpatrick S, Hoehne A, Matimelo SM, Mazimba S, Nkhata I, et al. Assessing the Impact of Leveraging Traditional Leadership on Access to Sanitation in Rural Zambia. *Am J Trop Med Hyg*. 2017 Nov;97(5):1355–61.
- 1100
- 1101

- 1102 92. Behnke NL, Klug T, Cronk R, Shields KF, Lee K, Kelly ER, et al. Resource mobilization for
1103 community-managed rural water systems: evidence from Ghana, Kenya, and Zambia. *J Clean*
1104 *Prod.* 2017;156:437–44.
- 1105 93. Kosinski KC, Crocker JJ, Durant JL, Osabutey D, Adjei MN, Gute DM. A novel community-based
1106 water recreation area for schistosomiasis control in rural Ghana. *J Water Sanit Hyg Dev Lond.*
1107 *2011;1(4):259–68.*
- 1108 94. Hubbard B, Sarisky J, Gelting R, Baffigo V, Seminario R, Centurion C. A community demand-
1109 driven approach toward sustainable water and sanitation infrastructure development. *Int J*
1110 *Hyg Environ Health.* 2011;214(4):326–34.
- 1111 95. Kayoka C, Itimu-Phiri A, Biran A, Holm RH. Lasting results: A qualitative assessment of efforts
1112 to make community-led total sanitation more inclusive of the needs of people with
1113 disabilities in Rumphi District, Malawi. *Disabil Health J.* 2019;12(4):718–21.
- 1114 96. Smyrilli C, Selvakumaran S, Alderson M, Pizarro A, Almendrades D, Harris B, et al. Sustainable
1115 decentralised wastewater treatment schemes in the context of Lobitos, Peru. *J Environ Eng*
1116 *Sci.* 2018;13(1):8–16.
- 1117 97. Kwangware J, Mayo A, Hoko Z. Sustainability of donor-funded rural water supply and
1118 sanitation projects in Mbire district, Zimbabwe. *Phys Chem Earth.* 2014;76–78:134–9.
- 1119 98. Bright-Davies L, Lüthi C, Jachnow A. DEWATS for urban Nepal: a comparative assessment for
1120 community wastewater management. *Waterlines.* 2015;34(2):119–38.
- 1121 99. Nti EK, Wongnaa CA, Edusah NSE, Bakang J-EA. Assessment of the sustainability of
1122 community-managed water supply services in Ghana. *Environ Dev Sustain.* 2020;22(7):7097–
1123 120.
- 1124 100. Degebas MZ, Weldemichael DZ, Marama MT. Diarrheal status and associated factors in
1125 under five years old children in relation to implemented and unimplemented community-led
1126 total sanitation and hygiene in Yaya Gulele in 2017. *Pediatr Health Med Ther.* 2018;9:109–21.
- 1127 101. Gebremariam B, Tsehay K. Effect of community led total sanitation and hygiene (CLTSH)
1128 implementation program on latrine utilization among adult villagers of North Ethiopia: A
1129 cross-sectional study. *BMC Res Notes.* 2019;12(1).

- 1
2
3 1130 102. Orgill-Meyer J, Pattanayak SK, Chindarkar N, Dickinson KL, Panda U, Rai S, et al. Long-term
4 1131 impact of a community-led sanitation campaign in India, 2005-2016. *Bull World Health Organ.*
5 1132 2019;97(8):523.
6
7
8
9 1133 103. Babb C, Makotsi N, Heimler I, Bailey RC, Hershow RC, Masanga P, et al. Evaluation of the
10 1134 effectiveness of a latrine intervention in the reduction of childhood diarrhoeal health in
11 1135 Nyando District, Kisumu County, Kenya. *Epidemiol Infect.* 2018;146(9):1079–88.
12
13
14
15 1136 104. Pickering AJ, Null C, Winch PJ, Mangwadu G, Arnold BF, Prendergast AJ, et al. The WASH
16 1137 Benefits and SHINE trials: interpretation of WASH intervention effects on linear growth and
17 1138 diarrhoea. *Lancet Glob Health.* 2019;7(8):e1139–46.
18
19
20
21 1139 105. Thomas E, Andrés LA, Borja-Vega C, Sturzenegger G. Innovations in WASH Impact Measures:
22 1140 Water and Sanitation Measurement Technologies and Practices to Inform the Sustainable
23 1141 Development Goals. World Bank Publications; 2018. 131 p.
24
25
26
27 1142 106. Halder AK, Molyneaux JW, Luby SP, Ram PK. Impact of duration of structured observations on
28 1143 measurement of handwashing behavior at critical times. *BMC Public Health.* 2013;13(1):705.
29
30
31
32 1144 107. Ram PK, Halder AK, Granger SP, Jones T, Hall P, Hitchcock D, et al. Is structured observation a
33 1145 valid technique to measure handwashing behavior? Use of acceleration sensors embedded in
34 1146 soap to assess reactivity to structured observation. *Am J Trop Med Hyg.* 2010;83(5):1070–6.
35
36
37
38 1147 108. Green LW, Ottoson JM, García C, Hiatt RA. Diffusion theory and knowledge dissemination,
39 1148 utilization, and integration in public health. *Annu Rev Public Health.* 2009;30(1):151–74.
40
41
42 1149 109. Haider M, Kreps GL. Forty years of diffusion of innovations: utility and value in public health. *J*
43 1150 *Health Commun.* 2004;9 Suppl 1:3–11.
44
45
46 1151 110. Parker JM, Wilby RL. Quantifying household water demand: a review of theory and practice in
47 1152 the UK. *Water Resour Manag.* 2013;27(4):981–1011.
48
49
50
51 1153 111. Johansson RC, Tsur Y, Roe TL, Doukkali R, Dinar A. Pricing irrigation water: a review of theory
52 1154 and practice. *Water Policy.* 2002;4(2):173–99.
53
54
55 1155 112. Lachapelle P. A sense of ownership in community development: understanding the potential
56 1156 for participation in community planning efforts. *Community Dev.* 2008;39(2):52–9.
57
58
59
60

- 1157 113. Iwelunmor J, Blackstone S, Veira D, Nwaozuru U, Airhihenbuwa C, Munodawafa D, et al.
1158 Toward the sustainability of health interventions implemented in sub-Saharan Africa: a
1159 systematic review and conceptual framework. *Implement Sci IS*. 2016;11.
- 1160 114. Riley KE, Ulrich MR, Hamann HA, Ostroff JS. Decreasing smoking but increasing stigma? Anti-
1161 tobacco campaigns, public health, and cancer care. *AMA J Ethics*. 2017;19(5):475–85.
- 1162 115. Puhl RM, Heuer CA. Obesity stigma: important considerations for public health. *Am J Public*
1163 *Health*. 2010;100(6):1019–28.
- 1164 116. UNICEF. Field Notes: UNICEF Policy and Programming in Practice [Internet]. 2009. Available
1165 from: [https://www.unicef.org/socialpolicy/files/Field_Note_-](https://www.unicef.org/socialpolicy/files/Field_Note_-_Community_Approaches_to_Total_Sanitation.pdf)
1166 [_Community_Approaches_to_Total_Sanitation.pdf](https://www.unicef.org/socialpolicy/files/Field_Note_-_Community_Approaches_to_Total_Sanitation.pdf)
- 1167 117. Brewis A, Wutich A. Why we should never do it: stigma as a behaviour change tool in global
1168 health. *BMJ Glob Health*. 2019;4(5):e001911.
- 1169 118. Lewis H. Shame and guilt in neurosis. *Psychoanal Rev*. 1971;58(3):419–38.
- 1170 119. Bateman M, Engel S. To shame or not to shame—that is the sanitation question. *Dev Policy*
1171 *Rev*. 2018;36(2):155–73.
- 1172 120. Arno A, Thomas S. The efficacy of nudge theory strategies in influencing adult dietary
1173 behaviour: a systematic review and meta-analysis. *BMC Public Health*. 2016;16(1):676.
- 1174 121. Sigler R, Mahmoudi L, Graham JP. Analysis of behavioral change techniques in community-led
1175 total sanitation programs. *Health Promot Int*. 2015;30(1):16–28.
- 1176 122. Kraemer SM, Mosler H-J. Persuasion factors influencing the decision to use sustainable
1177 household water treatment. *Int J Environ Health Res*. 2010;20(1):61–79.
- 1178 123. Morgan TKKB. An indigenous perspective on water recycling. *Desalination*. 2006;187(1–
1179 3):127–36.

Figure/Legends

Figure 1: Results taken in the literature search

Table 1: Steps taken in the realist analysis

Table 2: Enabling context-mechanism-outcome configurations

1
2
3 1185 Figure 2: The study country origin
4
5 1186 Figure 3: Intervention focus
6
7 1187
8 1188
9

For peer review only

10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

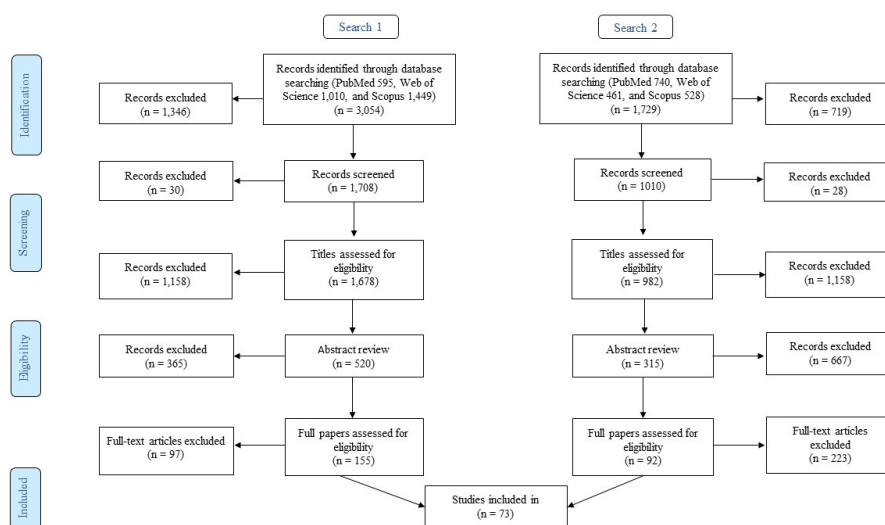


Figure 1: Results taken in the literature search

338x190mm (96 x 96 DPI)

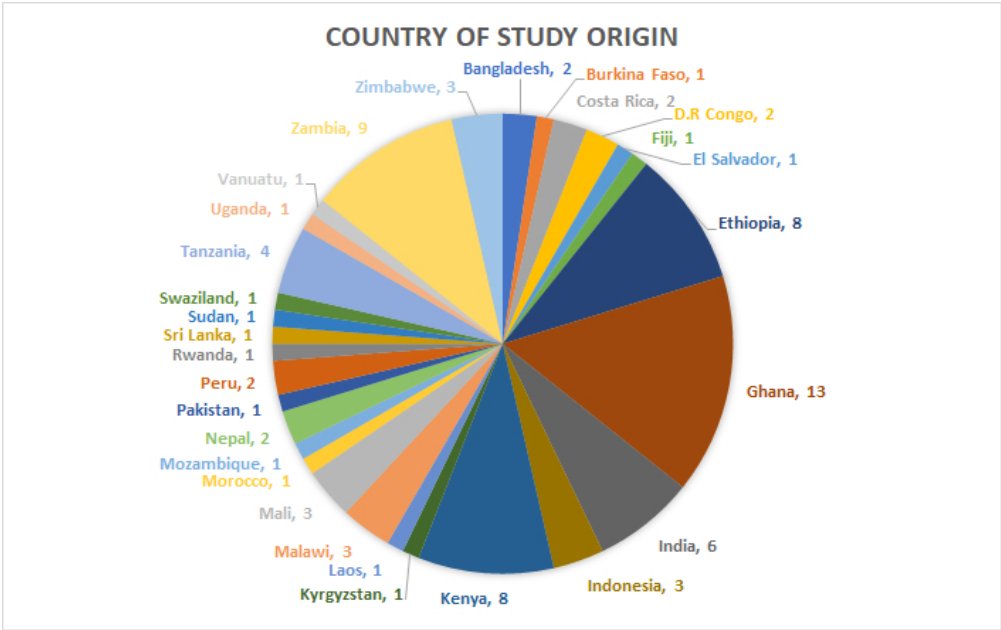


Figure 2: The study country origin
124x78mm (144 x 144 DPI)

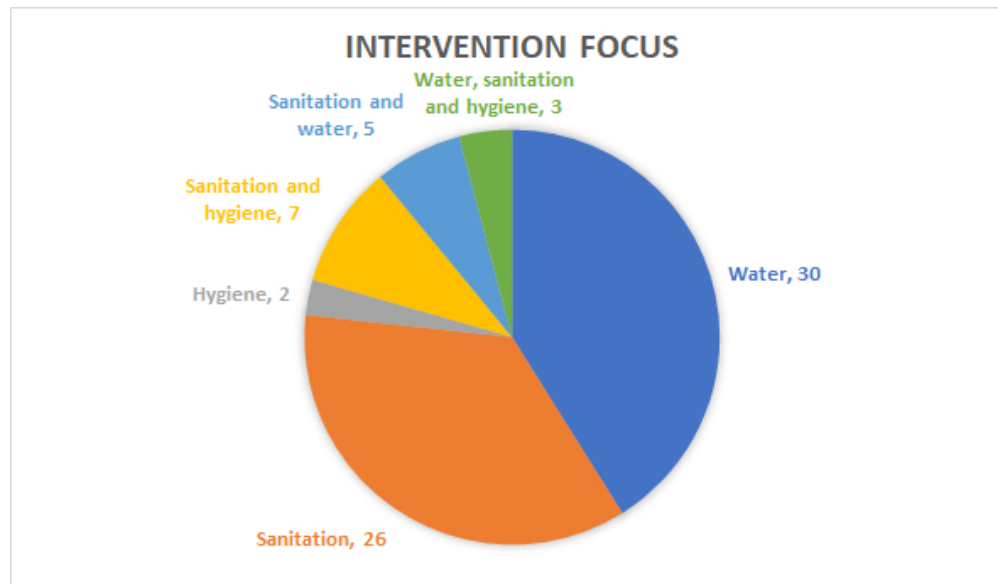


Figure 3: Intervention focus

104x60mm (144 x 144 DPI)

	Paper details	Country	Intervention	Exogenous or Endogenous	Mechanism(s)	Outcome
1	Abedin, M. A., Habiba, U., & Shaw, R. (2014). Community perception and adaptation to safe drinking water scarcity: salinity, arsenic, and drought risks in coastal Bangladesh. <i>International Journal of Disaster Risk Science</i> , 5(2), 110-124.	Bangladesh	Water	Both	Accountability Ownership	Availability
2	Dey, N. C., Parvez, M., Islam, M. R., Mistry, S. K., & Levine, D. I. (2019). Effectiveness of a community-based water, sanitation, and hygiene (WASH) intervention in reduction of diarrhoea among under-five children: Evidence from a repeated cross-sectional study (2007–2015) in rural Bangladesh. <i>International journal of hygiene and environmental health</i> , 222(8), 1098-1108.	Bangladesh	Water, sanitation and hygiene	Exogenous	Accountability Diffusion Ownership	Availability Change
3	Dickin, S., Bisung, E., & Savadogo, K. (2017). Sanitation and the commons: The role of collective action in sanitation use. <i>Geoforum</i> , 86, 118-126.	Burkina Faso	Sanitation	Exogenous	Accountability Diffusion Ownership	Availability
4	Madrigal-Ballester, R., & Naranjo, M. A. (2015). Adaptive capacity, drought and the performance of community-based drinking water organizations in Costa Rica. <i>Journal of Water and Climate Change</i> , 6(4), 831-847.	Costa Rica	Water	Exogenous	Accountability Diffusion Ownership Market	Availability Longevity
5	Madrigal-Ballester, R. (2019). Household and community responses to seasonal droughts in rural areas of Costa Rica. <i>Waterlines</i> , 38(4), 286-304.	Costa Rica	Water	Exogenous	Accountability Ownership	Availability Longevity
6	Jimenez-Redal, R., Soriano, J., Holowko, N., Almandoz, J., & Arregui, F. (2018). Assessing sustainability of rural gravity-fed water schemes on Idjwi Island, DR Congo. <i>International Journal of Water Resources Development</i> , 34(6), 1022-1035.	D.R Congo	Water	Exogenous	Ownership	Availability Longevity
7	Andrade, E. L., Bingenheimer, J. B., Edberg, M. C., Zoerhoff, K. L., & Putzer, E. M. (2019). Evaluating the effectiveness of a community-based hygiene promotion program in a rural Salvadoran setting. <i>Global Health Promotion</i> , 26(1), 69-80.	El Salvador	Hygiene	Exogenous	Ownership	Change
8	Degebasa, M. Z., Weldemichael, D. Z., & Marama, M. T. (2018). Diarrheal status and associated factors in under five years old children in relation to implemented and unimplemented community-led total sanitation and hygiene in Yaya Gulele in 2017. <i>Pediatric health, medicine and therapeutics</i> , 9, 109.	Ethiopia	Sanitation and Hygiene	Exogenous	Ownership Shame	Availability Change
9	Zelege, D. A., Gelaye, K. A., & Mekonnen, F. A. (2019). Community-Led Total Sanitation and the rate of latrine ownership. <i>BMC research notes</i> , 12(1), 14.	Ethiopia	Sanitation	Exogenous	Diffusion Shame	Availability
10	Tessema, R. A. (2017). Assessment of the implementation of community-led total sanitation, hygiene, and associated factors in Diretiyara district, Eastern Ethiopia. <i>PloS one</i> , 12(4), e0175233.	Ethiopia	Sanitation	Exogenous	Diffusion Ownership Shame	Availability Change

11	Anthonj, C., Fleming, L., Cronk, R., Godfrey, S., Ambelu, A., Bevan, J., ... & Bartram, J. (2018). Improving monitoring and water point functionality in rural Ethiopia. <i>Water</i> , 10(11), 1591.	Ethiopia	Water	Exogenous	Accountability Ownership	Availability Change Longevity
12	Crocker, J., Geremew, A., Atalie, F., Yetie, M., & Bartram, J. (2016). Teachers and sanitation promotion: an assessment of community-led total sanitation in Ethiopia. <i>Environmental science & technology</i> , 50(12), 6517-6525.	Ethiopia	Sanitation	Exogenous	Diffusion Ownership Shame	Availability Change
13	Gebremariam, B., & Tsehay, K. (2019). Effect of community led total sanitation and hygiene (CLTSH) implementation program on latrine utilization among adult villagers of North Ethiopia: a cross-sectional study. <i>BMC research notes</i> , 12(1), 1-6.	Ethiopia	Sanitation and Hygiene	Exogenous	Shame	Change
14	Soboksa, N. E., Hailu, A. B., Gari, S. R., & Alemu, B. M. (2019). Water supply, sanitation and hygiene interventions and childhood diarrhea in Kersa and Omo Nada districts of Jimma Zone, Ethiopia: a comparative cross-sectional study. <i>Journal of Health, Population and Nutrition</i> , 38(1), 1-14.	Ethiopia	Water, Sanitation and Hygiene	Exogenous	Diffusion Shame	Availability Change
15	Crocker, J., Saywell, D., & Bartram, J. (2017). Sustainability of community-led total sanitation outcomes: Evidence from Ethiopia and Ghana. <i>International Journal of Hygiene and Environmental Health</i> , 220(3), 551-557.	Ethiopia and Ghana	Sanitation	Exogenous	Diffusion Ownership Shame	Availability Change
16	Opere, S. (2011). Sustaining water supply through a phased community management approach: Lessons from Ghana's "oats" water supply scheme. <i>Environment, Development and Sustainability</i> , 13, 1021-1042.	Ghana	Water	Exogenous	Accountability Diffusion Ownership	Availability Change Longevity
17	Nunbogu, A. M., Harter, M., & Mosler, H. J. (2019). Factors associated with levels of latrine completion and consequent latrine use in northern Ghana. <i>International journal of environmental research and public health</i> , 16(6), 920.	Ghana	Sanitation	Exogenous	Diffusion Shame	Availability Change
18	Crocker J, Abodoo E, Asamani D, Domapielle W, Gyapong B, Bartram J. (2016). Impact evaluation of training natural leaders during a community-led total sanitation intervention: A cluster-randomized field trial in Ghana. <i>Environ Sci Technol</i> . 50(16):8867–75.	Ghana	Sanitation	Exogenous	Diffusion Shame	Availability Change
19	Kosinski, K. C., Crocker, J. J., Durant, J. L., Osabutey, D., Adjei, M. N., & Gute, D. M. (2011). A novel community-based water recreation area for schistosomiasis control in rural Ghana. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 1(4), 259-268.	Ghana	Water	Exogenous	Ownership	Change
20	Woode, P. K., Dwumfour-Asare, B., Nyarko, K. B., & Appiah-Effah, E. (2018). Cost and effectiveness of water, sanitation and hygiene promotion intervention in Ghana: the case of four communities in the Brong Ahafo region. <i>Heliyon</i> , 4(10), e00841.	Ghana	Sanitation	Exogenous	Shame	Change

