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Water, sanitation and hygiene (WASH) system strengthening in low- and middle-income countries (LMICs): a systematic review on the state of the evidence

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Abstract

System strengthening has become a central objective of water, sanitation and hygiene (WASH) policy and programming, yet the evidence base for its effectiveness remains poorly consolidated. To address this gap, we conducted a systematic review of studies that assessed outcomes arising from WASH system strengthening (WASH-SS) interventions, with a study follow-up period of at least six months. Our search identified a limited body of evidence: only 17 studies met the inclusion criteria, and these displayed substantial variation in focus, methodological approaches and contextual settings. We mapped reported outcomes along a logic model and found that the most reported outcomes clustered around process-level changes, systems outputs and intermediate outcomes, whereas distal health and socioeconomic impacts were rarely reported. This distribution partly reflects the complex nature of WASH system strengthening and the difficulty of evaluating distal outcomes, a challenge also found in the health systems strengthening literature. Notably, the evidence suggest that domestically driven reforms are more closely associated with sustained, long-term outcomes and successful financial leveraging, compared to initiatives driven by international organisations. In doing so, the review offers a replicable logic model for classifying WASH-SS outcomes and a preliminary signal that domestically embedded reforms are more closely associated with sustained outcomes and financing leverage. Overall, the review highlights the need for more robust, longitudinal studies capable of tracing the pathways through which system strengthening contributes to lasting, equitable WASH outcomes.

INTRODUCTION

Sustainable water, sanitation and hygiene (WASH) services depend on robust WASH systems: networks of social, financial, infrastructural and environmental actors and factors that work together to enable service delivery.[1,2] Approaches that simultaneously improve individual system pillars and the interactions between them are often described as WASH system strengthening (WASH-SS).[3,4] As well as reinforcing key system functions, the goal of WASH-SS is to address barriers to inclusive services.[2,5] This dual focus is central to equitable WASH development. Historical analyses show that WASH development has been known to improve services for urban elites first, a process that can worsen access inequalities and intensify wider socioeconomic and health disparities.[6,7,8,9] Therefore, the WASH systems perspective is increasingly informed by historic lessons and prior approaches, such as the enabling environment, seeking to support more sustainable and equitable service delivery.[10,11]

Donor and practitioner interest in systems-oriented approaches has grown alongside persistent failures of WASH interventions to achieve durable improvements in service delivery, particularly for marginalised populations.[12,13,14] Evidence from the 2025 UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) highlights the need for more consistent monitoring and data use for evidence-based decision making, stronger human resources, regulation and investment plans aligned to national targets.[15] The report recognises a growing adoption of systems thinking, rather than project-based approaches, as well as a positive trend in political commitments to WASH. More efficient use of resources and efforts to leverage financing require a consolidated evidence base establishing the state of the evidence for WASH-SS.[16]

Recent literature reflects a growing interest in understanding the state of the evidence based underpinning these claims for WASH-SS.[14] A 2020 broad scope systematic review examining the uptake of systems strengthening approaches was published in 2020, but it did not evaluate effectiveness or assess outcomes.[4] More recently in 2025, an expert prioritisation study identified key research questions for advancing WASH systems strengthening, highlighting ongoing uncertainties around mechanisms of change and evaluation approaches.[16] To date, peer reviewed synthesis of empirical evidence on WASH-SS outcomes remains limited.

In contrast, since the 2000s the healthcare field has taken up systems strengthening approaches,[17,18] based on the premise that systems approaches can greatly benefit overall sector development and capacity.[19] Stronger systems are produced through interventions that go beyond singular inputs but, critically, produce non-linear interactions between actors and factors, operating across multiple system building blocks.[20] Evaluating systems strengthening is a challenge due to this non-linear nature of change.[21] Reforms to strengthen complex systems, like health and WASH, require coordinated efforts involving multi-stakeholder partnerships, targeted investments, financial leveraging, government commitments and coherent policies, alongside a particular focus on vulnerable groups. [22,23]

In this study, we aim to synthesise the WASH-SS evidence base and contribute to the conceptualisation of WASH systems outcomes. We address the following question: what outcomes from WASH-SS interventions in low- and middle-income countries (LMICs) are

reported in the peer-reviewed literature? We defined a WASH-SS intervention as any initiative that targeted two or more WASH system building blocks, or a single building block with demonstrated spillover effects. Evidenced outcomes were mapped across an intervention logic model, spanning process outputs, intermediate outcomes, service delivery outcomes, longer-term outcomes and distal impacts. Through this article, we aim to provide a useful resource for practitioners and a basis for future, theory-informed evaluation in WASH systems research.