21	Morinville, C., & Harris, L. M. (2014). Participation, politics, and panaceas: exploring the possibilities and limits of participatory urban water governance in Accra, Ghana. <i>Ecology and Society</i> , 19(3).	Ghana	Water	Exogenous	Accountability Ownership	Availability Longevity
22	Harter, M., Inauen, J., & Mosler, H. J. (2020). How does Community-Led Total Sanitation (CLTS) promote latrine construction, and can it be improved? A cluster-randomized controlled trial in Ghana. <i>Social science & medicine</i> , 245, 112705.	Ghana	Sanitation	Exogenous	Accountability Diffusion Shame	Availability
23	Nti, E. K., Wongnaa, C. A., Edusah, N. S. E., & Bakang, J. E. A. (2020). Assessment of the sustainability of community-managed water supply services in Ghana. <i>Environment, Development and Sustainability</i> , 22(7), 7097-7120.	Ghana	Water	Exogenous	Ownership	Longevity
24	Klug, T., Shields, K. F., Cronk, R., Kelly, E., Behnke, N., Lee, K., & Bartram, J. (2017). Water system hardware and management rehabilitation: Qualitative evidence from Ghana, Kenya, and Zambia. <i>International journal of hygiene and environmental health</i> , 220(3), 531-538.	Ghana, Kenya, Zambia	Water	Exogenous	Accountability Ownership	Longevity
25	Kelly, E., Shields, K. F., Cronk, R., Lee, K., Behnke, N., Klug, T., & Bartram, J. (2018). Seasonality, water use and community management of water systems in rural settings: Qualitative evidence from Ghana, Kenya, and Zambia. <i>Science of the Total Environment</i> , 628, 715-721.	Ghana, Kenya, Zambia	Water	Exogenous	Market	Longevity
26	Behnke, N. L., Klug, T., Cronk, R., Shields, K. F., Lee, K., Kelly, E. R., ... & Bartram, J. (2017). Resource mobilization for community-managed rural water systems: Evidence from Ghana, Kenya, and Zambia. <i>Journal of Cleaner Production</i> , 156, 437-444.	Ghana, Kenya, Zambia	Water	Both	Ownership	Longevity
27	Kelly, E., Lee, K., Shields, K. F., Cronk, R., Behnke, N., Klug, T., & Bartram, J. (2017). The role of social capital and sense of ownership in rural community-managed water systems: Qualitative evidence from Ghana, Kenya, and Zambia. <i>Journal of Rural Studies</i> , 56, 156-166.	Ghana, Kenya, Zambia	Water	Both	Accountability Ownership	Availability
28	Sarkar, S., Greenleaf, J. E., Gupta, A., Ghosh, D., Blaney, L. M., Bandyopadhyay, P., ... & Sen Gupta, A. K. (2010). Evolution of community-based arsenic removal systems in remote villages in West Bengal, India: assessment of decade-long operation. <i>Water Research</i> , 44(19), 5813-5822.	India	Water	Exogenous	Accountability Market	Availability Longevity
29	Rout, S. (2014). Institutional variations in practice of demand responsive approach: evidence from rural water supply in India. <i>Water Policy</i> , 16(4), 650-668.	India	Water	Endogenous	Accountability Market Ownership	Longevity
30	Singh, C. (2018). Is participatory watershed development building local adaptive capacity? Findings from a case study in Rajasthan, India. <i>Environmental development</i> , 25, 43-58.	India	Water	Exogenous	Accountability Diffusion Ownership	Availability Longevity

31	Maheshwari, B., Varua, M., Ward, J., Packham, R., Chinnasamy, P., Dashora, Y., ... & Rao, P. (2014). The role of transdisciplinary approach and community participation in village scale groundwater management: insights from Gujarat and Rajasthan, India. <i>Water</i> , 6(11), 3386-3408.	India	Water	Exogenous	Accountability Ownership	Availability Longevity
32	Orgill-Meyer, J., Pattanayak, S. K., Chindarkar, N., Dickinson, K. L., Panda, U., Rai, S., ... & Jeuland, M. (2019). Long-term impact of a community-led sanitation campaign in India, 2005–2016. <i>Bulletin of the World Health Organization</i> , 97(8), 523.	India	Sanitation	Exogenous	Shame	Availability Change
33	String, G. M., Singleton, R. I., Mirindi, P. N., & Lantagne, D. S. (2020). Operational research on rural, community-managed water safety Plans: case study results from implementations in India, DRC, Fiji, and Vanuatu. <i>Water research</i> , 170, 115288.	India, DRC, Fiji, and Vanuatu	Water	Exogenous	Accountability Market	Availability Longevity
34	Cameron, L., Olivia, S., & Shah, M. (2019). Scaling up sanitation: evidence from an RCT in Indonesia. <i>Journal of development economics</i> , 138, 1-16.	Indonesia	Sanitation	Exogenous	Diffusion Ownership Shame	Change Longevity
35	Roekmi RAK, Baskaran K, Chua LH. (2018). Community-based water supplies in Cikarang, Indonesia: Are they sustainable? <i>Natural Resource Forum</i> ;42(2):108–22	Indonesia	Water	Endogenous	Accountability Market Ownership	Availability Longevity
36	Ganing, A., Abu, A., Muslimin, I., & Adam, A. (2018). Community empowerment in management community-based total sanitation through health education in Majene. <i>Indian Journal of Public Health Research & Development</i> , 9(12), 1466-1471.	Indonesia	Sanitation	Exogenous	Diffusion Ownership	Change Longevity
37	Ogendo, K. N., Kihara, A. B., Kosgei, R. J., Tweya, H., Kizito, W., Murkomen, B., & Ogutu, O. (2016). Assessment of community led total sanitation uptake in rural Kenya. <i>East African Medical Journal</i> , 93(10), 39-42.	Kenya	Sanitation	Exogenous	Shame	Change
38	Babb, C., Makotsi, N., Heimler, I., Bailey, R. C., Hershow, R. C., Masanga, P., & Mehta, S. D. (2018). Evaluation of the effectiveness of a latrine intervention in the reduction of childhood diarrhoeal health in Nyando District, Kisumu County, Kenya. <i>Epidemiology & Infection</i> , 146(9), 1079-1088.	Kenya	Sanitation	Exogenous	Shame	Change
39	Gimaiyo, G., McManus, J., Yarri, M., Singh, S., Trevett, A., Moloney, G., ... & Lehmann, L. (2019). Can child-focused sanitation and nutrition programming improve health practices and outcomes? Evidence from a randomised controlled trial in Kitui County, Kenya. <i>BMJ global health</i> , 4(1).	Kenya	Sanitation	Exogenous	Accountability Diffusion Shame	Change
40	Karinja, M., Schlienger, R., Pillai, G. C., Esterhuizen, T., Onyango, E., Gitau, A., & Ogutu, B. (2020). Risk reduction of diarrhea and respiratory infections following	Kenya	Hygiene	Exogenous	Diffusion	Change

	a community health education program-a facility-based case-control study in rural parts of Kenya. <i>BMC public health</i> , 20, 1-9.					
41	Wardle, C. (2018). Sustainability and long-term impact of community-managed water supply in rural Kyrgyzstan, Central Asia. <i>Waterlines</i> , 37(2), 118-131.	Kyrgyzstan	Water	Exogenous	Diffusion Market Ownership	Availability Change Longevity
42	Keoprasith, B., Kizuki, M., Watanabe, M., & Takano, T. (2013). The impact of community-based, workshop activities in multiple local dialects on the vaccination coverage, sanitary living and the health status of multiethnic populations in Lao PDR. <i>Health promotion international</i> , 28(3), 453-465.	Laos	Sanitation and hygiene	Exogenous	Accountability Diffusion	Change
43	Biran, A., Danquah, L., Chunga, J., Schmidt, W. P., Holm, R., Itimu-Phiri, A., ... & White, S. (2018). A cluster-randomized trial to evaluate the impact of an inclusive, community-led total sanitation intervention on sanitation access for people with disabilities in Malawi. <i>The American journal of tropical medicine and hygiene</i> , 98(4), 984-994.	Malawi	Sanitation	Exogenous	Accountability Ownership Shame	Availability
44	Kayoka, C., Itimu-Phiri, A., Biran, A., & Holm, R. H. (2019). Lasting results: A qualitative assessment of efforts to make community-led total sanitation more inclusive of the needs of people with disabilities in Rumphi District, Malawi. <i>Disability and health journal</i> , 12(4), 718-721.	Malawi	Sanitation	Exogenous	Ownership Shame	Availability
45	Longwe, B., Mganga, M., & Sinyiza, N. (2019). Review of sustainable solar powered water supply system design approach by Water Mission Malawi. <i>Water Practice and Technology</i> , 14(4), 749-763.	Malawi	Water	Exogenous	Accountability Market Ownership	Availability Longevity
46	Pickering, A. J., Djebbari, H., Lopez, C., Coulibaly, M., & Alzua, M. L. (2015). Effect of a community-led sanitation intervention on child diarrhoea and child growth in rural Mali: a cluster-randomised controlled trial. <i>The Lancet Global Health</i> , 3(11), e701-e711.	Mali	Sanitation	Exogenous	Accountability Shame	Change Longevity
47	Jones, S. (2011). Participation as citizenship or payment? A case study of rural drinking water governance in Mali. <i>Water alternatives</i> , 4(1).	Mali	Water	Exogenous	Accountability Diffusion Ownership	Availability
48	Alzúa, M. L., Djebbari, H., & Pickering, A. J. (2020). A community-based program promotes sanitation. <i>Economic Development and Cultural Change</i> , 68(2), 357-390.	Mali	Sanitation	Exogenous	Accountability Shame	Availability Change
49	Azemzi, H., & Erraoui, E. H. (2021). Irrigation water management and collective action: understanding the shift from community management to participatory management in Souss-Massa (Morocco). <i>Euro-Mediterranean Journal for Environmental Integration</i> , 6(1), 1-12.	Morocco	Water	Endogenous	Accountability Ownership	Availability Change Longevity

50	Harter, M., Mosch, S., & Mosler, H. J. (2018). How does Community-Led Total Sanitation (CLTS) affect latrine ownership? A quantitative case study from Mozambique. <i>BMC public health</i> , 18(1), 387.	Mozambique	Sanitation	Exogenous	Diffusion Ownership	Availability Longevity
51	Barrington, D., Fuller, K., & McMillan, A. (2013). Water safety planning: adapting the existing approach to community-managed systems in rural Nepal. <i>Journal of water, sanitation and hygiene for development</i> , 3(3), 392-401.	Nepal	Water	Exogenous	Diffusion	Longevity
52	Bright-Davies L, Lüthi C, Jachnow A. (2015). DEWATS for urban Nepal: a comparative assessment for community wastewater management. <i>Waterlines</i> . 34(2):119–38.	Nepal	Water	Exogenous	Ownership	Longevity
53	Padawangi, R. (2010). Community-driven development as a driver of change: water supply and sanitation projects in rural Punjab, Pakistan. <i>Water Policy</i> , 12(S1), 104-120.	Pakistan	Sanitation and water	Exogenous	Market Ownership	Availability Longevity
54	Hubbard, B., Sarisky, J., Gelting, R., Baffigo, V., Seminario, R., & Centurion, C. (2011). A community demand-driven approach toward sustainable water and sanitation infrastructure development. <i>International journal of hygiene and environmental health</i> , 214(4), 326-334.	Peru	Sanitation and Water	Endogenous	Ownership	Availability Change Longevity
55	Smyrilli, C., Selvakumaran, S., Alderson, M., Pizarro, A., Almendrades, D., Harris, B., & Bustamante, A. (2018). Sustainable decentralised wastewater treatment schemes in the context of Lobitos, Peru. <i>Journal of Environmental Engineering and Science</i> , 13(1), 8-16.	Peru	Water	Exogenous	Ownership	Longevity
56	Chankova, S., Hatt, L., & Musange, S. (2012). A community-based approach to promote household water treatment in Rwanda. <i>Journal of water and health</i> , 10(1), 116-129.	Rwanda	Water	Exogenous	Diffusion	Availability Change Longevity
57	Aladuwa, S., & Momsen, J. (2010). k, water resources management and women's empowerment: the Wanaraniya Water Project in Sri Lanka. <i>Gender & Development</i> , 18(1), 43-58.	Sri Lanka	Water	Endogenous	Diffusion Market Ownership	Availability Change Longevity
58	Ibrahim, S. H. (2017). Sustainability assessment and identification of determinants in community-based water supply projects using partial least squares path model. <i>Journal of Sustainable Development of Energy, Water and Environment Systems</i> , 5(3), 345-358.	Sudan	Water	Exogenous	Market	Longevity
59	Mlenga, D. H., & Baraki, Y. A. (2016). Community led total sanitation for community based disaster risk reduction: A case for non-input humanitarian relief. <i>Jàmbá: Journal of Disaster Risk Studies</i> , 8(2).	Swaziland	Sanitation	Exogenous	Accountability Diffusion Shame	Availability Change
60	Madon, S., Malecela, M. N., Mashoto, K., Donohue, R., Mubyazi, G., & Michael, E. (2018). The role of community participation for sustainable integrated	Tanzania	Sanitation and hygiene	Exogenous	Accountability Ownership Shame	Availability Change Longevity

	neglected tropical diseases and water, sanitation and hygiene intervention programs: a pilot project in Tanzania. <i>Social Science & Medicine</i> , 202, 28-37.					
61	Mwakitalima, A., Massa, K., Seleman, A., & Kassile, T. (2018). Scaling up rural sanitation in Tanzania: evidence from the National Sanitation Campaign. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 8(2), 290-306.	Tanzania	Sanitation	Exogenous	Accountability Diffusion Market Shame	Availability
62	Kema, K. M., Komwihangiro, J., & Kimaro, S. (2012). Integrated community based child survival, reproductive health and water and sanitation program in Mkuranga district, Tanzania: a replicable model of good practices in community based health care. <i>The Pan African Medical Journal</i> , 13(Suppl 1).	Tanzania	Sanitation and water	Exogenous	Accountability Ownership Shame	Availability
63	Safari, J., Mohamed, H., Dimoso, P., Akyoo, W., Odhiambo, F., Mpete, R., ... & Mwakitalima, A. (2019). Lessons learned from the national sanitation campaign in Njombe district, Tanzania. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 9(4), 754-764.	Tanzania	Sanitation	Exogenous	Accountability Diffusion Ownership Shame	Availability Change
64	Okolimong, C. D., Ndejjo, R., Mugambe, R. K., & Halage, A. A. (2020). Effect of a Community-Led Total Sanitation Intervention on Sanitation and Hygiene in Pallisa District, Uganda. <i>The American Journal of Tropical Medicine and Hygiene</i> , 103(4), 1735-1741.	Uganda	Sanitation and Hygiene	Exogenous	Accountability Diffusion Shame	Availability Change
65	Harvey, P. A. (2011). Zero subsidy strategies for accelerating access to rural water and sanitation services. <i>Water Science and Technology</i> , 63(5), 1037-1043.	Zambia	Sanitation and water	Exogenous	Market Ownership Shame	Availability Change Longevity
66	Zimba, R., Ngulube, V., Lukama, C., Manangi, A., Tiwari, A., Osbert, N., ... & Larsen, D. A. (2016). Chiengi district, Zambia open defecation free after 1 year of community-led total sanitation. <i>The American journal of tropical medicine and hygiene</i> , 95(4), 925-927.	Zambia	Sanitation	Exogenous	Accountability Diffusion Shame	Availability Change
67	Russpatrick, S., Tiwari, A., Markle, L., Musonda, E., Mutunda, A., Osbert, N., ... & Larsen, D. A. (2017). Mobility up the sanitation ladder following community-led total sanitation in rural Zambia. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 7(3), 436-444.	Zambia	Sanitation	Exogenous	Accountability Diffusion Shame	Availability
68	Tiwari, A., Russpatrick, S., Hoehne, A., Matimelo, S. M., Mazimba, S., Nkhata, I., ... & Larsen, D. A. (2017). Assessing the impact of leveraging traditional leadership on access to sanitation in rural Zambia. <i>The American Journal of Tropical Medicine and Hygiene</i> , 97(5), 1355-1361.	Zambia	Sanitation	Exogenous	Accountability Diffusion Ownership Shame	Availability
69	Yeboah-Antwi, K., MacLeod, W. B., Biemba, G., Sijenyi, P., Höhne, A., Verstraete, L., ... & Hamer, D. H. (2019). Improving sanitation and hygiene through	Zambia	Sanitation and hygiene	Exogenous	Diffusion Shame	Availability Change

	community-led total sanitation: the Zambian experience. <i>The American journal of tropical medicine and hygiene</i> , 100(4), 1005-1012.					
70	Whaley, L., & Webster, J. (2011). The effectiveness and sustainability of two demand-driven sanitation and hygiene approaches in Zimbabwe. <i>Journal of Water, Sanitation and Hygiene for development</i> , 1(1), 20-36.	Zimbabwe	Sanitation and hygiene	Exogenous	Shame	Availability Longevity
71	Madziyauswa, V. (2018). Assessing sustainability of community managed NGOs' WASH interventions in rural Zimbabwe: the case of Chivi district in Masvingo province. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 8(4), 640-649.	Zimbabwe	Water, sanitation, and hygiene	Exogenous	Market	Longevity
72	Kwangware, J., Mayo, A., & Hoko, Z. (2014). Sustainability of donor-funded rural water supply and sanitation projects in Mbire district, Zimbabwe. <i>Physics and Chemistry of the Earth, Parts A/B/C</i> , 76, 134-139.	Zimbabwe	Sanitation and water	Exogenous	Accountability Market Ownership	Longevity
73	Dhoba, L. (2020). Going to scale with rural water supply: a reflection on experiences from sustaining community managed piped water schemes in rural Zimbabwe. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 10(3), 527-538.	Zimbabwe	Water	Exogenous	Accountability Ownership	Longevity

BMJ Open

How community participation in water and sanitation interventions impacts human health, WASH infrastructure and service longevity in low- and middle-income countries: a realist review

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-053320.R1
Article Type:	Original research
Date Submitted by the Author:	02-Nov-2021
Complete List of Authors:	Nelson, Sarah; The University of Sydney, School of Public Health Drabarek, Dorothy; The University of Sydney, School of Public Health Jenkins, Aaron; The University of Sydney, School of Public Health; Edith Cowan University, School of Science Negin, Joel; The University of Sydney, School of Public Health Abimbola, Seye; The University of Sydney, School of Public Health
Primary Subject Heading:	Global health
Secondary Subject Heading:	Health policy
Keywords:	PUBLIC HEALTH, Health policy < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Tropical medicine < INFECTIOUS DISEASES

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

How community participation in water and sanitation interventions impacts human health, WASH infrastructure and service longevity in low- and middle-income countries: a realist review

Sarah Nelson^{1*}, Dorothy Drabarek¹, Aaron Jenkins^{1,2}, Joel Negin¹, Seye Abimbola¹

1: School of Public Health, University of Sydney, Fisher Road, Camperdown, NSW 2006, Australia

2: School of Science, Edith Cowan University, Joondalup Drive, Joondalup, WA 6027, Australia

*Corresponding author

Email: s.a.nelson@live.com

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Abstract

Objective: To understand how, and under what circumstances community participation in water and sanitation interventions impacts the availability of safe water and sanitation, a change in health status or behaviour, and the longevity of WASH resources and services.

Design: Realist review

Data sources: PubMed, Web of Science and Scopus databases were used to identify papers from low- and middle-income countries from 2010 to 2020.

Eligibility criteria for selecting studies: Criteria were developed for papers to be included. The contribution of each paper was assessed based on its relevance and rigour (e.g., can it contribute to context, mechanism or outcome, and is the method used to generate that information credible).

Analysis: Inductive and deductive coding was used to generate context–mechanism–outcome configurations.

Results: 73 studies conducted in 29 countries were included. We identified five mechanisms that explained the availability, change and longevity outcomes: 1) accountability (policies and procedures to hold communities responsible for their actions and outcomes of an intervention), 2) diffusion (spread of an idea or behaviour by innovators over time through communication amongst members of a community), 3) market (the interplay between demand and supply of a WASH service or resource), 4) ownership (a sense of possession and control of the WASH service or resource), and 5) shame (a feeling of disgust in one’s behaviour or actions). Contextual elements identified included community leadership and communication, technical skills and knowledge, resource access and dependency, committee activity such as the rules and management plans, location, and the level of community participation.

Conclusions: The findings highlight five key mechanisms, impacted by 19 contextual factors that explain the outcomes of community water and sanitation interventions. Policymakers, program implementers, and institutions should consider community dynamics, location, resources, committee activity, and practices, and nature of community participation, before introducing community water and sanitation interventions.

Strengths and limitations

- The size of the review allowed for diverse context–mechanism–outcome configurations to be explored and understood from a variety of contexts from 29 countries.
- The paper identified 19 contextual factors that explain the outcomes of community water and sanitation interventions.

- The papers selected for this review were limited to those available in English, peer-reviewed and available online through a database search but did not include grey literature.
- Most of the papers identified focused on outcomes over a short time period, with only a few looking over five years. The short time frames are usually insufficient for behaviour change or WASH resource/service longevity to be observed.
- The review only included papers that looked at communities' natural resource management and interventions linked to water, it only included papers where an external party such as an NGO or government was involved in the water natural resource management and/or intervention/s.

Keywords: Context-mechanism-outcome configuration, low- and middle-income countries, realist review, communities

Introduction

Access to water and sanitation is fundamental for human health (1). Water, sanitation and hygiene (WASH) interventions continue to be implemented to improve the availability and services, especially in low- and middle-income countries (LMICs). This paper examines a range of WASH interventions including hardware interventions such as new latrines and water supply systems and their operation and maintenance, and software interventions such as the introduction of WASH or water committees, and health promotion and education programmes and training. The literature shows mixed effects of these interventions – some display positive impacts, with others showing no impact (2,3). In an effort to understand why WASH interventions fail, there is an expanding body of research seeking to examine the contexts (environmental, socio-cultural, institutional, economic) into which the interventions are introduced (4–7). This research emphasises the importance of understanding the influence of context on the success (or failure) of community WASH interventions and highlights that no single strategy can be successful in all contexts and circumstances (1,8,9).

WASH interventions can be designed to take into account a broad range of factors such as cultural traditions (10,11), resource dependency (12), service quality and satisfaction (13), and the rules and procedures used by a community (14). Further, the resources required for long term maintenance of WASH interventions are often limited in LMICs, leading to their failure (1). Failure of WASH interventions can occur for several reasons, such as a lack of community participation in design (15,16), a lack of community ownership (17,18), the abuse of funds or poor financial management

1
2
3 79 (19), a lack of willingness of community members to contribute (18–20), a lack of communication and
4
5 80 connectedness (21), and no ongoing support and acknowledgement of behaviour change (22–24).
6
7 81
8 82 Current literature shows multiple benefits of community participation; for example, participation is a
9
10 83 vehicle for cultural exchange and the building of knowledge amongst the implementing partners, and
11
12 84 is useful for ensuring interventions are relevant to local priorities (7,25). Also, the literature shows
13
14 85 that communities (particularly Indigenous communities), have developed knowledge structures by
15
16 86 place, space, and relationality over generations that are passed from one generation to the next,
17
18 87 which provide information on how to use water resources to promote their longevity (7). Without
19
20 88 participation issues can arise such as as communities may have beliefs that do not align with the
21
22 89 intervention (26). Lack of community participation is often seen as a hindrance in collaborative action
23
24 90 (27).
25
26 91
27 92 The definition and manifestation of community participation in WASH interventions vary significantly
28
29 93 across articles and studies (4). In rural areas, community participation involves the active engagement
30
31 94 of users in water services management (4). It can also mean the involvement of community members
32
33 95 in the planning, construction, decision-making, and ongoing management of their water system (28).
34
35 96 Community participation also refers to enabling communities to initiate project ideas, make decisions
36
37 97 about technology type and facility location that best suits their needs (19). In the context of this paper,
38
39 98 community participation is defined as community members having a role in planning, design,
40
41 99 construction, decision-making, delivery or management (including financial, operations and
42
43 100 maintenance) of WASH interventions (4,19,25,28).
44
45 101
46 102 Understanding the impact of contextual factors is important for designing and implementing long-
47
48 103 lasting WASH services within communities, given the vast heterogeneity of community contexts (6).
49
50 104 Some literature reviews have been conducted to examine the impact of specific contextual factors or
51
52 105 a single water or sanitation intervention (4–7), but none have examined contextual factors and
53
54 106 interventions in LIMICs generally. Our realist review has been undertaken to address this gap in the
55
56 107 literature. The aim of the review is to determine how and under what circumstances community
57
58 108 participation in water and sanitation interventions impacts the availability of safe water and
59
60 109 sanitation, a change in health status or WASH behaviour, or the longevity of water resources,
110
111 infrastructure and services.

112 **Materials and Methods**

Rationale for using a realist approach

The realist approach was chosen as this approach aims to understand and unpack the mechanisms through which an intervention works or fails in different contexts and settings (29). It is a theory-driven approach that can help explain why an intervention works in one setting and not in another (29). The realist approach begins with the understanding that interventions are complex because of their reliance on the interpretation, reasoning and actions of social agents to bring about change (30,31), and that the human agency of these social agents are in turn influenced by the socioeconomic, geographical, institutional structures in which they exist (i.e. context) (29). In realist synthesis, an outcome of an intervention is shaped by the interaction between these contextual factors and the intervention, which triggers action or inaction among social agents as determined by their reasoning, which then results in some kind of change (or not). Context-Mechanism-Outcome (CMO) configurations summarise explanations of how contextual factors (C), influence the production of outcomes (O), by triggering human agency in the form of mechanisms (M). 'Mechanism' refers to the combination of reasoning and resources that influence the actions of participants and stakeholders in an intervention. The mechanism may only be activated under the right contextual conditions (32). Therefore, WASH interventions may change how a community receives or responds to an intervention, and this is dependent on the context in which they live.

Search strategy

In preparation for the realist review, we conducted preparatory sessions by reading a variety of WASH literature. This helped us identify possible outcomes, contexts, and mechanisms to guide the literature search and the best keywords to use. We conducted preliminary searches to see what type of papers were identified, and the breadth and depth of WASH interventions covered. This process guided the final review question as it highlighted gaps in documented knowledge, and in turn shaped the interventions we focused on i.e. "new" interventions that were endogenous or exogenous in origin.

Two literature searches of PubMed, Web of Science and Scopus were conducted to identify peer-reviewed papers on how community participation in water and sanitation interventions impact the availability of safe water and sanitation, a change in health status or behaviour, and the longevity of water resources and services outcomes in LMICs. The search terms used were 'water', 'WASH', 'water resource', 'hygiene', 'sanitation', 'community participation', 'demand driven', 'community led', 'community engage*', 'community based', 'community manage', 'sustain*' and 'health'. The search strategy was developed with the assistance of a research librarian. Filters were applied to exclude reviews. Only English papers were considered. Only articles from 01-01-2010 to 03-04-2019 were

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

considered in the first search conducted in April 2019, and only articles from 01-01-2019 to 31-12-2020 were considered in the second search conducted in March 2021. The ten-year time period was chosen because given the breadth and depth of the work in the field prior to 2010, the number of papers included would otherwise be so large as to preclude an in-depth, realist review (33,34). Papers were identified and exported into Zotero. Duplicates were identified and removed. In conducting and reporting this realist synthesis we followed the RAMESES synthesis production and quality standards (33), realist review training materials (34), and other examples of realist reviews (30,35).

After screening the abstracts, full papers were assessed on the intervention, the outcome of interest, community role, study type and location. Interventions were considered endogenous if initiated by community members, and exogenous if initiated by external organisations e.g., government or NGOs. To be included, the intervention had to have an intended outcome linked to water, sanitation, health or resource/service longevity. Secondly, the community had to participate in one or more of the following ways: a) community had the full authority in decision-making, autonomy of the management or delivery of the water resource or intervention, b) community had the majority of authority in decision-making, management or delivery of the water resource or intervention, whether it was endogenous or exogenous in origin, or c) community members (e.g., leaders, community health workers) were involved in the design and/or delivery of an intervention by an external agent, d) community had a role through participation, consultation or engagement in activities and actions of an intervention by an external agent. Thirdly, the study needed to be conducted in countries considered to be LMICs according to World Bank definitions (36); finally the paper needed to include primary data. In planning the review we were aware that community members may have had varying degrees of autonomy in their work and decision-making power; and the levels of decision-making power of community members could vary and may be low and easily overruled by an external agent.

Formal quality appraisal was not carried out for individual papers as each paper could contribute to a different element of the CMO configurations and exclusion of papers reduces the ability of a realist review to achieve in-depth understanding(29). The contribution of sections of each paper were assessed based on relevance (i.e. whether it can contribute to emerging CMO configurations); and rigour (i.e. whether the method used to generate each piece of data relevant to the CMO configurations is credible).

Data extraction and categorisation

The first database searches found 595 entries from PubMed, 1,010 from Web of Science and 1,449 from Scopus (Figure 1). The searches from each database were merged, and 1,346 duplications were removed. A further 30 publications were removed based on their format, as they were a book or a review. After review of the remaining titles and abstracts, 1,523 were excluded reducing the selection to 155 publications. These 155 papers were read and assessed according to the inclusion and exclusion criteria by reviewers (SN and DD, in consultation with SA) on their relevance and rigour. Judgements on inclusion and exclusion were based upon two criteria: relevance (does the paper contribute to the understanding of how community participation in WASH interventions impacts any outcome of interest) and rigour (whether the paper is trustworthy, reliable and valid e.g., appropriate statistical tests were conducted for the data used when quantitative, or there is evidence of triangulation and decision-making trail when qualitative). The second database searches found 739 entries from PubMed, 460 from Web of Science and 528 from Scopus (Figure 1). The same data extraction and categorisation steps were carried out resulting in 73 papers being added to the review.

[INSERT FIGURE 1 AROUND HERE]

We followed the stepwise approach used by Abimbola et al (30) (Table 1). Five papers were randomly selected, and iterative data extraction was conducted independently by three of the authors (SN, DD and SA) to determine the categories into which data would be extracted and to determine the consistency of the extraction process across authors. Data from the papers were extracted into an excel spreadsheet into the following categories: study population, country, community role, intervention, water, sanitation or hygiene linkage, study type, and context, mechanism, and outcome components. The extraction process guided the initial development of preliminary understandings of what was involved in behaviours, actions, social phenomena and reasonings that connected outcomes with contexts in each paper. These preliminary understandings contributed to the creation of mechanisms. It was not always possible to extract data about the outcome, context, and mechanism from each paper.

By synthesising the information in each paper, we identified five mechanisms that explain the outcomes from the papers: accountability, diffusion, market, ownership, and shame. Individual papers revealed multiple mechanisms. Across the five mechanisms three sets of outcomes were identified:

- (1) Availability of resources and services such as clean water, and sanitation at an individual or community level;

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

- (2) Behaviour Change to prevent disease, such as a reduction in open defecation and increase the use of handwashing, altering health status e.g., reduction in disease levels or in health status such as diarrheal rates at an individual or community level;
- (3) Longevity of water and sanitation infrastructure, services, and resources, including factors that impact on their long-term use, such as the technical capacity to repair, operate and maintain infrastructure, resource, or service.

We identified factors (socioeconomic, geographical, institutional) that enabled or hindered outcomes, and these were categorised as context. Concurrently, a list of potential midrange theories that could help explain our interpretations of relationships among identified contexts, WASH interventions and outcomes of interest was drawn from the literature and team discussions. The list was refined until five theories could coherently explain the identified outcomes of community participation in WASH interventions.

227 Table 1: Steps taken in the realist analysis

Step	Process
Step 1: Identifying outcomes (description)	This involved reading and re-reading the papers, first to gain familiarity with the studies and second to identify outcomes which occur because of community WASH interventions e.g., how community engagement in water and sanitation interventions impact the availability (of safe water and sanitation), a change (in health status or behaviour), and the longevity (of WASH resources).
Step 2: Identifying contextual components of outcomes (abduction)	This involved further reviewing of papers to find enabling and hindering factors from the identified outcomes. These included skills and knowledge (including financial capabilities and technical abilities for operation and maintenance), social cohesion and connectedness, communication, willingness to pay, leadership, diverse involvement in the intervention (of women and at different stages of design, planning and implementation), community characteristics and location.
Step 3: Theoretical redescription (abduction)	<p>This step involved exploring the selected outcomes and their contextual components within the theories to better understand what they represent. Five theories informed our analysis.</p> <p>1) Social accountability holds people in place to achieve actions because of fear of exposure, professional or public reprisal or cost of reputation leads to responsiveness by following a certain behaviour or idea (35). We adapted this theory to include formal accountability mechanisms such as policies, procedures and rules to hold communities and committees responsible for their actions and outcomes of an intervention.</p> <p>2) Diffusion of innovation theory is the spread or adaption of an idea or a behaviour through a process which people adopt over time (37). The idea or behaviour spreads through innovators (those who try and idea or behaviour first), and early adopters (opinion leaders who enjoy leadership roles and embrace change opportunities) who influence and change ideas or behaviours throughout the community (37). We utilised this theory to explain leaders and key people in the community being innovators who shape and influence WASH behaviours within the community.</p> <p>3) Demand theory is an economic theory that is the interplay between demand and supply of a good or service (it is a balanced supply and the price that people are willing to pay for it) (38). There is an important dynamic to ensure the market system does not fail, because of changes in price or demand. This theory was adapted to focus on the supply and demand for water resources, and a community's or individuals' willingness to pay for them and other factors that influence the supply and demand balance.</p> <p>4) Arnstein's ladder of participation proposes that increased meaningful community participation correlates with more power in the decision-making process and thus more control over the change it may bring, leading to a sense of ownership (39). With this mechanism, we focused on how a sense of ownership within resources or service related to WASH such as water can help build a sense of value, and lead communities or individuals to manage the resources or service better. The idea being a stronger sense of ownership means they are more likely to protect it and use it effectively.</p> <p>5) Social comparison theory purports humans need to compare themselves and evaluate their opinions and abilities of themselves, and evaluate their abilities and opinions through comparing themselves with other people (40). The influence of social comparison,</p>

	and desire to fit into a specific situation can cause changes in verbal and nonverbal behaviour to fit the situation. Comparison can have negative impacts on behaviours. We adapted this theory to focus on the elements of shame as a form of social comparison, for people to conform to an appropriate socially accepted WASH behaviour.
Step 4: Identifying mechanisms (retroduction)	This step involved examining the identified outcomes with their hindering or enabling contextual factors with the aim of creating processes and systems that resulted from observed patterns across LMICs. This involved moving back and forth between primary data theories created in this review to develop explanations for the outcome and contextual linkages.

228

For peer review only

229

230 These five theories are broad in their potential application. For this reason, they were only a starting
231 point for the development in the CMO configurations. Through a process of retroductive analysis (37),
232 the five theories produced five mechanisms: social accountability became 'accountability' (e.g.,
233 policies and procedures to hold communities and committees responsible for their actions and
234 outcomes of an intervention), diffusion of innovation became 'diffusion' (e.g., the spread or adoption
235 of the behaviour or action due to leaders or influential community members making the change
236 earlier), demand theory became 'market' (the interplay between demand and supply of a service or
237 resource to ensure its availability or longevity), Arnstein's Ladder became 'ownership' (e.g., the level
238 of individual or community participation impacts the degrees of control and sense of possession over
239 a service or resource and this impacts the outcomes of interest), and lastly social comparison became
240 'shame' (e.g., a feeling of disgust in one's behaviour or actions as they are not seen as desired or do
241 not comply with other people's behaviours in the community).

242

243 **Results**

244 Overall, 73 papers were identified, and presented data from 29 countries (Figure 2), with different
245 WASH intervention focus (Figure 3). We identified five mechanisms made possible by WASH
246 interventions: accountability, diffusion, market, ownership and shame, with 19 contextual factors
247 (Table 2). The analysis focused on mechanisms, rather than the country as we concentrated on
248 community-based interventions and each community intervention and context contributes to a piece
249 of the development of the mechanism. As the country and the type of intervention were not
250 specifically named in the findings a separate table concerning these has been included in the
251 Supplementary Appendix.

252

253 [INSERT FIGURE 2 AROUND HERE]

254 [INSERT FIGURE 3 AROUND HERE]

255

256 The next section commences with a detailed description of each mechanism. This is followed by a
257 description of each mechanism based on the individual outcome, and key contextual factors identified
258 through in the review (Table 3 provides a summary).

259

260 Table 2: Contextual factor examples

	Contextual Factor	Examples
1	Community location	Easily accessible location and community layout and size with reliable transport (38–40)
2	Communities with similar characteristics	Communities with similar values and homogenous characteristics such as socio-economic status (41–44)
3	Communication	Regular communication, and places to share information e.g., meetings between communities, committees or organisations (10,17,20,22,28,38,39,44–52)
4	Leadership	Community or committee leadership lead and help enforce change in behaviours or standards of services (10,11,41,44,53–63)
5	Fines or penalties	Fines or penalties in communities when people do not conform to the desired behaviour or their sanitation facility is not up to the appropriate standard (10,25,38,45)
6	Seasonality	Variation in weather over different times of the year (64,65)
7	Resource dependency	Communities’ need the water resource for their health, livelihood or income (16,19,50,66–68)
8	Access to resources and funding	The communities or committees’ ability to access funds through user fees or funds from the community or government (21,38,45,49,50,59,69–71)
9	Financial and technical skills and knowledge	Community or committee ability to manage money and make financial decisions. Technical skills to operate and maintain WASH services or infrastructure over time or when issues arise (18–21,24,38–40,43,54,59,72–75)
10	Ongoing support and acknowledgement of change	External or government support for communities with the resources they need; and acknowledgment of changes in behaviour (22–24,75).
11	Community connectedness and social cohesion	Ongoing interaction, and linkages in communities and cooperation as people engage and work together (8,21,38,41,72,76,77). These can be through collective action or mobilisation of resources to work as a community (28,67,76,78,79)
12	Community willingness to pay	Communities’ willingness to pay user fees or provide money to invest in resources or services for use or operations and maintenance (17–19,21,59,65,71,80–82)
13	Committees with followed and understood responsibilities	Committee with clear responsibilities that are followed and understood by its members (25,39,83)
14	Rules and management plans	Structures and processes in place that guide actions for operation and maintenance of resources, services, and behaviours of the community or committee (15,17,19,21,25,41,45,50,71,73,81,83)
15	Active committees that include women	Committees that are active and inclusive in communities with decision-making, maintaining resources and services (16,19–21,25,28,39,64,66,68,69,77,83,84)

16	Community/committee involvement in the design, planning or implementation of the intervention	Community and committee involvement including women and those with disabilities with design, planning or implementation of the intervention to ensure the needs of all people are considered and met (15,16,19,73,81,85–91)
17	Monitoring (including reports)	Ongoing monitoring of communities and committees including reports by internal or external parties to ensure availability and longevity of resources or services and behaviour change occurs (10,15,22,38,39,44,46,49,50,53,64,69,77,81,83,92–95)
18	Trust	Trust in, by or among members of communities, committees, and organisations inspires confidence that allow people to comply with paying fines (18,25,45), take action or change their behaviour.
19	Incentives and rewards	Communities rewarded through internal or external parties e.g., through prizes or sharing success stories in the newspaper (10,39,40,44,51,95)

262 **Table 3: Enabling context-mechanism-outcome configurations**

Context	Mechanism	Outcome
<ul style="list-style-type: none">• Easily accessible community (e.g., size and location) to allow access for monitoring visits.• Having opportunities to share information (e.g., meetings) between users and committee members for internal monitoring.• Having active and functional community committees for internal monitoring.• Committees with clear responsibilities, rules and management plans that are followed and understood (e.g., written working plans for system breakdowns).• Having consequences for not conforming to change (e.g., fines).	Accountability	<ul style="list-style-type: none">• Availability of WASH service or a water resource e.g., to ensure that sanitation facilities are in place or to assess the levels of groundwater.• Changes in behaviour or health outcomes e.g., reduction of open defecation, improvements in children’s height and weight.• Longevity of water resources and services.
<ul style="list-style-type: none">• Having strong leaders or committees to help share the spread of ideas and initiate change;• Having higher levels of social cohesion and connectedness in small rural and remote communities to help create supportive environment for change and influence new social norms.• Having regular communication among peers to build and share knowledge.	Diffusion	<ul style="list-style-type: none">• Availability of resources or services e.g. latrines, handwashing facilities and water.• Changes in behaviour or health outcomes e.g. reduction of open defecation, water purification and waterborne diseases.• Maintenance and longevity of latrines and water access/systems.
<ul style="list-style-type: none">• Having community or committee knowledge or skills e.g., technical - the ability to repair hardware.• Having resource dependency to ensure community investment in supply and ongoing maintenance and operational costs..• Having a resource or services that is not impacted by the weather.	Market	<ul style="list-style-type: none">• Availability of resources e.g., water.• Longevity of water services or latrine quality.
<ul style="list-style-type: none">• Having community or committee knowledge or skills e.g., technical - the ability to repair hardware.• Having resource dependency to ensure community investment in supply and ongoing maintenance and operational costs.• Community involvement (including women and those with disability) in the design, planning or implementation to promote accessibility, equitable access and the desire to maintain the resource.• Having opportunities to communicate about the state of the resource or service to help maintenance.	Ownership	<ul style="list-style-type: none">• Availability of resources or services e.g., water and latrines.• Longevity of the water system or service.