METHODS

Search strategy

The search strategy was originally developed by the London School of Hygiene and Tropical Medicine (LSHTM) library team for the WASH Systems for Health (WS4H) programme[24] and expanded for this review. The search strategy was developed in OvidSP Medline and structured around three core concepts: (1) systems strengthening, (2) water, sanitation and hygiene (WASH), and (3) low- and middle-income country settings. The search strategy was iteratively refined with the project team and subsequently adapted for each database using database-specific syntax and controlled vocabularies, in line with established systematic review guidance and the PRISMA statement.

Final searches were conducted across ten bibliographic databases of articles published between 1946 and 2025 (Medline ALL, Embase Classic, Embase, Global Health, EconLit, CINAHL Complete, Africa-Wide Information, Web of Science Core Collection, Web of Science SciELO, WHO Global Index Medicus, and PubMed) on 19 March 2025. No other limits were applied initially to maximise sensitivity. Full details of the search strategies are publicly available via LSHTM Data Compass.[25]

Eligibility criteria

Inclusion criteria

We included studies that reported on WASH-SS interventions implemented in LMICs. Studies were eligible regardless of the population group targeted, with no restrictions applied to age, gender, or vulnerability status, provided the intervention focused on populations residing in LMIC contexts. Eligible studies were required to describe the intervention in sufficient detail and report documented outcomes related to changes in WASH systems. Interventions were included if they targeted at least two WASH systems building blocks, or if they focused on a single building block with demonstrated spill-over effects on other system components. Studies of any design were eligible for inclusion.

To ensure relevance and interpretability, included studies were required to describe the methods used to measure system-level change and to account for contextual factors influencing intervention implementation or effectiveness.

Exclusion criteria

We excluded studies conducted exclusively in high-income countries, studies with a follow-up period of less than six months, and studies published prior to 1946. Finally, studies that did not report any relevant outcomes related to WASH-SS were excluded.

Titles and abstracts were screened independently by two reviewers (RS and EC) using Rayyan systematic review software. Full-text articles were then assessed by the same two reviewers. Disagreements at both stages were resolved through discussion, with a third reviewer (LDG or PH) consulted where consensus was not reached. Inter-rater agreement was not formally calculated, though discrepancies were documented and discussed.

The six-month follow-up requirement was a deliberate choice to ensure studies captured meaningful system-level change; failure to report documented outcomes was the most common reason for exclusion at full-text screening. Restricting inclusion to peer-reviewed literature was similarly intentional. This review should therefore be understood as characterising the peer-reviewed evidence base for WASH-SS outcomes, not the totality of available evidence, which includes a substantial body of practitioner-led grey literature.

Conceptual model and data extraction

We designed a logic model of WASH-SS to guide data extraction, analysis and narrative synthesis, shown below in Fig. 1, drawing on the nine WASH systems building blocks.[3] Our conceptual logic model depicts the hypothesised relationships between how interventions are expected to generate change across interconnected building blocks, rather than through isolated effects. The logic model informed the classification of interventions according to the primary WASH system building blocks they sought to strengthen.

We note two important limitations of this analytical approach. First, the nine building blocks model, as defined by IRC WASH[3] is one of several frameworks in circulation for describing WASH system pillars.[5,27] Building block frameworks simplify system complexity by separating out distinct components, but this decomposition can itself obscure the dynamic, non-linear interactions between components that are the defining feature of complex systems.[4] Second, the linear logic model used to organise our synthesis reflects a conventional results chain approach to systems change. Systems strengthening is better understood as a non-linear, iterative, and often emergent process rather than a sequential chain from inputs to impacts.[13,19] Readers should therefore treat the logic model as an example guide for organising findings from outcome evaluation, rather than as a complex theory of how WASH-SS produces outcomes.