<ul style="list-style-type: none">• Small, cohesive, and isolated communities with high social cohesion and connectedness helps the conformity of behaviour.• Having community involvement allows understanding of the impacts of the behaviour and the benefits of change.• Shame initiated by leaders and people known within the community helps acceptance, monitoring and enforcement.• Community technical or financial capabilities allows the ability to conform to change.• Ongoing support and acknowledgement of change for community motivation to maintain changes.	Shame	<ul style="list-style-type: none">• Availability of WASH resources e.g., individual or household ownership of latrines and handwashing facilities.• Change in behaviour or health outcomes e.g., reduction in open defecation, hand washing with soap, reduction in roundworm infestation and stunting.
--	-------	--

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

265

266

267

268

269

270

271

272

273

274

275

276

277

278

279

280

281

282

283

284

285

286

287

288

289

290

291

292

293

294

295

296

297

298

ACCOUNTABILITY

Accountability is more likely to be achieved when the community is easily accessible, opportunities are present to share information and there is a strong and functional water committee as it is easier to uphold and enforce rules, procedures, and policies. The three outcomes identified were availability, change and longevity.

Availability

Triggered by internal or external monitoring, accountability may result in improved community availability to a WASH resource or service. The focus of such monitoring may be progress towards achieving a goal. The goal may be about the availability of a service – e.g., to ensure that sanitation facilities are in place (10,22,38,44,49,53,69,93,95), that facilities meet the needs of people with disabilities (46), or that water is accessible (39,83). The goal may also be resource preservation (safety and/or accessibility) so that water is available to be accessed as desired – e.g., to check water samples for faecal or arsenic contamination (15,45,50,64,81), or to assess the level of groundwater available for agriculture throughout the year (77). Internal monitoring can be conducted by a chief or village headman (10,22,44), locally trained volunteers (50), community members (53,77) or by the community’s health, water or community—total led sanitation committee (38,39,49,50,69,81,83). External monitoring can be conducted by NGO facilitators (46,53), health workers (49,92,95) or political leaders and council officials (38).

Opportunities and platforms for regular communication and meetings involving community members, service users and health or water committees help build a sense of trust and connection amongst all parties and helps to hold everyone accountable (45,46,50). This is reinforced where community leadership is transparent and has open channels for communicating with community members (10,22,39,44), communities make plans to change i.e. display of stickers to show the commitment to build latrines (93), and the use of technology allows up-to-date monitoring (44,81). Government guidelines can reinforce safe standards and monitoring of resources e.g., water (38,71). Accountability is also strengthened where there is a functional, long-standing water or health committee whose members are active, motivated and committed, and have clear roles and responsibilities (39,83). These roles and responsibilities can be reinforced through committee trainings (81). A gender-balanced committee opens up the space for accountability, as more opinions and views are considered on what factors are important and need consideration (39,64,66,69,83,84). There can be challenges in accepting the involvement of women in a gender-balanced committee (69).

299

Change

Ongoing external monitoring can hold communities accountable for changing their health, hygiene and sanitation behaviours (38,40,46,49,53,69,92,94), leading to improved health of children as seen in height and weight changes and diarrhoea occurrence (40,69). Without ongoing internal or external monitoring, loss of momentum for change can occur, halting behaviour change progress (23,38). Ongoing monitoring is enabled by regular meetings and sharing of information to enforce behaviour change (25,50,69). However, limited availability to communities due to a remote location, inadequate or unreliable transport, violence, and large community size and layout, or understaffed organisations are barriers to ongoing external monitoring (38–40). Accountability can also influence behaviour change when triggered by fines (e.g., money, goat, or chicken) imposed as a penalty for not conforming to the desired behaviour. For example, penalties can be used to enforce standards for latrines (25), for not constructing a latrine, and for open defecation (10,38), and fines given for not abiding by water use limits (45). Trust is an essential contextual factor for such penalties – tensions arise when a community does not trust the person or committee collecting the fines and what they will do with the fines (18,25). Trust depends on the person or committee's record of financial management, and whether they have clear rules about the use of such penalties. Lack of trust from external organisations can also prevent change in communities' behaviours (45).

317

Longevity

Accountability within community committees can facilitate their continued activities, therefore promoting the longevity of WASH resources and services for which they are responsible. This requires that committees have internal feedback systems, take minutes and set agendas with written working plans, demonstrate high self-organising capabilities, and a sense of obligation among committee members to attend meetings and take action to manage and maintain resources, thus contributing to the longevity of water and sanitation interventions (17,25,41,50,71,83). Accountability to government entities (e.g., water boards) for reports and abiding by government policies can promote longevity as this can hold committees and communities responsible for funds to maintain WASH resources and services (15,17,48,71,90). Communication with the broader community holds committees accountable for their roles and responsibilities concerning water and sanitation infrastructure in a community (17,28,48). Communication can also help enable the diffusion of efforts to change the landscape of governance within local communities, check the progress of actions, and the enforcement of rules (10,20,45).

332

1
2
3 333 Committee accountability is enabled when committees have clear roles, responsibilities, rules and
4 334 procedures (which they understand) on responding to system breakdowns, and managing ongoing
5 335 maintenance and missing parts, with direct implications for the longevity of water availability and
6 336 WASH infrastructure (21,25,71,73,81,83). The longevity of resources and services is facilitated by a
7 337 committee’s ability to make funds available or having bank accounts for operational and maintenance
8 338 costs, and by the committee having rules and procedures for fund management (e.g., having an
9 339 educated treasurer who manages and collects funds within the community), or by having the
10 340 community participate actively in monitoring committee finances (15,19,21,45,83). Issues with
11 341 longevity can also arise when there has been abuse of funds or poor financial management, and
12 342 therefore community members are less willing to contribute (18–20). Transparency in committee
13 343 activities and community trust can help address this (45). Committee activity and social participation
14 344 play key roles in managing maintenance and operation of water and sanitation systems and can assist
15 345 in the management of funds ensuring continued service provision (16,65,66,73,80). This can promote
16 346 good governance and practice (16). While committee activity and social participation is an enabling
17 347 factor, this alone is not enough to ensure the longevity of community water and sanitation
18 348 infrastructure (82).

19
20
21
22
23
24
25
26
27
28
29
30 349

31
32 350 **DIFFUSION**

33 351 This mechanism captures the processes by which an idea, technology or behaviour that is perceived
34 352 as new (i.e. they are considered innovations in a community) spreads and is adopted by individuals or
35 353 a community. Our interpretation of how the diffusion of innovation theory works to bring about
36 354 change was guided by the LMICs contexts from which we drew our review data. Diffusion of ideas in
37 355 communities was observed as mostly unplanned, horizontal, and peer-mediated spread (31), however
38 356 in cases where the innovation was endogenous it was more likely (when compared to exogenous
39 357 interventions) that adoption was actively promoted (60), this difference can be explained by the effect
40 358 of a sense of ownership, which is explained in the mechanism ownership.

41
42
43
44
45
46
47 359
48 360 The diffusion mechanism underscores that strong and stable social relations are essential for wide and
49 361 sustained adoption of WASH interventions in communities, and illustrates the importance of *who*
50 362 introduces new ideas, behaviours or technologies (exogenous WASH interventions) or champions
51 363 homegrown new ideas, behaviours or technologies (endogenous WASH interventions). Champions are
52 364 identified as “innovators” (i.e. individuals who are the first to develop and try out new ideas) and
53 365 “early adopters” (i.e. opinion leaders who enjoy leadership roles and embrace change opportunities)
54
55
56
57
58 366 who over time through their influence and their existing relationships and communication with
59
60

members of the community (55,96) can encourage adoption of new ideas, both passively and actively. Innovators and early adopters in a community include teachers (56,62), leaders (10,22,38,44,55–58,62), healthcare workers (47,56,61,62,92), and community committees (21,41,67,68). This mechanism is triggered primarily by contexts of strong social relations, and our analysis resulted in availability, change, and longevity outcomes.

Availability

In communities lacking provision of basic WASH infrastructure by governments, availability to services can be obtained through external agencies such as NGOs or by internal innovation. In both cases availability of services is not instantaneous and depends on motivation, organisation and negotiation, the successes of which are in turn shaped by the character of social relations within a community, the more cohesive the better. In this way, availability of resources such as latrines (8,11,38,41,44,49,51,57,58,60,72,93), water infrastructure such as pipes (28,68,70,79) and handwashing facilities (38,49,51,60) can be driven by diffusion; when these facilities or the idea of them are new, the collective action necessary to build or obtain them depends on the extent to which appreciation for their value spreads in the community.

Additionally, information on community-led interventions that reflect the needs of the community take root more readily than interventions introduced by external sources, as they often do not address community needs accurately or at all. Information about the need for the WASH infrastructure or service can diffuse more readily where people have similar experiences of need and importantly high levels of social cohesion and sense of connectedness. Social cohesion and connectedness refers to the extent of ongoing interaction and linkages in communities, and cooperation as people engage and work together (8,38,41,72). This builds on social constructs such as social capital and collective action, where individuals' shared knowledge and trust can promote cooperation through self-organisation, action and information sharing (21,41). Communities with greater cooperation, shared norms and values can act more collectively (41,72,77). This means that people may be more concerned about others, may be more likely to cooperate, communicate and work with one another, and agree on community priorities and goals. Attainment of WASH resources is made easier if a significant number of people believe in its benefit and value. Social cohesion helps to promote infrastructure or resource attainment and ultimately change in access to WASH, as without it early adopters are not be able to build the necessary momentum, enthusiasm and confidence (8,41,72,93). In communities of high social cohesion, innovators can draw on the existing influence of leaders to set new social norms (11,44,57,93), and early adopters draw on the existing skills within the community to work on a

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

resource or intervention (28,41,44,68). The success, respect and acceptance of the early adopters can provide the rest of the community confidence to adopt the new social norm (38,93). Diffusion can also occur within sections of the community such as among women and other community groups, as within these smaller groups they may have different sets of social norms and acceptable behaviours (11,68). Locally accessible resources enable availability (38,49).

Change

Diffusion can occur through communication among peers, which leads to shared understanding, therefore reinforcing the adoption of new behaviour at an individual or community level (41,44,56,79). Examples of diffusion influencing behaviour change include reduction of open defecation (10,38,49,55,59,60,62,90,94), water purification (79), disposal of rubbish and care of animals (94), and sanitation and hygiene behaviours such as handwashing and safe disposal of faecal material (58,60,68,69), which may lead to improved health outcomes such as a reduction in diarrhoea rates, waterborne diseases and respiratory infections (38,47,68,69,92). Behaviour change is enabled by diffusion in communities with high levels of social cohesion and connectedness by enabling communication among peers, to build and share knowledge i.e. through community and marketing events or radio shows (38,41,47,49,51,60), and as highly regarded leaders influence the spread of new behaviour and create new social norms through their endorsement (11,20,55,60,62). Higher levels of social cohesion in small rural and remote communities can also help sustain long-term behaviour change (e.g., reduction in open defecation), especially where people stick together to create a supportive environment for long-lasting change. In these contexts, the focus is on behaviour change at the community rather than at an individual’s level (62,94). Increased latrine quality and cleanliness can reinforce behaviour change (49,69).

Longevity

The longevity of resources such as water pumps or piping infrastructure has often been difficult to achieve in LMICs where resources and technical expertise required for their maintenance are not readily available. However, if the value of the resource, through demonstrated health benefit for example has diffused and taken root in a community, this can assist in the mobilisation of efforts to maintain the resource or service. Strong social bonds amongst community members characterised by shared goals and trust helps facilitate the spread of information about the benefit of new ideas and encourages their adoption (28,41,56,57). The perceived need to collectively mobilise resources to address water or sanitation problems is shared by committees and within communities (28,67,78,79,97). The willingness of community members to help one another further leads to

longevity of resources such as latrines (8,51) and water access (67,79), through the maintenance of the resources (28). Gender-balanced committees or the active involvement of women facilitates the spread of ideas within the community, especially about resources such as water systems that women are particularly involved in using and managing daily (20,21,68,77,83).

MARKET

The market mechanism operates through the balance of demand and supply, determining the price of a good or service. It is a mechanism that allows the distribution of resources, however the dynamic balance between supply and demand can easily be thrown out of balance, and cause failure. Typically, when a good or service becomes more readily available and supply increases, prices tend to fall, and when the demand for a good or service reduces, prices tend to increase. The continued presence of a market system is important as it is also a way that communities and people support themselves. Supply and demand of resources, especially in relation to WASH is influenced by contextual factors such as community or committee knowledge and skills, resource dependency and use in the community, ability to access resources for operation and maintenance, and a weather resilience system. These factors influence the want and need for WASH services and resources. Market systems need to be resilient and adaptable to address fluctuations in supply and demand to ensure that there are continued WASH resource or service availability and longevity for communities.

Availability

Knowledge mediates relations between supply and demand, and lack of knowledge results in an imbalance between supply and demand. Without knowledge, the availability of a WASH resource or service may remain low, even when it is available at an affordable price. Hence, to lead to improved use, efforts to increase and improve the quality of supply (e.g. through training to increase the skills of local artisans on well design), require complementary efforts to increase household knowledge (e.g. through social media and public demonstrations) (43).

Where communities have alternatives to a safer water supply that they perceive as meeting their needs and protecting their health, they may be less willing to invest in the longevity of the safe water resource/service. Hence, a greater perceived need for a WASH resources (e.g., high levels of need for clean, safe, drinkable water for domestic purposes) means it is more likely that a community will invest in its supply (e.g. by promoting local development of skills required to maintain hardware), thus, helping to maintain or increase the availability of water (16,19,50,66–68).

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Longevity

Varying levels of demand for a WASH resource or service due to seasonality can influence longevity. For example, water kiosk services are viable during the dry season when people are willing to pay for water because of limited rain and availability of water. Market failure occurs for water kiosks during the wet season as there is increased water supply with cheaper options, and the service becomes unviable in the long term (65). Willingness to pay for a water system (17–19,21,65) and community water supply project costs (80–82) often determines a system's reliability or longevity, and this is linked to demand, affordability and financial capacity in a community. The ability to access resources and funding is important when communities lack knowledge and skills, and the ability to pay for such skills lacking (50).

User fees are often imposed when there is limited internal or external financial support, and the WASH resource or service requires ongoing maintenance and operational costs. User fees can help to regulate demand and promote the responsible use of resources, promoting longevity (50,71,80), although this requires enforcement to pay fees (45). Low levels of willingness to pay (sometimes reflecting low levels of need or capacity to pay) can be a barrier to operation and maintenance and longevity of the water service and latrine quality (16,19,21,50,80). Where willingness exists in conjunction with the inability to access funds, resources or need from external funding availability to water and latrines is compromised (21,59,71). Willingness to pay may also depend on satisfaction with and quality of the service, which in turn depends on how well a service is operated or maintained (19).

OWNERSHIP

Endogenous interventions (interventions initiated by community members) are better at reflecting and meeting a community's needs compared to interventions that are brought into the community by external agents with minimal or without community consultation and involvement. These are two extremes of a spectrum of community involvement captured in Arnstein's Ladder of Citizen Participation (98), which proposes that increased meaningful community participation correlates with more power in the decision-making process and thus more control over the change it may bring. Control of an object, process or idea is considered a key characteristic of the phenomenon of ownership (99). Examples of total ownership are rare in the literature yet are common in day-to-day practice within communities. However, well-planned collaboration between communities and external agents, which engage communities in co-planning, co-production, and co-management (100) or maintenance can achieve 'citizen control' and build an effective sense of ownership while overcoming barriers of access posed by lack of resources. Meaningful participation as co-production

is important as people often feel that they own something they create, shape or produce (99). A secure sense of ownership over a water resource, water infrastructure or hardware is crucial as it promotes investment and commitment to its preservation at individual and community levels. Community involvement and inclusion, power and control are all necessary for an individual or community to feel a sense of ownership over WASH infrastructure, and this sense of ownership has significant impact on shaping outcomes availability and longevity of WASH interventions.

Availability

The need for the resource can help promote ownership, as the communities have a dependency on it and take greater steps to ensure the availability of resources such as water and latrines (38,44,45,51,64,77). Ownership can be initiated by need or want of a resource: such that as a community plays a role in obtaining an intervention, their sense of ownership can be increased when the intervention is in place, thus creating a self-reinforcing loop between availability and ownership. The extent to which community members feel a sense of ownership towards a resource can influence whether they seek external or draw on internal technical and financial support to ensure that the resources (e.g., water and sanitation facilities) are in place (21,28,41,50,62,69,85). High levels of social cohesion and connectedness is an enabler of efforts to access external funds or mobilise community resources (21,28,41,45,85). Access to loans and grants can help promote ownership (45,69). The involvement of a broad range of community members in water and sanitation interventions can promote a collective sense of ownership, which, in turn, can facilitate social cohesion and connectedness by providing opportunities for a community to share a common goal (8,87,88). Promoting community ownership of a resource, involving community members in capacity building (e.g., in managing the resource), and involving women, leaders and people with disabilities (e.g., in decision-making) can ensure availability, and access is equitable and safe (38,44–46,48,51,56,74,77,83,88). Ownership by a range of community members, including those who are often underrepresented in positions of power and control, can increase availability for these community members as with ownership comes the opportunity for people to alter what they own, therefore satisfying their needs (99).

Longevity

Ownership is enabled by the involvement of communities in the co-design, co-planning and co-implementation of hardware, increasing the likelihood that the resource reflects the community needs (15,87), the costs are appropriate and affordable (16,19), the community has the appropriate information for operations and maintenance (19,73,81,91), and the community is willing and able to

1
2
3 537 commit to bear hardware costs and ongoing operational and maintenance costs (16,86,90,101), thus
4
5 538 becoming self-sufficient (16,19,85). In the absence of this, a community may need to rely on external
6
7 539 sources for the longevity of resources (18,64,80,86,91). Ownership is enabled when communities are
8
9 540 allowed or granted decision-making authority in operations and have responsibility for the
10
11 541 maintenance of hardware (18,89). Taking ownership requires a leader or committee to champion
12
13 542 action (17,35,50,81,85), especially when a leader or committee has to manage the hardware (e.g., in
14
15 543 terms of speed and adequacy of repair), and to raise and manage funds necessary to maintain the
16
17 544 hardware (e.g., their water system) in the long term (50,67,70,73,81,83–85). Financial management
18
19 545 ability, can be hampered when communities have low budget resources or communities are unable
20
21 546 to afford the service and the committee receives limited funds to maintain a water system, impacting
22
23 547 the longevity of the water service (15,50,64).
24
25 548
26
27 549 The capacity to manage WASH hardware can promote a sense of ownership (17,21,77,80,81,87).
28
29 550 Therefore, retention of human resources and committee members can lead to resource/service
30
31 551 longevity as knowledge and skills are retained in communities (21,39,54,73). Having a broad variety
32
33 552 of members (including women) on such committees can promote buy-in from the community, and
34
35 553 diverse voices in decisions can lead to a greater sense of ownership, and desire to maintain the
36
37 554 resource (16,19,25,28,39,64,83). Men typically manage the operations and maintenance of water
38
39 555 systems, and women manage the collection and domestic uses. This leads to women facing a greater
40
41 556 burden in maintaining water quality and supply. Women may need to travel further to collect the
42
43 557 same volume of water or to care for ill family members. Because of this burden it is important for
44
45 558 women to have a voice in decision-making. Involvement of women can increase their sense of
46
47 559 ownership and enable them to independently fund, plan, build and maintain water systems (68),
48
49 560 allowing them to gain status, take on leadership roles and support younger women in the community
50
51 561 (16,68). Women can communicate with the committees about system breakdowns and without this,
52
53 562 such information sharing that leads to repair may not occur (28). Such active communication reflects
54
55 563 ownership and indicates a willingness to work together and build connections within the community
56
57 564 which promotes longevity by facilitating ongoing response to maintenance issues (21,67,77,79). Lack
58
59 565 of ownership of hardware can occur in communities with low socioeconomic status as they may have
60
566 other priorities, or where the need for the hardware is limited, which in turn limits commitment to its
567 maintenance (17).
568
569 **SHAME**

Shame is based on the theory of social comparison where others compare themselves to those around them to determine their own self-worth. This comparison can trigger disgust, disappointment, or embarrassment in one's behaviour or actions. Shame is activated by individuals comparing themselves with others. The shame of not conforming to the appropriate (handwashing) or undesirable WASH behaviours (open defecation), leads communities or individuals to change their behaviour or action to become more socially acceptable. Shame can be leveraged as a feature of interventions that seek to reset community norms, e.g., community members can be educated that open defecation and not washing hands is disgusting and is harmful to the whole community. Comparison between individuals, between households and between communities, can lead to shame as it brings out elements of competition and can result in shame from the loss. Capturing shame may manifest by the introduction of incentives (e.g. prizes and rewards) to motivate communities to achieve a water or sanitation goal in comparison to others (10,39,40,44,51,95). Contextual factors such as socioeconomic status, location, leadership, resources, and social capital enable and reinforce the appropriate and desired behaviour or action. Availability and behaviour change are the two outcomes associated with the shame mechanism.

Availability

Without external support, shame can promote availability of and individual/household ownership of latrines (22,38,42,44,46,49,51,53,58–63,74,75,93) and handwashing facilities (38,49,51,56,60,95). These outcomes are limited in communities and households with financial and technical challenges (24,38,40,59,72,74,75). Enablers include initiating shame by leaders and people known within the community, which helps the acceptance, monitoring and enforcement of new norms (22,44,51,53,58,60–63). For example, effective leadership in smaller homogenous communities may be more likely to achieve behaviour change, because people have closer relationships and are mindful of the impact of their behaviours on others (44).

Social cohesion and connectedness are important enablers of household latrine construction because cooperation and collective action can help overcome the inequality in resources and skills necessary to build latrines (11,23,38,41,55–57,72). Together, social cohesion and connectedness can promote friendship and community respect, and an appreciation of social benefit of private goods that may help reduce open defecation (51). Collectively they can also enable shame to be transmitted throughout a community. However, when communities lack technical or financial capabilities (24,59,74), availability may be compromised by the lack of privacy and safety (e.g., in the construction of low standard latrines) (74), although when the new social norm is sufficiently established,

1
2
3 604 communities may seek to repair or rebuild such facilities (59,62). The shame of losing in a competition
4
5 605 can have a negative effect on the non-winners who may be demotivated as a result (51).
6
7 606 Improvements in the availability of latrines and handwashing facilities (51,95) may occur as a result of
8
9 607 the motivation of winning prizes (e.g., motorcycles) or simply the right of a leader to claim they ‘won’
10
11 608 by their community being first to become open defecation free (44,95).
12

13 609
14
15 610 **Change**
16
17 611 Efforts to avoid shame can result in a change in sanitation behaviour (i.e. reduction in open defecation,
18
19 612 increase latrine use, appropriate disposal of excreta material and clean facilities) (10,11,24,38–40,42–
20
21 613 44,52,53,55,56,58–60,63,75) and an increase in levels of overall hygiene behaviour, including
22
23 614 handwashing (24,25,42,60) and safe drinking water and storage (24,58). These changes impact health
24
25 615 outcomes such as a reduction in childhood diarrheal disease, roundworm infestation and stunting
26
27 616 (40,44,58,59,63,72). Behaviour change for sanitation and handwashing is limited where prior beliefs
28
29 617 about the negative impact of open defecation are weak (63), where open defecation solves a cultural
30
31 618 problem such as men and women not being allowed to share a toilet (10,11), where there is a focus
32
33 619 on latrine construction over utilisation (42), where there is a lack of water for latrine cleaning and
34
35 620 hand washing facilities close to latrines (59), or where the latrine is full (75). Slippage in behaviour
36
37 621 change for safe drinking water and storage could be due to fatigue or loss of motivation, for example,
38
39 622 refusing to cover stored drinking water (24), or because of affordability issues (58).
40
41 623

42
43 624 Shame may be a better mechanism situated in smaller, cohesive, and isolated communities with
44
45 625 shared views, as people want to fit in and conform to social norms (42,43), or where effective
46
47 626 leadership and community involvement help reinforce a change in social norms (10,53,56,59), or
48
49 627 where high social cohesion and connectedness makes people more likely to conform for the benefit
50
51 628 and social wellbeing of the community (8,38,72), especially as social pressure mounts and community
52
53 629 tolerance for undesirable behaviour decreases (11,22,72). Latrine quality and cleanliness can help
54
55 630 ensure people utilise latrines and feel safe (53). Increased respect and social acceptance for latrine
56
57 631 ownership can help the shift social norms (38). Celebration by village members and local media
58
59 632 coverage of open defecation free status can reinforce the undesirable behaviour and shame of those
60
61 633 not conforming to the social norm (53).
62

63 634
64
65 635 Effective leadership is an important enabler of reduced levels of open defecation in communities, as
66
67 636 it helps reinforce changes in social norms (10,56,59,60). High rates of latrine ownership and
68
69 637 availability, can indicate a change in social norms and the acceptance of the new behaviour (62).
70

Communities with a lead role in an intervention can help identify the impacts of their behaviour and help individuals understand the importance of change in behaviour leading to a paradigm shift to promote sanitation facilities and stop open defecation (59). However, an increase in latrine ownership does not always guarantee their sustained use, nor link to an increase in handwashing or reduction in open defecation (10,24,59,62). Without ongoing support, acknowledgement of change and loss of messaging impact, behaviour change is unlikely to be sustained as there is a tendency for fatigue or loss of motivation within communities (22–24,75).

Discussion

In this realist review, we investigated how (mechanisms) and under what circumstances (context) community efforts and decisions regarding WASH interventions promote health and resource or service longevity (outcomes) in LMICs. We identified five mechanisms: accountability, diffusion, market, ownership, and shame, and 19 contextual factors (Table 2) that may led to positive and negative outcomes for availability, behaviour change, health, and resource or service longevity in both external and internal interventions in a community setting.

Our findings are similar to those of Jiménez et al (4), Loevinsohn et al (5), Novotný et al (6) and Stefanelli et al (7) who reported that community cohesion and connectedness, community participation or empowerment and skills and knowledge are enabling factors. Other factors that these papers found to influence availability and longevity of WASH interventions were access to adequate and timely information (4), and limited transparency and accountability which can lead to inequalities in services (5). These other findings reflect the need for awareness of the key contextual factors we identified such as leadership and diverse involvement to be considered when establishing interventions. These contextual factors were shown to have positive and negative outcomes. Of the 19 contextual factors, social cohesion and connectedness, leadership, and diverse involvement in the intervention (including of women and at different stages of design, planning and implementation) stood out as being common across successful interventions. Other evidence highlights limitations in existing WASH interventions aimed at reducing infections and suggest the need for greater intensity (e.g., through frequent contact between promoters and community members) to facilitate and track behaviour change.

Monitoring is a major component of the accountability mechanism, and it can be conducted through multiple forms including reports and follow up visits. The wider health literature shows other forms that monitoring takes including sentinel surveillance, syndromic surveillance, surveillance by proxy,

1
2
3 672 environmental monitoring or event-based surveillance (102–105). Downsides of ongoing monitoring
4
5 673 is that it is expensive, time-consuming, labour and resource-intensive, and increased frequency can
6
7 674 induce reactivity from subjects (106,107). Outsider reporting of activities and changes may also not
8
9 675 be accurate (106). The length of time involved in monitoring and observation may be inconvenient for
10
11 676 households and communities and may change their routines (107). While there are downsides,
12
13 677 increased focus on the utilisation of monitoring is an important tool in WASH interventions and should
14
15 678 be prioritised. Monitoring can also be utilised further as a tool to help guide decisions, for disease
16
17 679 prevention and resource allocation (104,108).

18
19 680
20 681 Diffusion of innovation has been widely identified as a mechanism in public health and not just in the
21
22 682 WASH sector, for example in the adoption of new health policies and technologies, and the use of new
23
24 683 drugs (109). Other findings are in line with studies showing the application of diffusion of innovation
25
26 684 in sanitation interventions (110,111), and add to the new growing body of literature the use of
27
28 685 diffusion in water interventions (112). While diffusion of innovation is an important mechanism, it is
29
30 686 important to acknowledge the psychological and physical health benefits of what is being adopted
31
32 687 (113), and new behaviours may need to be adapted to meet the cultural needs of the target population
33
34 688 (109,113) before adoption. A downside of the diffusion mechanism is that blame can be put on an
35
36 689 individual and on those of lower social-economic status who are unable to conform or adopt an
37
38 690 innovation or new behaviour due to financial barriers (113). These are important components to
39
40 691 consider while planning WASH interventions to prevent unintended consequences such as creating
41
42 692 further taboo and increased inequalities that can grow and create divisions within communities. If
43
44 693 diffusion of innovation is utilised as a mechanism then steps need to be taken such as funding and
45
46 694 support to ensure all members of a community can engage in the new WASH behaviour.

47
48 695
49 696 The market mechanism builds on the economic theory of demand. For this mechanism to be sustained
50
51 697 there needs to be a delicate balance between supply, demand and pricing of the resource (114). The
52
53 698 downside of markets is that they may not be sensitive to the cultural and social dimensions involved
54
55 699 in the use of water and sanitation services or resources (115,116). To address this, pilot programs
56
57 700 should include consideration of relevant cultural and social dimensions in their assessment of
58
59 701 acceptability. Further, the market mechanism does not take into consideration the effects of climate
60
702 change and the changing population demands (115,116). Climate change is an important component
703 that needs to be prioritised and considered in designing for market systems but may require changes
704 in planning and costing. The incorporation of climate change into market systems could help create
705 more resilient adaptable WASH systems and wider environmental benefits, without the need for

major policy changes (117,118). The market mechanism could also be applied at a global scale to help address the growing pressure on global water resources.

The finding that ownership is a key component for health intervention sustainability, has also been reported in Sub-Saharan Africa (119), and in successful water supply and sanitation interventions in LMICs in other regions (120). Ownership can be difficult to achieve, especially so it is characterised by equality and fairness within a community, particularly as privilege and socioeconomic status impact who has a voice, whose voice is listened to, who has the power or influence within the community to be involved in decision-making and negotiations (121). In other research, the literature that was used to inform the development of ownership mechanisms and a focus on co-production was based on examples in high-income contexts where priorities and the power of communities and individuals are different to those in LMIC settings. Further research is required to better understand the relationship of ownership and power in LMIC settings.

The shame mechanism was found to be woven into many behaviour change sanitation interventions and has been employed by community-led total sanitation since the 1990s (122). However, recent arguments in global health emphasise that shame should never be employed as a mechanism to drive improved health outcomes (123), because it can lead to psychological harm especially among poor households who cannot afford to make the required changes, and because it can be a direct attack on a person's identity or dignity and be detrimental to their self-esteem (124,125). A focus on shame could create further taboo in WASH behaviours, and potentially limit discussions and acceptance of interventions in communities. Before using this mechanism, detailed discussions with community leaders and members needs to occur to highlight the potential downside of focusing on shame and whether alternative mechanisms are more appropriate.

Further work is needed to refine our five proposed mechanisms and CMO configurations in empirical studies. We recognise that there are alternative theories that could be used to explain the outcomes in the identified studies. For example, nudge theory would provide an alternative explanation to accountability where positive nudges within the community such as monitoring or meetings, act as a positive reinforcement for their behaviour change or actions. Ongoing meetings and monitoring may also be seen as positive nudges for people to perform the socially acceptable behaviour or action. On the other hand, fines for defaulting act as negative nudges and reinforce the appropriate actions and behaviours (126). The transtheoretical (or "stages of change") model also offers an alternative explanation for behaviour change at the community level with a key contextual factor being the

1
2
3 740 selection of natural leaders who can help guide and influence communities through the stages of
4
5 741 behaviour change (127). The transtheoretical model can be linked to shame, as actions taken to
6
7 742 provide information about others approval for a behaviour such as a walk of shame to indicate open
8
9 743 defecation behaviour in a community (127). Indeed, shame itself may represent a negative nudge.
10
11 744 Persuasion theory is yet another theory that could explain changes in behaviour around water use and
12
13 745 open defecation (128). In smaller communities, monitoring, strong leadership, and communication in
14
15 746 the community can be used to persuade people to change their behaviour as they understand the
16
17 747 consequences. Greater knowledge and understanding of the impact of the change and social influence
18
19 748 can persuade people to achieve a more desirable behaviour. While these alternative theories offer
20
21 749 potential explanations they were not chosen as they do not include the diversity of contextual factors
22
23 750 and are mainly linked to behaviour change outcomes. The five guiding theories that were selected are
24
25 751 flexible, and well-studied in the literature, enabling us to build a detailed understanding of
26
27 752 mechanisms, contextual factors and outcomes in the WASH sector.
28
29 753
30
31 754 Based on these review findings, the diverse involvement of community members to participate in the
32
33 755 design and plan of an intervention is one of the most important enabling factors for resource or service
34
35 756 availability, longevity and behaviour change. For water resource-focused interventions where the goal
36
37 757 is to promote availability or longevity of the resource, the accountability, market and ownership
38
39 758 mechanisms are particularly important, but these mechanisms depend on a broad range of
40
41 759 community-level contextual factors. To achieve behaviour change, the mechanisms of shame and
42
43 760 diffusion were shown to be particularly effective, and are most effective in smaller homogenous
44
45 761 communities. Before initiating any intervention, it is important to understand the contextual factors
46
47 762 within each community and to tailor the intervention accordingly. For example, interventionists who
48
49 763 want to consider using the accountability mechanism to achieve desired outcomes will do well to ask
50
51 764 themselves if the communities in which they seek to intervene have the necessary contextual factors
52
53 765 (e.g., easy geographical accessible community location to allow monitoring visits, community-level
54
55 766 platforms that facilitate internal monitoring etc) as shown in Table 3. If not, whether to consider
56
57 767 another mechanism or support their target communities to develop favourable contextual factors
58
59 768 before or while introducing an intervention.
60
769

770 **Strengths and limitations**

771 This review involved a thorough detailed search, which identified 73 papers, from 29 countries for
772 inclusion. The size of the review allowed for diverse CMOs to be explored and understood. However,
773 one paper from Small Island Developing States (SIDS), and five from the Latin American region were

included in the review. Most papers included in the study were from the African and Asian LMICs. Due to this, it is unreasonable to generalise the findings to all contexts, we would need to include papers from a wider range of contexts and varied locations. This is an important factor to consider as SIDS and Latin America have different priorities and challenges for water and sanitation in comparison to Asian and African countries. Research should be conducted within SIDS and Latin America to further refine the CMO configurations identified in this review and to develop further CMO configurations which can be used to explain multiple outcomes around water and sanitation interventions in these settings, as the literature has tended to only look at one or the other.

The papers selected for this review were limited to those available in English, peer-reviewed and available online through a database search. We also only looked at published articles and did not include grey literature such as NGO and government reports. Given the ten-year limit in the search strategy, we may have missed work looking at these issues in 1990s and early 2000s after the Water Decade and the start of the MDG period (129). As only papers published in English were included, we may have missed experiences of francophone and lusophone Africa, or Latin America. However, it is worth noting that these sets of omissions are consistent with the realist approach to evidence synthesis. The goal is to identify, if tentatively, CMO configurations which may subsequently be enriched through primary research or further reviews. In addition, also consistent with the realist approach to evidence synthesis (33,34), no formal quality appraisal was conducted on the papers included in this study.

Among the papers included in the study, it was difficult to identify 'physical' and 'social' contextual factors, as often very limited relevant information was provided. If additional information was available, then the types of contextual factors may have been found to play a more substantial role than we identified. Lastly, we did not include papers that looked at communities' natural resource management and interventions except those associated with water for a health connection, and we only included papers where an external party such as NGO or government was involved in the water natural resource management and interventions. Further research needs to be conducted to identify the mechanisms involved in such interventions.

Conclusion

This study brings together the knowledge generated from 73 water, sanitation and hygiene interventions in LMICs where communities are involved. Health, behaviour change, infrastructure and resource/service longevity-related outcomes are influenced by five mechanisms. The mechanisms are,

1
2
3 808 1) accountability (policies and procedures to hold communities and committees responsible for their
4 809 actions and outcomes of an intervention), 2) diffusion (spread of an idea or behaviour by innovators
5 810 over time through communication amongst members of a community), 3) market (the interplay
6 811 between demand and supply of a WASH service or resource), 4) ownership (sense of possession and
7 812 control of a WASH service or resource), and 5) shame (a feeling of disgust in one's behaviour or
8 813 actions). Nineteen contextual factors including leadership, monitoring and rewards that impact these
9 814 mechanisms. These contextual factors can be utilised by policymakers, program designers and
10 815 implementers and NGOs in the development of interventions. They can also help improve the
11 816 likelihood of success for targeted outcomes and infrastructure and service longevity. The results also
12 817 provide a framework for analysing and understanding the performance of WASH interventions
13 818 retrospectively.

- 21 819
22
23 820 Abbreviations:
24
25 821 LMICs – Low-and-middle income countries
26 822 NGO – Nongovernmental organisation
27 823 SIDS - Small Island Developing States
28 824 WASH – Water, sanitation, and hygiene
29
30
31
32 825

33 826 Data availability statement
34
35 827 Data sharing is not applicable to this article as no datasets were generated or analysed during this
36 828 current study.

37 829
38
39 830 Patient and Public Involvement
40
41 831 No patient involved
42
43 832

44 833 Competing interests
45
46 834 The authors have declared that no competing interests exist.
47
48 835

49 836 Funding
50
51 837 This work was supported by the Stronger Systems for Health Security grant scheme by the Indo-Pacific
52 838 Centre for Health Security, Department of Foreign Affairs and Trade Australia (Grant No: SSHS 74427),
53 839 and Bloomberg Philanthropies Vibrant Oceans Initiative (Grant No: 53006). The funders had no role in
54 840 the study design, data collection and analysis, decision to publish or preparation of this manuscript.
55
56 841

842 Authors' contributions

- 843 Conceptualization: Sarah Nelson, Joel Negin, Seye Abimbola
 844 Data Curation: Sarah Nelson, Dorothy Drabarek
 845 Formal analysis: Sarah Nelson, Dorothy Drabarek, Seye Abimbola
 846 Funding acquisition: Aaron Jenkins, Joel Negin, Seye Abimbola
 847 Investigation: Sarah Nelson, Dorothy Drabarek
 848 Methodology: Sarah Nelson, Dorothy Drabarek, Seye Abimbola
 849 Supervision: Aaron Jenkins, Joel Negin, Seye Abimbola
 850 Validation: Sarah Nelson, Seye Abimbola
 851 Visualisation: Sarah Nelson, Seye Abimbola
 852 Writing – original draft preparation: Sarah Nelson, Dorothy Drabarek
 853 Writing – review & editing: Sarah Nelson, Dorothy Drabarek, Aaron Jenkins, Joel Negin, Seye Abimbola

855 Ethical Approval Statement

856 Not Applicable

858 References

- 859 1. Humphrey JH. Reducing the user burden in WASH interventions for low-income countries.
 860 Lancet Glob Health. 2019;7(9):e1158–9.
- 861 2. Garn JV, Sclar GD, Freeman MC, Penakalapati G, Alexander KT, Brooks P, et al. The impact of
 862 sanitation interventions on latrine coverage and latrine use: A systematic review and meta-
 863 analysis. Int J Hyg Environ Health. 2017 Apr;220(2):329–40.
- 864 3. Bhutta ZA, Gaffey MF, Crump JA, Steele D, Breiman RF, Mintz ED, et al. Typhoid Fever: Way
 865 Forward. Am J Trop Med Hyg. 2018 Sep 6;99(3_Suppl):89–96.
- 866 4. Jiménez A, LeDeunff H, Giné R, Sjödin J, Cronk R, Murad S, et al. The enabling environment for
 867 participation in water and sanitation: A conceptual framework. Water. 2019;11(2):308.
- 868 5. Loevinsohn M, Mehta L, Cuming K, Nicol A, Cumming O, Ensink JHJ. The cost of a knowledge
 869 silo: A systematic re-review of water, sanitation and hygiene interventions. Health Policy Plan.
 870 2015;30(5):660–74.
- 871 6. Novotný J, Hasman J, Lepič M. Contextual factors and motivations affecting rural community
 872 sanitation in low- and middle-income countries: A systematic review. Int J Hyg Environ Health.
 873 2018;221(2):121–33.
- 874 7. Stefanelli RD, Castleden H, Harper SL, Martin D, Cunsolo A, Hart C. Experiences with
 875 integrative indigenous and western knowledge in water research and management: A
 876 systematic realist review of literature from Canada, Australia, New Zealand, and the United
 877 States. Environ Rev. 2017;25(3):323–33.

1
2
3 878 8. Harter M, Mosch S, Mosler H-J. How does community-led total sanitation (CLTS) affect latrine
4 879 ownership? A quantitative case study from Mozambique. BMC Public Health. 2018;18(1):387.
5
6 880 9. Valcourt N, Walters J, Javernick-Will A, Linden K, Hailegiorgis B. Understanding rural water
7 881 services as a complex system: An assessment of key factors as potential leverage points for
8 882 improved service sustainability. Sustainability. 2020;12(3):1243.
9
10 883 10. Zimba R, Ngulube V, Lukama C, Manangi A, Tiwari A, Osbert N, et al. Chiengi District, Zambia
11 884 open defecation free after 1 year of community-led total sanitation. Am J Trop Med Hyg.
12 885 2016;95(4):925–7.
13
14 886 11. Mlenga DH, Baraki YA. Community led total sanitation for community based disaster risk
15 887 reduction: A case for non-input humanitarian relief. Jambá J Disaster Risk Stud. 2016;8(2).
16
17 888 12. Jennewein JS, Jones KW. Examining ‘willingness to participate’ in community-based water
18 889 resource management in a transboundary conservation area in Central America. Water
19 890 Policy. 2016;18(6):1334–52.
20
21 891 13. Garn JV, Sclar GD, Freeman MC, Penakalapati G, Alexander KT, Brooks P, et al. The impact of
22 892 sanitation interventions on latrine coverage and latrine use: A systematic review and meta-
23 893 analysis. Int J Hyg Environ Health. 2017;220(2):329–40.
24
25 894 14. McGinnis MD, Ostrom E. Social-ecological system framework: initial changes and continuing
26 895 challenges. Ecol Soc. 2014;19(2).
27
28 896 15. Abedin MdA, Habiba U, Shaw R. Community perception and adaptation to safe drinking water
29 897 scarcity: Salinity, arsenic, and drought risks in coastal Bangladesh. Int J Disaster Risk Sci.
30 898 2014;5(2):110–24.
31
32 899 16. Padawangi R. Community-driven development as a driver of change: water supply and
33 900 sanitation projects in rural Punjab, Pakistan. Water Policy Oxf. 2010;12(S1):104–20.
34
35 901 17. Klug T, Shields KF, Cronk R, Kelly E, Behnke N, Lee K, et al. Water system hardware and
36 902 management rehabilitation: Qualitative evidence from Ghana, Kenya, and Zambia. Int J Hyg
37 903 Environ Health. 2017;220(3):531–8.
38
39 904 18. Jimenez-Redal R, Soriano J, Holowko N, Almandoz J, Arregui F. Assessing sustainability of rural
40 905 gravity-fed water schemes on Idjwi Island, D.R. Congo. Int J Water Resour Dev.
41 906 2018;34(6):1022–35.
42
43 907 19. Kwangware J, Mayo A, Hoko Z. Sustainability of donor-funded rural water supply and
44 908 sanitation projects in Mbire district, Zimbabwe. Phys Chem Earth Parts ABC. 2014;76–78:134–
45 909 9.
46
47 910 20. Jones S. Participation as citizenship or payment? A case study of rural drinking water
48 911 governance in Mali. Water Altern. 2011;4(1):18.
49
50 912 21. Madrigal-Ballesteros R, Naranjo MA. Adaptive capacity, drought and the performance of
51 913 community-based drinking water organizations in Costa Rica. J Water Clim Change.
52 914 2015;6(4):831–47.
53
54
55
56
57
58
59
60

- 915 22. Russpatrick S, Tiwari A, Markle L, Musonda E, Mutunda A, Osbert N, et al. Mobility up the
916 sanitation ladder following community-led total sanitation in rural Zambia. *J Water Sanit Hyg*
917 *Dev.* 2017;7(3):436–44.
- 918 23. Ogendo KN, Kihara AB, Kosgei RJ, Tweya H, Kizito W, Murkomen B, et al. Assessment of
919 community led total sanitation uptake in rural Kenya. *East Afr Med J.* 2016;5.
- 920 24. Woode PK, Dwumfour-Asare B, Nyarko KB, Appiah-Effah E. Cost and effectiveness of water,
921 sanitation and hygiene promotion intervention in Ghana: The case of four communities in the
922 Brong Ahafo region. *Heliyon.* 2018;4(10).
- 923 25. Madon S, Malecela MN, Mashoto K, Donohue R, Mubyazi G, Michael E. The role of
924 community participation for sustainable integrated neglected tropical diseases and water,
925 sanitation and hygiene intervention programs: A pilot project in Tanzania. *Soc Sci Med.*
926 2018;202:28–37.
- 927 26. Nguyen TH, Ross A. Barriers and opportunities for the involvement of Indigenous knowledge
928 in water resources management in the Gam river basin in North-East Vietnam. *Water Altern.*
929 2017;10(1):26.
- 930 27. Naiga R, Penker M. Determinants of users' willingness to contribute to safe water provision in
931 rural Uganda. *Lex Localis.* 2014;12(3):695.
- 932 28. Kelly E, Lee K, Shields KF, Cronk R, Behnke N, Klug T, et al. The role of social capital and sense
933 of ownership in rural community-managed water systems: Qualitative evidence from Ghana,
934 Kenya, and Zambia. *J Rural Stud.* 2017;56:156–66.
- 935 29. Pawson R, Greenhalgh T, Harvey G, Walshe K. Realist review - a new method of systematic
936 review designed for complex policy interventions. *J Health Serv Res Policy.* 2005;10(Suppl
937 1):21–34.
- 938 30. Abimbola S, Baatiema L, Bigdeli M. The impacts of decentralization on health system equity,
939 efficiency and resilience: A realist synthesis of the evidence. *Health Policy Plan.*
940 2019;34(8):605–17.
- 941 31. Greenhalgh T, Robert G, Bate P, Macfarlane F, Kyriakidou O. Diffusion of innovations in health
942 service organisations: A systematic literature review. John Wiley & Sons; 2008.
- 943 32. Pawson R, Tilley N. Realistic evaluation. sage; 1997.
- 944 33. Wong G, Greenhalgh T, Westhorp G, Buckingham J, Pawson R. RAMESES publication
945 standards: realist syntheses. *BMC Med.* 2013;11(1):21.
- 946 34. Wong G, Westhorp G, Pawson R, Greenhalgh T. Realist synthesis - Rameses training materials.
947 2013.
- 948 35. Lodenstein E, Dieleman M, Gerretsen B, Broerse JEW. Health provider responsiveness to
949 social accountability initiatives in low- and middle-income countries: A realist review. *Health*
950 *Policy Plan.* 2017;32(1):125–40.
- 951 36. World Bank. World Bank Country and Lending Groups [Internet]. [cited 2019 May 5].
952 Available from: [https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-](https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups)
953 [bank-country-and-lending-groups](https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups)

- 954 37. Greenhalgh T, Pawson R, Wong G, Westhorp G, Greenhalgh J, Manzano A, et al. Retrodution
955 in realist evaluation. The RAMESES II project. 2017; Available from: www.ramesesproject.org
- 956 38. Safari J, Mohamed H, Dimoso P, Akyoo W, Odhiambo F, Mpete R, et al. Lessons learned from
957 the national sanitation campaign in Njombe district, Tanzania. *J Water Sanit Hyg Dev*.
958 2019;9(4):754–64.
- 959 39. Kema KM, Komwihangiro J, Kimaro S. Integrated community based child survival,
960 reproductive health and water and sanitation program in Mkuranga district, Tanzania: a
961 replicable model of good practices in community based health care. *Pan Afr Med J*.
962 2012;13(Suppl 1).
- 963 40. Pickering AJ, Djebbari H, Lopez C, Coulibaly M, Alzua ML. Effect of a community-led sanitation
964 intervention on child diarrhoea and child growth in rural Mali: A cluster-randomised
965 controlled trial. *Lancet Glob Health*. 2015;3(11):e701–11.
- 966 41. Dickin S, Bisung E, Savadogo K. Sanitation and the commons: the role of collective action in
967 sanitation use. *Geoforum*. 2017;86:118–26.
- 968 42. Gebremariam B, Tsehay K. Effect of community led total sanitation and hygiene (CLTSH)
969 implementation program on latrine utilization among adult villagers of North Ethiopia: A
970 cross-sectional study. *BMC Res Notes*. 2019;12(1).
- 971 43. Harvey PA. Zero subsidy strategies for accelerating access to rural water and sanitation
972 services. *Water Sci Technol Lond*. 2011;63(5):1037–43.
- 973 44. Tiwari A, Russpatrick S, Hoehne A, Matimelo SM, Mazimba S, Nkhata I, et al. Assessing the
974 impact of leveraging traditional leadership on access to sanitation in rural Zambia. *Am J Trop
975 Med Hyg*. 2017;97(5):1355–61.
- 976 45. Azemzi H, Erraoui EH. Irrigation water management and collective action: understanding the
977 shift from community management to participatory management in Souss-Massa (Morocco).
978 *Euro-Mediterr J Environ Integr*. 2020;6(1):1.
- 979 46. Biran A, Danquah L, Chunga J, Schmidt W-P, Holm R, Itimu-Phiri A, et al. A cluster-randomized
980 trial to evaluate the impact of an inclusive, community-led total sanitation intervention on
981 sanitation access for people with disabilities in Malawi. *Am J Trop Med Hyg*. 2018;98(4):984–
982 94.
- 983 47. Karinja M, Schlienger R, Pillai GC, Esterhuizen T, Onyango E, Gitau A, et al. Risk reduction of
984 diarrhea and respiratory infections following a community health education program - a
985 facility-based case-control study in rural parts of Kenya. *Bmc Public Health*. 2020;20(1).
- 986 48. Morinville C, Harris LM. Participation, politics, and panaceas: Exploring the possibilities and
987 limits of participatory urban water governance in Accra, Ghana. *Ecol Soc*. 2014;19(3):art36.
- 988 49. Okolimong CD, Ndejjo R, Mugambe RK, Halage AA. Effect of a community-led total sanitation
989 intervention on sanitation and hygiene in Pallisa District, Uganda. *Am J Trop Med Hyg*.
990 2020;103(4):1735–41.
- 991 50. Roekmi RAK, Baskaran K, Chua LH. Community-based water supplies in Cikarang, Indonesia:
992 Are they sustainable? *Nat Resour Forum*. 2018;42(2):108–22.

- 993 51. Whaley L, Webster J. The effectiveness and sustainability of two demand-driven sanitation
994 and hygiene approaches in Zimbabwe. *J Water Sanit Hyg Dev.* 2011;1(1):20–36.
- 995 52. Babb C, Makotsi N, Heimler I, Bailey RC, Hershow RC, Masanga P, et al. Evaluation of the
996 effectiveness of a latrine intervention in the reduction of childhood diarrhoeal health in
997 Nyando District, Kisumu County, Kenya. *Epidemiol Infect.* 2018;146(9):1079–88.
- 998 53. Alzua ML, Djebbari H, Pickering AJ. A community-based program promotes sanitation. *Econ
999 Dev Cult Change.* 2020;68(2):357–90.
- 1000 54. Andrade EL, Bingenheimer JB, Edberg MC, Zoerhoff KL, Putzer EM. Evaluating the
1001 effectiveness of a community-based hygiene promotion program in a rural Salvadoran
1002 setting. *Glob Health Promot St-Denis Cedex.* 2019;26(1):69–80.
- 1003 55. Crocker J, Abodoo E, Asamani D, Domapielle W, Gyapong B, Bartram J. Impact evaluation of
1004 training natural leaders during a community-led total sanitation intervention: A cluster-
1005 randomized field trial in Ghana. *Environ Sci Technol.* 2016;50(16):8867–75.
- 1006 56. Crocker J, Geremew A, Atalie F, Yetie M, Bartram J. Teachers and sanitation promotion: An
1007 assessment of community-led total sanitation in Ethiopia. *Environ Sci Technol.*
1008 2016;50(12):6517–25.
- 1009 57. Nunbogu AM, Harter M, Mosler H-J. Factors associated with levels of latrine completion and
1010 consequent latrine use in Northern Ghana. *Int J Environ Res Public Health.* 2019;16(6):920.
- 1011 58. Soboksa NE, Hailu AB, Gari SR, Alemu BM. Water supply, sanitation and hygiene interventions
1012 and childhood diarrhea in Kersa and Omo Nada districts of Jimma Zone, Ethiopia: a
1013 comparative cross-sectional study. *J Health Popul Nutr.* 2019;38(1):45.
- 1014 59. Tessema RA. Assessment of the implementation of community-led total sanitation, hygiene,
1015 and associated factors in Diretiyara district, Eastern Ethiopia. *PLOS ONE.*
1016 2017;12(4):e0175233.
- 1017 60. Yeboah-Antwi K, MacLeod WB, Biemba G, Sijenyi P, Höhne A, Verstraete L, et al. Improving
1018 Sanitation and Hygiene through Community-Led Total Sanitation: The Zambian Experience.
1019 *Am J Trop Med Hyg.* 2019;100(4):1005–12.
- 1020 61. Zeleke DA, Gelaye KA, Mekonnen FA. Community-led total sanitation and the rate of latrine
1021 ownership. *BMC Res Notes.* 2019;12(1):14.
- 1022 62. Crocker J, Saywell D, Bartram J. Sustainability of community-led total sanitation outcomes:
1023 Evidence from Ethiopia and Ghana. *Int J Hyg Environ Health.* 2017;220(3):551–7.
- 1024 63. Degebasa MZ, Weldemichael DZ, Marama MT. Diarrheal status and associated factors in
1025 under five years old children in relation to implemented and unimplemented community-led
1026 total sanitation and hygiene in Yaya Gulele in 2017. *Pediatr Health Med Ther.* 2018;9:109–21.
- 1027 64. Madrigal-Ballesteros R, Capitán T, Salas A, Córdoba D. Household and community responses to
1028 seasonal droughts in rural areas of Costa Rica. *Waterlines.* 2019;38(4):286–304.
- 1029 65. Kelly E, Shields KF, Cronk R, Lee K, Behnke N, Klug T, et al. Seasonality, water use and
1030 community management of water systems in rural settings: Qualitative evidence from Ghana,
1031 Kenya, and Zambia. *Sci Total Environ.* 2018;628–629:715–21.

- 1032 66. Sarkar S, Greenleaf JE, Gupta A, Ghosh D, Blaney LM, Bandyopadhyay P, et al. Evolution of
1033 community-based arsenic removal systems in remote villages in West Bengal, India:
1034 Assessment of decade-long operation. *Water Res.* 2010;44(19):5813–22.
- 1035 67. Wardle C, Zakiriaeva N. Sustainability and long-term impact of community-managed water
1036 supply in rural Kyrgyzstan, Central Asia. *Waterlines.* 2018;37(2):118–31.
- 1037 68. Aladuwa S, Momsen J. Sustainable development, water resources management and
1038 women's empowerment: The Wanaraniya water project in Sri Lanka. *Gend Dev.*
1039 2010;18(1):43–58.
- 1040 69. Dey NC, Parvez M, Islam MR, Mistry SK, Levine DI. Effectiveness of a community-based water,
1041 sanitation, and hygiene (WASH) intervention in reduction of diarrhoea among under-five
1042 children: Evidence from a repeated cross-sectional study (2007–2015) in rural Bangladesh. *Int*
1043 *J Hyg Environ Health.* 2019;222(8):1098–108.
- 1044 70. Singh C. Is participatory watershed development building local adaptive capacity? Findings
1045 from a case study in Rajasthan, India. *Environ Dev.* 2018;25:43–58.
- 1046 71. String GM, Singleton RI, Mirindi PN, Lantagne DS. Operational research on rural, community-
1047 managed water safety plans: case study results from implementations in India, DRC, Fiji, and
1048 Vanuatu. *Water Res.* 2020;170:115288.
- 1049 72. Cameron L, Olivia S, Shah M. Scaling up sanitation: Evidence from an RCT in Indonesia. *J Dev*
1050 *Econ.* 2019;138:1–16.
- 1051 73. Dhoba L. Going to scale with rural water supply: A reflection on experiences from sustaining
1052 community managed piped water schemes in rural Zimbabwe. *J Water Sanit Hyg Dev.*
1053 2020;10(3):527–38.
- 1054 74. Kayoka C, Itimu-Phiri A, Biran A, Holm RH. Lasting results: A qualitative assessment of efforts
1055 to make community-led total sanitation more inclusive of the needs of people with
1056 disabilities in Rumphi District, Malawi. *Disabil Health J.* 2019;12(4):718–21.
- 1057 75. Orgill-Meyer J, Pattanayak SK, Chindarkar N, Dickinson KL, Panda U, Rai S, et al. Long-term
1058 impact of a community-led sanitation campaign in India, 2005–2016. *Bull World Health Organ.*
1059 2019;97(8):523.
- 1060 76. Ganing A, Abu A, Harpenas, Muslimin I, Adam A. Community Empowerment in Management
1061 Community-based Total Sanitation through Health Education in Majene. *Indian J Public*
1062 *Health Res Dev.* 2018;9(12):1466.
- 1063 77. Maheshwari B, Varua M, Ward J, Packham R, Chinnasamy P, Dashora Y, et al. The role of
1064 transdisciplinary approach and community participation in village scale groundwater
1065 management: Insights from Gujarat and Rajasthan, India. *Water.* 2014;6(11):3386–408.
- 1066 78. Barrington D, Fuller K, McMillan A. Water safety planning: adapting the existing approach to
1067 community-managed systems in rural Nepal. *J Water Sanit Hyg Dev.* 2013;3(3):392–401.
- 1068 79. Chankova S, Hatt LE, Musange SF. A community-based approach to promote household water
1069 treatment in Rwanda. *J Water Health.* 2012;10(1):116–29.

- 1070 80. Rout S. Institutional variations in practice of demand responsive approach: Evidence from
1071 rural water supply in India. *Water Policy*. 2014;16(4):650–68.
- 1072 81. Longwe B, Mganga M, Sinyiza N. Review of sustainable solar powered water supply system
1073 design approach by water mission Malawi. *Water Pract Technol*. 2019;14(4):749–63.
- 1074 82. Ibrahim SH. Sustainability assessment and identification of determinants in community-based
1075 water supply projects using partial least squares path model. *J Sustain Dev Energy Water
1076 Environ Syst*. 2017;5(3):345–58.
- 1077 83. Anthonj C, Fleming L, Cronk R, Godfrey S, Ambelu A, Bevan J, et al. Improving monitoring and
1078 water point functionality in rural Ethiopia. *Water*. 2018;10(11):1591.
- 1079 84. Madziyauswa V. Assessing sustainability of community managed NGOs' WASH interventions
1080 in rural Zimbabwe: The case of Chivi district in Masvingo province. *J Water Sanit Hyg Dev*.
1081 2017;640–9.
- 1082 85. Behnke NL, Klug T, Cronk R, Shields KF, Lee K, Kelly ER, et al. Resource mobilization for
1083 community-managed rural water systems: Evidence from Ghana, Kenya, and Zambia. *J Clean
1084 Prod*. 2017;156:437–44.
- 1085 86. Bright-Davies L, Lüthi C, Jachnow A. DEWATS for urban Nepal: a comparative Assessment for
1086 community wastewater management. *Waterlines*. 2015;34(2):119–38.
- 1087 87. Hubbard B, Sarisky J, Gelting R, Baffigo V, Seminario R, Centurion C. A community demand-
1088 driven approach toward sustainable water and sanitation infrastructure development. *Int J
1089 Hyg Environ Health*. 2011;214(4):326–34.
- 1090 88. Kosinski KC, Crocker JJ, Durant JL, Osabutey D, Adjei MN, Gute DM. A novel community-based
1091 water recreation area for schistosomiasis control in rural Ghana. *J Water Sanit Hyg Dev Lond*.
1092 2011;1(4):259–68.
- 1093 89. Nti EK, Wongnaa CA, Edusah NSE, Bakang J-EA. Assessment of the sustainability of
1094 community-managed water supply services in Ghana. *Environ Dev Sustain*. 2020;22(7):7097–
1095 120.
- 1096 90. Opare S. Sustaining water supply through a phased community management approach:
1097 Lessons from Ghana's "oats" water supply scheme. *Environ Dev Sustain*. 2011;13(6):1021–42.
- 1098 91. Smyrilli C, Selvakumaran S, Alderson M, Pizarro A, Almendrades D, Harris B, et al. Sustainable
1099 decentralised wastewater treatment schemes in the context of Lobitos, Peru. *J Environ Eng
1100 Sci*. 2018;13(1):8–16.
- 1101 92. Gimaiyo G, McManus J, Yarri M, Singh S, Trevett A, Moloney G, et al. Can child-focused
1102 sanitation and nutrition programming improve health practices and outcomes? Evidence
1103 from a randomised controlled trial in Kitui County, Kenya. *BMJ Glob Health*. 2019;4(1).
- 1104 93. Harter M, Inauen J, Mosier H-J. How does Community-Led Total Sanitation (CLTS) promote
1105 latrine construction, and can it be improved? A cluster-randomized controlled trial in Ghana.
1106 *Soc Sci Med*. 2020;245:112705.

1
2
3 1107 94. Keoprasith B, Kizuki M, Watanabe M, Takano T. The impact of community-based, workshop
4 1108 activities in multiple local dialects on the vaccination coverage, sanitary living and the health
5 1109 status of multiethnic populations in Lao PDR. *Health Promot Int.* 2013;28(3):453–65.
6
7 1110 95. Mwakitalima A, Massa K, Seleman A, Kassile T. Scaling up rural sanitation in Tanzania:
8 1111 Evidence from the national sanitation campaign. *J Water Sanit Hyg Dev Lond.* 2018;8(2):290–
9 1112 306.
10
11 1113 96. Rogers EM. *Diffusion of Innovations*, 5th Edition. Simon and Schuster; 2010.
12
13 1114 97. Ganing A, Abu A, Harpenas, Muslimin I, Adam A. Community empowerment in management
14 1115 community-based total sanitation through health education in Majene. *Indian J Public Health*
15 1116 *Res Dev.* 2018;9(12):1466–71.
16
17 1117 98. Arnstein SR. A Ladder Of Citizen Participation. *J Am Inst Plann.* 1969 Jul 1;35(4):216–24.
18
19 1118 99. Pierce JL, Kostova T, Dirks KT. Toward a Theory of Psychological Ownership in Organizations.
20 1119 *Acad Manage Rev.* 2001;26(2):298–310.
21
22 1120 100. Van Eijk C, Steen T. Why engage in co-production of public services? Mixing theory and
23 1121 empirical evidence. *Int Rev Adm Sci.* 2016;82(1):28–46.
24
25 1122 101. Kwangware J, Mayo A, Hoko Z. Sustainability of donor-funded rural water supply and
26 1123 sanitation projects in Mbire district, Zimbabwe. *Phys Chem Earth.* 2014;76–78:134–9.
27
28 1124 102. Lau C. Combating infectious diseases in the Pacific Islands: Sentinel surveillance,
29 1125 environmental health, and geospatial tools. *Rev Environ Health.* 2014;29(1–2).
30
31 1126 103. Craig AT, Kaldor J, Schierhout G, Rosewell AE. Surveillance strategies for the detection of
32 1127 disease outbreaks in the Pacific islands: meta-analysis of published literature, 2010–2019.
33 1128 *Trop Med Int Health.* 2020;25(8):906–18.
34
35 1129 104. Birkhead GS, Klompas M, Shah NR. Uses of Electronic Health Records for Public Health
36 1130 Surveillance to Advance Public Health. *Annu Rev Public Health.* 2015;36(1):345–59.
37
38 1131 105. Morse SS. Public Health Surveillance and Infectious Disease Detection. *Biosecurity*
39 1132 *Bioterrorism Biodefense Strategy Pract Sci.* 2012;10(1):6–16.
40
41 1133 106. Thomas E, Andrés LA, Borja-Vega C, Sturzenegger G. Innovations in WASH Impact Measures:
42 1134 Water and Sanitation Measurement Technologies and Practices to Inform the Sustainable
43 1135 Development Goals. World Bank Publications; 2018. 131 p.
44
45 1136 107. Halder AK, Molyneaux JW, Luby SP, Ram PK. Impact of duration of structured observations on
46 1137 measurement of handwashing behavior at critical times. *BMC Public Health.* 2013;13(1):705.
47
48 1138 108. Groseclose SL, Buckeridge DL. Public Health Surveillance Systems: Recent Advances in Their
49 1139 Use and Evaluation. *Annu Rev Public Health.* 2017;38(1):57–79.
50
51 1140 109. Green LW, Ottoson JM, García C, Hiatt RA. Diffusion theory and knowledge dissemination,
52 1141 utilization, and integration in public health. *Annu Rev Public Health.* 2009;30(1):151–74.
53
54
55
56
57
58
59
60

- 1142 110. Helgegren I, Rauch S, Cossio C, Landaeta G, McConville J. Importance of triggers and veto-
1143 barriers for the implementation of sanitation in informal peri-urban settlements – The case of
1144 Cochabamba, Bolivia. *PLOS ONE*. 2018;13(4):e0193613.
- 1145 111. Ramani SV, SadreGhazi S, Duysters G. On the diffusion of toilets as bottom of the pyramid
1146 innovation: Lessons from sanitation entrepreneurs. *Technol Forecast Soc Change*.
1147 2012;79(4):676–87.
- 1148 112. Wehn U, Montalvo C. Knowledge transfer dynamics and innovation: Behaviour, interactions
1149 and aggregated outcomes. *J Clean Prod*. 2018;171:S56–68.
- 1150 113. Haider M, Kreps GL. Forty years of diffusion of innovations: utility and value in public health. *J*
1151 *Health Commun*. 2004;9 Suppl 1:3–11.
- 1152 114. Hicks JR. A Revision of Demand Theory [Internet]. Oxford University Press; 1986 [cited 2019
1153 Nov 26]. Available from: <https://ideas.repec.org/b/oxp/obooks/9780198285502.html>
- 1154 115. Parker JM, Wilby RL. Quantifying household water demand: a review of theory and practice in
1155 the UK. *Water Resour Manag*. 2013;27(4):981–1011.
- 1156 116. Johansson RC, Tsur Y, Roe TL, Doukkali R, Dinar A. Pricing irrigation water: A review of theory
1157 and practice. *Water Policy*. 2002;4(2):173–99.
- 1158 117. Kahil MT, Dinar A, Albiac J. Modeling water scarcity and droughts for policy adaptation to
1159 climate change in arid and semiarid regions. *J Hydrol*. 2015;522:95–109.
- 1160 118. Kahil MT, Connor JD, Albiac J. Efficient water management policies for irrigation adaptation to
1161 climate change in Southern Europe. *Ecol Econ*. 2015;120:226–33.
- 1162 119. Iwelunmor J, Blackstone S, Veira D, Nwaozuru U, Airhihenbuwa C, Munodawafa D, et al.
1163 Toward the sustainability of health interventions implemented in sub-Saharan Africa: A
1164 systematic review and conceptual framework. *Implement Sci IS*. 2016;11.
- 1165 120. Murungi C, Blokland MW. Benchmarking for the provision of water supply and sanitation
1166 services to the urban poor: an assessment framework. *Int J Water*. 2016;10(2–3):155–74.
- 1167 121. Lachapelle P. A sense of ownership in community development: Understanding the potential
1168 for participation in community planning efforts. *Community Dev*. 2008;39(2):52–9.
- 1169 122. UNICEF. Field Notes: UNICEF Policy and Programming in Practice [Internet]. 2009. Available
1170 from: [https://www.unicef.org/socialpolicy/files/Field_Note_-](https://www.unicef.org/socialpolicy/files/Field_Note_-_Community_Approaches_to_Total_Sanitation.pdf)
1171 [_Community_Approaches_to_Total_Sanitation.pdf](https://www.unicef.org/socialpolicy/files/Field_Note_-_Community_Approaches_to_Total_Sanitation.pdf)
- 1172 123. Brewis A, Wutich A. Why we should never do it: stigma as a behaviour change tool in global
1173 health. *BMJ Glob Health*. 2019;4(5):e001911.
- 1174 124. Lewis H. Shame and guilt in neurosis. *Psychoanal Rev*. 1971;58(3):419–38.
- 1175 125. Bateman M, Engel S. To shame or not to shame—that is the sanitation question. *Dev Policy*
1176 *Rev*. 2018;36(2):155–73.
- 1177 126. Arno A, Thomas S. The efficacy of nudge theory strategies in influencing adult dietary
1178 behaviour: A systematic review and meta-analysis. *BMC Public Health*. 2016;16(1):676.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1179 127. Sigler R, Mahmoudi L, Graham JP. Analysis of behavioral change techniques in community-led
1180 total sanitation programs. *Health Promot Int.* 2015;30(1):16–28.

1181 128. Kraemer SM, Mosler H-J. Persuasion factors influencing the decision to use sustainable
1182 household water treatment. *Int J Environ Health Res.* 2010;20(1):61–79.

1183 129. United Nations. A 10-Year Story: The Water for Life Decade 2005 [Internet]. United Nations;
1184 n.d. Available from: <https://www.un.org/waterforlifedecade/>

1185
1186 Figure/Legends

1187 Figure 1: Results taken in the literature search

1188 Table 1: Steps taken in the realist analysis

1189 Table 2: Enabling context-mechanism-outcome configurations

1190 Figure 2: The study country origin

1191 Figure 3: Intervention focus

1192
1193

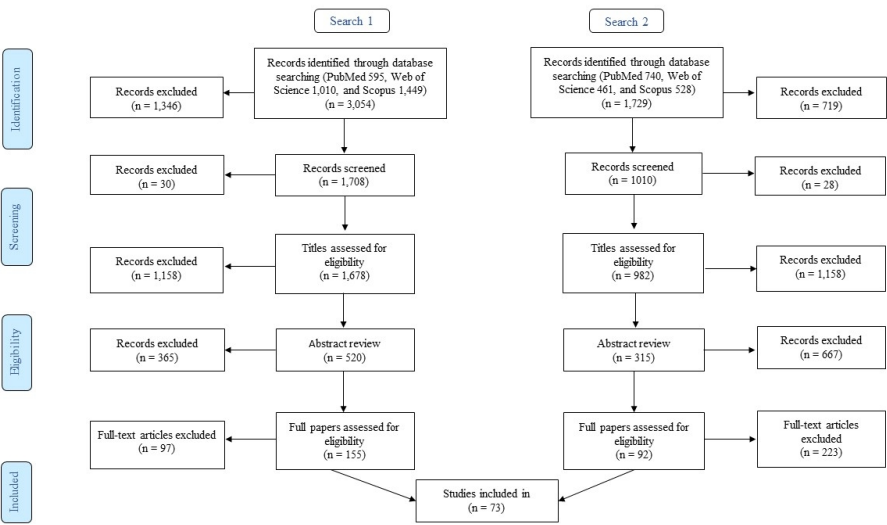


Figure 1: Results taken in the literature search

338x190mm (96 x 96 DPI)

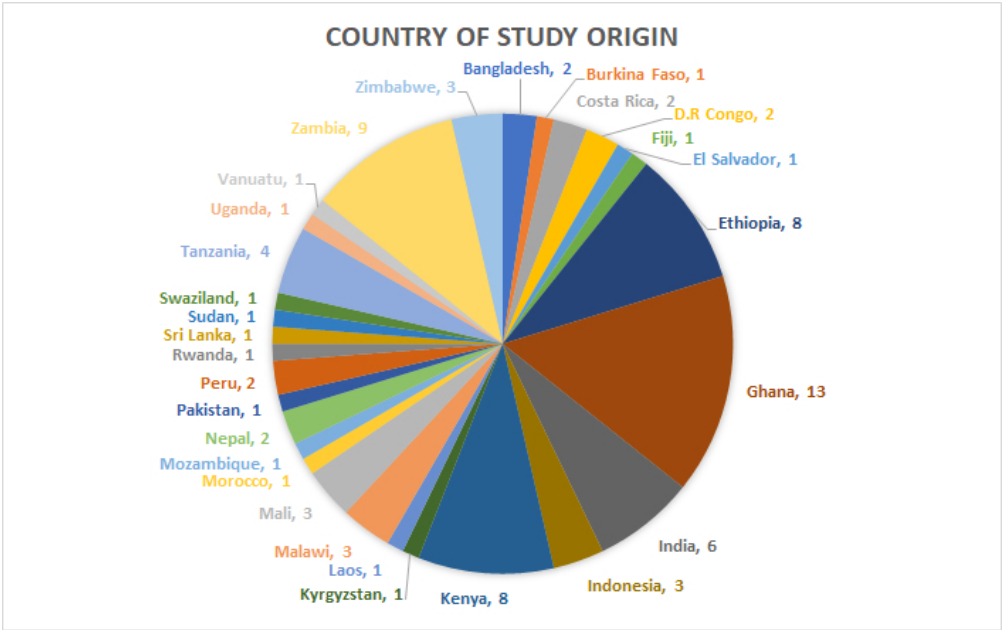


Figure 2: The study country origin
124x78mm (144 x 144 DPI)

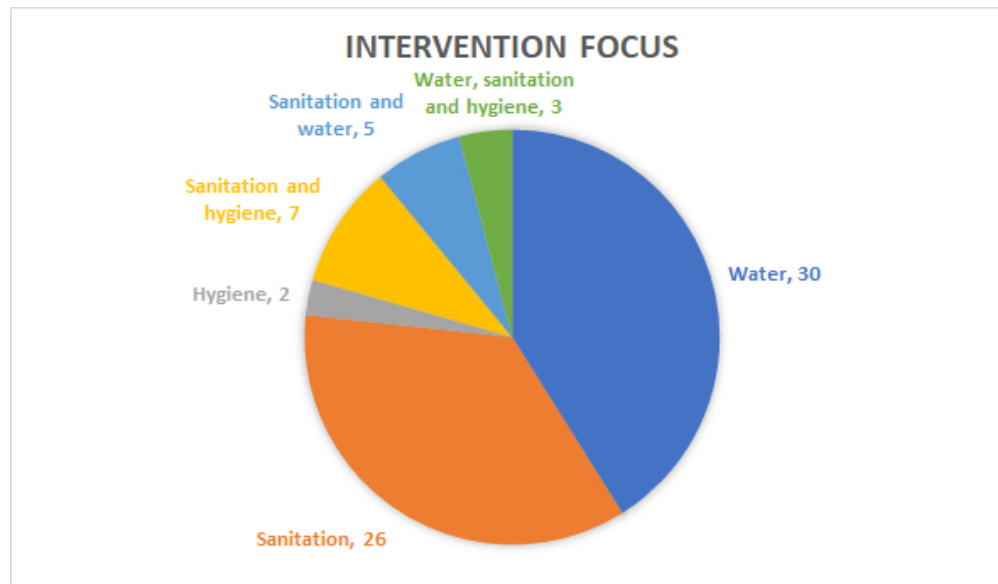


Figure 3: Intervention focus

104x60mm (144 x 144 DPI)

	Paper details	Country	Intervention	Exogenous or Endogenous	Mechanism(s)	Outcome
1	Abedin, M. A., Habiba, U., & Shaw, R. (2014). Community perception and adaptation to safe drinking water scarcity: salinity, arsenic, and drought risks in coastal Bangladesh. <i>International Journal of Disaster Risk Science</i> , 5(2), 110-124.	Bangladesh	Water	Both	Accountability Ownership	Availability
2	Dey, N. C., Parvez, M., Islam, M. R., Mistry, S. K., & Levine, D. I. (2019). Effectiveness of a community-based water, sanitation, and hygiene (WASH) intervention in reduction of diarrhoea among under-five children: Evidence from a repeated cross-sectional study (2007–2015) in rural Bangladesh. <i>International journal of hygiene and environmental health</i> , 222(8), 1098-1108.	Bangladesh	Water, sanitation and hygiene	Exogenous	Accountability Diffusion Ownership	Availability Change
3	Dickin, S., Bisung, E., & Savadogo, K. (2017). Sanitation and the commons: The role of collective action in sanitation use. <i>Geoforum</i> , 86, 118-126.	Burkina Faso	Sanitation	Exogenous	Accountability Diffusion Ownership	Availability
4	Madrigal-Ballester, R., & Naranjo, M. A. (2015). Adaptive capacity, drought and the performance of community-based drinking water organizations in Costa Rica. <i>Journal of Water and Climate Change</i> , 6(4), 831-847.	Costa Rica	Water	Exogenous	Accountability Diffusion Ownership Market	Availability Longevity
5	Madrigal-Ballester, R. (2019). Household and community responses to seasonal droughts in rural areas of Costa Rica. <i>Waterlines</i> , 38(4), 286-304.	Costa Rica	Water	Exogenous	Accountability Ownership	Availability Longevity
6	Jimenez-Redal, R., Soriano, J., Holowko, N., Almandoz, J., & Arregui, F. (2018). Assessing sustainability of rural gravity-fed water schemes on Idjwi Island, DR Congo. <i>International Journal of Water Resources Development</i> , 34(6), 1022-1035.	D.R Congo	Water	Exogenous	Ownership	Availability Longevity
7	Andrade, E. L., Bingenheimer, J. B., Edberg, M. C., Zoerhoff, K. L., & Putzer, E. M. (2019). Evaluating the effectiveness of a community-based hygiene promotion program in a rural Salvadoran setting. <i>Global Health Promotion</i> , 26(1), 69-80.	El Salvador	Hygiene	Exogenous	Ownership	Change
8	Degebasa, M. Z., Weldemichael, D. Z., & Marama, M. T. (2018). Diarrheal status and associated factors in under five years old children in relation to implemented and unimplemented community-led total sanitation and hygiene in Yaya Gulele in 2017. <i>Pediatric health, medicine and therapeutics</i> , 9, 109.	Ethiopia	Sanitation and Hygiene	Exogenous	Ownership Shame	Availability Change
9	Zelege, D. A., Gelaye, K. A., & Mekonnen, F. A. (2019). Community-Led Total Sanitation and the rate of latrine ownership. <i>BMC research notes</i> , 12(1), 14.	Ethiopia	Sanitation	Exogenous	Diffusion Shame	Availability
10	Tessema, R. A. (2017). Assessment of the implementation of community-led total sanitation, hygiene, and associated factors in Diretiyara district, Eastern Ethiopia. <i>PloS one</i> , 12(4), e0175233.	Ethiopia	Sanitation	Exogenous	Diffusion Ownership Shame	Availability Change

11	Anthonj, C., Fleming, L., Cronk, R., Godfrey, S., Ambelu, A., Bevan, J., ... & Bartram, J. (2018). Improving monitoring and water point functionality in rural Ethiopia. <i>Water</i> , 10(11), 1591.	Ethiopia	Water	Exogenous	Accountability Ownership	Availability Change Longevity
12	Crocker, J., Geremew, A., Atalie, F., Yetie, M., & Bartram, J. (2016). Teachers and sanitation promotion: an assessment of community-led total sanitation in Ethiopia. <i>Environmental science & technology</i> , 50(12), 6517-6525.	Ethiopia	Sanitation	Exogenous	Diffusion Ownership Shame	Availability Change
13	Gebremariam, B., & Tsehay, K. (2019). Effect of community led total sanitation and hygiene (CLTSH) implementation program on latrine utilization among adult villagers of North Ethiopia: a cross-sectional study. <i>BMC research notes</i> , 12(1), 1-6.	Ethiopia	Sanitation and Hygiene	Exogenous	Shame	Change
14	Soboksa, N. E., Hailu, A. B., Gari, S. R., & Alemu, B. M. (2019). Water supply, sanitation and hygiene interventions and childhood diarrhea in Kersa and Omo Nada districts of Jimma Zone, Ethiopia: a comparative cross-sectional study. <i>Journal of Health, Population and Nutrition</i> , 38(1), 1-14.	Ethiopia	Water, Sanitation and Hygiene	Exogenous	Diffusion Shame	Availability Change
15	Crocker, J., Saywell, D., & Bartram, J. (2017). Sustainability of community-led total sanitation outcomes: Evidence from Ethiopia and Ghana. <i>International Journal of Hygiene and Environmental Health</i> , 220(3), 551-557.	Ethiopia and Ghana	Sanitation	Exogenous	Diffusion Ownership Shame	Availability Change
16	Opere, S. (2011). Sustaining water supply through a phased community management approach: Lessons from Ghana's "oats" water supply scheme. <i>Environment, Development and Sustainability</i> , 13, 1021-1042.	Ghana	Water	Exogenous	Accountability Diffusion Ownership	Availability Change Longevity
17	Nunbogu, A. M., Harter, M., & Mosler, H. J. (2019). Factors associated with levels of latrine completion and consequent latrine use in northern Ghana. <i>International journal of environmental research and public health</i> , 16(6), 920.	Ghana	Sanitation	Exogenous	Diffusion Shame	Availability Change
18	Crocker J, Abodoo E, Asamani D, Domapielle W, Gyapong B, Bartram J. (2016). Impact evaluation of training natural leaders during a community-led total sanitation intervention: A cluster-randomized field trial in Ghana. <i>Environ Sci Technol</i> . 50(16):8867–75.	Ghana	Sanitation	Exogenous	Diffusion Shame	Availability Change
19	Kosinski, K. C., Crocker, J. J., Durant, J. L., Osabutey, D., Adjei, M. N., & Gute, D. M. (2011). A novel community-based water recreation area for schistosomiasis control in rural Ghana. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 1(4), 259-268.	Ghana	Water	Exogenous	Ownership	Change
20	Woode, P. K., Dwumfour-Asare, B., Nyarko, K. B., & Appiah-Effah, E. (2018). Cost and effectiveness of water, sanitation and hygiene promotion intervention in Ghana: the case of four communities in the Brong Ahafo region. <i>Heliyon</i> , 4(10), e00841.	Ghana	Sanitation	Exogenous	Shame	Change

21	Morinville, C., & Harris, L. M. (2014). Participation, politics, and panaceas: exploring the possibilities and limits of participatory urban water governance in Accra, Ghana. <i>Ecology and Society</i> , 19(3).	Ghana	Water	Exogenous.	Accountability Ownership	Availability Longevity
22	Harter, M., Inauen, J., & Mosler, H. J. (2020). How does Community-Led Total Sanitation (CLTS) promote latrine construction, and can it be improved? A cluster-randomized controlled trial in Ghana. <i>Social science & medicine</i> , 245, 112705.	Ghana	Sanitation	Exogenous	Accountability Diffusion Shame	Availability
23	Nti, E. K., Wongnaa, C. A., Edusah, N. S. E., & Bakang, J. E. A. (2020). Assessment of the sustainability of community-managed water supply services in Ghana. <i>Environment, Development and Sustainability</i> , 22(7), 7097-7120.	Ghana	Water	Exogenous	Ownership	Longevity
24	Klug, T., Shields, K. F., Cronk, R., Kelly, E., Behnke, N., Lee, K., & Bartram, J. (2017). Water system hardware and management rehabilitation: Qualitative evidence from Ghana, Kenya, and Zambia. <i>International journal of hygiene and environmental health</i> , 220(3), 531-538.	Ghana, Kenya, Zambia	Water	Exogenous	Accountability Ownership	Longevity
25	Kelly, E., Shields, K. F., Cronk, R., Lee, K., Behnke, N., Klug, T., & Bartram, J. (2018). Seasonality, water use and community management of water systems in rural settings: Qualitative evidence from Ghana, Kenya, and Zambia. <i>Science of the Total Environment</i> , 628, 715-721.	Ghana, Kenya, Zambia	Water	Exogenous	Market	Longevity
26	Behnke, N. L., Klug, T., Cronk, R., Shields, K. F., Lee, K., Kelly, E. R., ... & Bartram, J. (2017). Resource mobilization for community-managed rural water systems: Evidence from Ghana, Kenya, and Zambia. <i>Journal of Cleaner Production</i> , 156, 437-444.	Ghana, Kenya, Zambia	Water	Both	Ownership	Longevity
27	Kelly, E., Lee, K., Shields, K. F., Cronk, R., Behnke, N., Klug, T., & Bartram, J. (2017). The role of social capital and sense of ownership in rural community-managed water systems: Qualitative evidence from Ghana, Kenya, and Zambia. <i>Journal of Rural Studies</i> , 56, 156-166.	Ghana, Kenya, Zambia	Water	Both	Accountability Ownership	Availability
28	Sarkar, S., Greenleaf, J. E., Gupta, A., Ghosh, D., Blaney, L. M., Bandyopadhyay, P., ... & Sen Gupta, A. K. (2010). Evolution of community-based arsenic removal systems in remote villages in West Bengal, India: assessment of decade-long operation. <i>Water Research</i> , 44(19), 5813-5822.	India	Water	Exogenous	Accountability Market	Availability Longevity
29	Rout, S. (2014). Institutional variations in practice of demand responsive approach: evidence from rural water supply in India. <i>Water Policy</i> , 16(4), 650-668.	India	Water	Endogenous	Accountability Market Ownership	Longevity
30	Singh, C. (2018). Is participatory watershed development building local adaptive capacity? Findings from a case study in Rajasthan, India. <i>Environmental development</i> , 25, 43-58.	India	Water	Exogenous	Accountability Diffusion Ownership	Availability Longevity

31	Maheshwari, B., Varua, M., Ward, J., Packham, R., Chinnasamy, P., Dashora, Y., ... & Rao, P. (2014). The role of transdisciplinary approach and community participation in village scale groundwater management: insights from Gujarat and Rajasthan, India. <i>Water</i> , 6(11), 3386-3408.	India	Water	Exogenous	Accountability Ownership	Availability Longevity
32	Orgill-Meyer, J., Pattanayak, S. K., Chindarkar, N., Dickinson, K. L., Panda, U., Rai, S., ... & Jeuland, M. (2019). Long-term impact of a community-led sanitation campaign in India, 2005–2016. <i>Bulletin of the World Health Organization</i> , 97(8), 523.	India	Sanitation	Exogenous	Shame	Availability Change
33	String, G. M., Singleton, R. I., Mirindi, P. N., & Lantagne, D. S. (2020). Operational research on rural, community-managed water safety Plans: case study results from implementations in India, DRC, Fiji, and Vanuatu. <i>Water research</i> , 170, 115288.	India, DRC, Fiji, and Vanuatu	Water	Exogenous	Accountability Market	Availability Longevity
34	Cameron, L., Olivia, S., & Shah, M. (2019). Scaling up sanitation: evidence from an RCT in Indonesia. <i>Journal of development economics</i> , 138, 1-16.	Indonesia	Sanitation	Exogenous	Diffusion Ownership Shame	Change Longevity
35	Roekmi RAK, Baskaran K, Chua LH. (2018). Community-based water supplies in Cikarang, Indonesia: Are they sustainable? <i>Natural Resource Forum</i> ;42(2):108–22	Indonesia	Water	Endogenous	Accountability Market Ownership	Availability Longevity
36	Ganing, A., Abu, A., Muslimin, I., & Adam, A. (2018). Community empowerment in management community-based total sanitation through health education in Majene. <i>Indian Journal of Public Health Research & Development</i> , 9(12), 1466-1471.	Indonesia	Sanitation	Exogenous	Diffusion Ownership	Change Longevity
37	Ogendo, K. N., Kihara, A. B., Kosgei, R. J., Tweya, H., Kizito, W., Murkomen, B., & Ogutu, O. (2016). Assessment of community led total sanitation uptake in rural Kenya. <i>East African Medical Journal</i> , 93(10), 39-42.	Kenya	Sanitation	Exogenous	Shame	Change
38	Babb, C., Makotsi, N., Heimler, I., Bailey, R. C., Hershow, R. C., Masanga, P., & Mehta, S. D. (2018). Evaluation of the effectiveness of a latrine intervention in the reduction of childhood diarrhoeal health in Nyando District, Kisumu County, Kenya. <i>Epidemiology & Infection</i> , 146(9), 1079-1088.	Kenya	Sanitation	Exogenous	Shame	Change
39	Gimaiyo, G., McManus, J., Yarri, M., Singh, S., Trevett, A., Moloney, G., ... & Lehmann, L. (2019). Can child-focused sanitation and nutrition programming improve health practices and outcomes? Evidence from a randomised controlled trial in Kitui County, Kenya. <i>BMJ global health</i> , 4(1).	Kenya	Sanitation	Exogenous	Accountability Diffusion Shame	Change
40	Karinja, M., Schlienger, R., Pillai, G. C., Esterhuizen, T., Onyango, E., Gitau, A., & Ogutu, B. (2020). Risk reduction of diarrhea and respiratory infections following	Kenya	Hygiene	Exogenous	Diffusion	Change

	a community health education program-a facility-based case-control study in rural parts of Kenya. <i>BMC public health</i> , 20, 1-9.					
41	Wardle, C. (2018). Sustainability and long-term impact of community-managed water supply in rural Kyrgyzstan, Central Asia. <i>Waterlines</i> , 37(2), 118-131.	Kyrgyzstan	Water	Exogenous	Diffusion Market Ownership	Availability Change Longevity
42	Keoprasith, B., Kizuki, M., Watanabe, M., & Takano, T. (2013). The impact of community-based, workshop activities in multiple local dialects on the vaccination coverage, sanitary living and the health status of multiethnic populations in Lao PDR. <i>Health promotion international</i> , 28(3), 453-465.	Laos	Sanitation and hygiene	Exogenous	Accountability Diffusion	Change
43	Biran, A., Danquah, L., Chunga, J., Schmidt, W. P., Holm, R., Itimu-Phiri, A., ... & White, S. (2018). A cluster-randomized trial to evaluate the impact of an inclusive, community-led total sanitation intervention on sanitation access for people with disabilities in Malawi. <i>The American journal of tropical medicine and hygiene</i> , 98(4), 984-994.	Malawi	Sanitation	Exogenous	Accountability Ownership Shame	Availability
44	Kayoka, C., Itimu-Phiri, A., Biran, A., & Holm, R. H. (2019). Lasting results: A qualitative assessment of efforts to make community-led total sanitation more inclusive of the needs of people with disabilities in Rumphi District, Malawi. <i>Disability and health journal</i> , 12(4), 718-721.	Malawi	Sanitation	Exogenous	Ownership Shame	Availability
45	Longwe, B., Mganga, M., & Sinyiza, N. (2019). Review of sustainable solar powered water supply system design approach by Water Mission Malawi. <i>Water Practice and Technology</i> , 14(4), 749-763.	Malawi	Water	Exogenous	Accountability Market Ownership	Availability Longevity
46	Pickering, A. J., Djebbari, H., Lopez, C., Coulibaly, M., & Alzua, M. L. (2015). Effect of a community-led sanitation intervention on child diarrhoea and child growth in rural Mali: a cluster-randomised controlled trial. <i>The Lancet Global Health</i> , 3(11), e701-e711.	Mali	Sanitation	Exogenous	Accountability Shame	Change Longevity
47	Jones, S. (2011). Participation as citizenship or payment? A case study of rural drinking water governance in Mali. <i>Water alternatives</i> , 4(1).	Mali	Water	Exogenous	Accountability Diffusion Ownership	Availability
48	Alzúa, M. L., Djebbari, H., & Pickering, A. J. (2020). A community-based program promotes sanitation. <i>Economic Development and Cultural Change</i> , 68(2), 357-390.	Mali	Sanitation	Exogenous	Accountability Shame	Availability Change
49	Azemzi, H., & Erraoui, E. H. (2021). Irrigation water management and collective action: understanding the shift from community management to participatory management in Souss-Massa (Morocco). <i>Euro-Mediterranean Journal for Environmental Integration</i> , 6(1), 1-12.	Morocco	Water	Endogenous	Accountability Ownership	Availability Change Longevity

50	Harter, M., Mosch, S., & Mosler, H. J. (2018). How does Community-Led Total Sanitation (CLTS) affect latrine ownership? A quantitative case study from Mozambique. <i>BMC public health</i> , 18(1), 387.	Mozambique	Sanitation	Exogenous	Diffusion Ownership	Availability Longevity
51	Barrington, D., Fuller, K., & McMillan, A. (2013). Water safety planning: adapting the existing approach to community-managed systems in rural Nepal. <i>Journal of water, sanitation and hygiene for development</i> , 3(3), 392-401.	Nepal	Water	Exogenous	Diffusion	Longevity
52	Bright-Davies L, Lüthi C, Jachnow A. (2015). DEWATS for urban Nepal: a comparative assessment for community wastewater management. <i>Waterlines</i> . 34(2):119–38.	Nepal	Water	Exogenous	Ownership	Longevity
53	Padawangi, R. (2010). Community-driven development as a driver of change: water supply and sanitation projects in rural Punjab, Pakistan. <i>Water Policy</i> , 12(S1), 104-120.	Pakistan	Sanitation and water	Exogenous	Market Ownership	Availability Longevity
54	Hubbard, B., Sarisky, J., Gelting, R., Baffigo, V., Seminario, R., & Centurion, C. (2011). A community demand-driven approach toward sustainable water and sanitation infrastructure development. <i>International journal of hygiene and environmental health</i> , 214(4), 326-334.	Peru	Sanitation and Water	Endogenous	Ownership	Availability Change Longevity
55	Smyrilli, C., Selvakumaran, S., Alderson, M., Pizarro, A., Almendrades, D., Harris, B., & Bustamante, A. (2018). Sustainable decentralised wastewater treatment schemes in the context of Lobitos, Peru. <i>Journal of Environmental Engineering and Science</i> , 13(1), 8-16.	Peru	Water	Exogenous	Ownership	Longevity
56	Chankova, S., Hatt, L., & Musange, S. (2012). A community-based approach to promote household water treatment in Rwanda. <i>Journal of water and health</i> , 10(1), 116-129.	Rwanda	Water	Exogenous	Diffusion	Availability Change Longevity
57	Aladuwa, S., & Momsen, J. (2010). k, water resources management and women's empowerment: the Wanaraniya Water Project in Sri Lanka. <i>Gender & Development</i> , 18(1), 43-58.	Sri Lanka	Water	Endogenous	Diffusion Market Ownership	Availability Change Longevity
58	Ibrahim, S. H. (2017). Sustainability assessment and identification of determinants in community-based water supply projects using partial least squares path model. <i>Journal of Sustainable Development of Energy, Water and Environment Systems</i> , 5(3), 345-358.	Sudan	Water	Exogenous	Market	Longevity
59	Mlenga, D. H., & Baraki, Y. A. (2016). Community led total sanitation for community based disaster risk reduction: A case for non-input humanitarian relief. <i>Jambá: Journal of Disaster Risk Studies</i> , 8(2).	Swaziland	Sanitation	Exogenous	Accountability Diffusion Shame	Availability Change
60	Madon, S., Malecela, M. N., Mashoto, K., Donohue, R., Mubyazi, G., & Michael, E. (2018). The role of community participation for sustainable integrated	Tanzania	Sanitation and hygiene	Exogenous	Accountability Ownership Shame	Availability Change Longevity

	neglected tropical diseases and water, sanitation and hygiene intervention programs: a pilot project in Tanzania. <i>Social Science & Medicine</i> , 202, 28-37.					
61	Mwakitalima, A., Massa, K., Seleman, A., & Kassile, T. (2018). Scaling up rural sanitation in Tanzania: evidence from the National Sanitation Campaign. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 8(2), 290-306.	Tanzania	Sanitation	Exogenous	Accountability Diffusion Market Shame	Availability
62	Kema, K. M., Komwihangiro, J., & Kimaro, S. (2012). Integrated community based child survival, reproductive health and water and sanitation program in Mkuranga district, Tanzania: a replicable model of good practices in community based health care. <i>The Pan African Medical Journal</i> , 13(Suppl 1).	Tanzania	Sanitation and water	Exogenous	Accountability Ownership Shame	Availability
63	Safari, J., Mohamed, H., Dimoso, P., Akyoo, W., Odhiambo, F., Mpete, R., ... & Mwakitalima, A. (2019). Lessons learned from the national sanitation campaign in Njombe district, Tanzania. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 9(4), 754-764.	Tanzania	Sanitation	Exogenous	Accountability Diffusion Ownership Shame	Availability Change
64	Okolimong, C. D., Ndejjo, R., Mugambe, R. K., & Halage, A. A. (2020). Effect of a Community-Led Total Sanitation Intervention on Sanitation and Hygiene in Pallisa District, Uganda. <i>The American Journal of Tropical Medicine and Hygiene</i> , 103(4), 1735-1741.	Uganda	Sanitation and Hygiene	Exogenous	Accountability Diffusion Shame	Availability Change
65	Harvey, P. A. (2011). Zero subsidy strategies for accelerating access to rural water and sanitation services. <i>Water Science and Technology</i> , 63(5), 1037-1043.	Zambia	Sanitation and water	Exogenous	Market Ownership Shame	Availability Change Longevity
66	Zimba, R., Ngulube, V., Lukama, C., Manangi, A., Tiwari, A., Osbert, N., ... & Larsen, D. A. (2016). Chiengi district, Zambia open defecation free after 1 year of community-led total sanitation. <i>The American journal of tropical medicine and hygiene</i> , 95(4), 925-927.	Zambia	Sanitation	Exogenous	Accountability Diffusion Shame	Availability Change
67	Russpatrick, S., Tiwari, A., Markle, L., Musonda, E., Mutunda, A., Osbert, N., ... & Larsen, D. A. (2017). Mobility up the sanitation ladder following community-led total sanitation in rural Zambia. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 7(3), 436-444.	Zambia	Sanitation	Exogenous	Accountability Diffusion Shame	Availability
68	Tiwari, A., Russpatrick, S., Hoehne, A., Matimelo, S. M., Mazimba, S., Nkhata, I., ... & Larsen, D. A. (2017). Assessing the impact of leveraging traditional leadership on access to sanitation in rural Zambia. <i>The American Journal of Tropical Medicine and Hygiene</i> , 97(5), 1355-1361.	Zambia	Sanitation	Exogenous	Accountability Diffusion Ownership Shame	Availability
69	Yeboah-Antwi, K., MacLeod, W. B., Biemba, G., Sijenyi, P., H�hne, A., Verstraete, L., ... & Hamer, D. H. (2019). Improving sanitation and hygiene through	Zambia	Sanitation and hygiene	Exogenous	Diffusion Shame	Availability Change

	community-led total sanitation: the Zambian experience. <i>The American journal of tropical medicine and hygiene</i> , 100(4), 1005-1012.					
70	Whaley, L., & Webster, J. (2011). The effectiveness and sustainability of two demand-driven sanitation and hygiene approaches in Zimbabwe. <i>Journal of Water, Sanitation and Hygiene for development</i> , 1(1), 20-36.	Zimbabwe	Sanitation and hygiene	Exogenous	Shame	Availability Longevity
71	Madziyauswa, V. (2018). Assessing sustainability of community managed NGOs' WASH interventions in rural Zimbabwe: the case of Chivi district in Masvingo province. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 8(4), 640-649.	Zimbabwe	Water, sanitation, and hygiene	Exogenous	Market	Longevity
72	Kwangware, J., Mayo, A., & Hoko, Z. (2014). Sustainability of donor-funded rural water supply and sanitation projects in Mbire district, Zimbabwe. <i>Physics and Chemistry of the Earth, Parts A/B/C</i> , 76, 134-139.	Zimbabwe	Sanitation and water	Exogenous	Accountability Market Ownership	Longevity
73	Dhoba, L. (2020). Going to scale with rural water supply: a reflection on experiences from sustaining community managed piped water schemes in rural Zimbabwe. <i>Journal of Water, Sanitation and Hygiene for Development</i> , 10(3), 527-538.	Zimbabwe	Water	Exogenous	Accountability Ownership	Longevity