Interventions were categorised according to their primary systems focus and theoretical approach to systems strengthening. We defined interventions as any distinct approach to strengthening WASH systems in a given context. Outcomes reported in included studies were mapped along the logic model results chain, with working definitions used to guide consistent identification and classification across heterogeneous study designs and contexts.

First, process- and system-outputs captured immediate or proximal system changes within individual WASH system building blocks, providing operational indicators of whether interventions influenced core system functions. As shown in Fig. 1, these outputs remain within the systems architecture. As such, they relate to changes within any of the building blocks or the interactions between them. All such changes indicate the potential for more extensive systems change. Examples include changes in financial allocation (e.g. resource mobilisation, budgeting, cost recovery, and financial oversight), institutional arrangements or capacity (e.g. roles, responsibilities, and coordination structures), planning or monitoring mechanisms (e.g. planning platforms, monitoring systems, and use of data for decision-making).

Second, intermediate system outcomes encompassed changes in governance, political economy, participation, and financing. These outcomes reflected shifts in accountability, transparency, decision-making processes, political engagement, inclusion, and financial incentives that shape how WASH systems function and are sustained and often mediated the relationship between proximal system outputs and downstream service outcomes.

Third, service delivery and service quality outcomes captured changes in the performance and characteristics of WASH services. Service delivery outcomes included changes in access, coverage, reliability, and functionality, while service quality outcomes reflected improvements in safety, acceptability, equity, and compliance with national standards or SDG 6 criteria.

Fourth, longer-term system outcomes captured the durability and resilience of WASH systems over time. Sustainability outcomes reflected service continuity and the persistence of financial and institutional arrangements, while resilience outcomes captured the capacity of WASH systems to absorb shocks, adapt to stressors, and transform in response to longer-term challenges such as climate change, conflict, and environmental degradation.

Finally, distal population-level outcomes captured broader effects beyond the WASH system itself. These included behavioural outcomes related to water, sanitation, and hygiene practices; socioeconomic outcomes such as time savings, educational effects, economic benefits, and gender equity; and health outcomes representing distal impacts of systems strengthening, including changes in morbidity, nutrition, and mortality associated with WASH conditions. Where reported, we noted whether interventions explicitly targeted marginalised populations and whether outcomes were disaggregated by income, gender, or vulnerability status, given the centrality of equity to sustainable WASH service delivery.

We developed, piloted, and refined a standardised data extraction form in Microsoft Excel (Supplementary Material 1). The draft extraction form was piloted on five included studies and revised based on reviewer feedback prior to full implementation. Data were extracted by one author (RS) and included study characteristics (e.g. study design, geographic setting, scale of intervention, duration of intervention, and duration of follow-up), outcome measurement methods and indicators, key findings, and reported limitations.

Given the heterogeneity of study designs, interventions, and outcome measures, we employed a narrative synthesis approach.[28] Synthesis proceeded in four stages, using a broadly deductive approach that combines a priori systems strengthening theory and the conceptual logic model, with inductive interpretation of emergent themes across studies.[29] Data were initially tabulated by study characteristics, intervention type, building blocks targeted, and outcome category, providing a preliminary overview of the evidence base. Recorded outcomes were then mapped onto the logic model results chain, with each outcome classified into one of the five categories, discussed above. Subsequently, themes and patterns were analysed, while the quality of studies was also integrated into analysis.

Quality assessment

The methodological quality of included studies was assessed using established critical appraisal tools appropriate to study design. Qualitative studies were appraised using the Critical Appraisal Skills Programme (CASP) checklist, mixed-methods studies using the Mixed Methods Appraisal Tool (MMAT), and quantitative studies using the Joanna Briggs Institute (JBI) Critical Appraisal Tool. Each study was assessed against tool-specific criteria. All studies were retained regardless of quality rating, and quality assessments were used to support interpretation of findings and assessment of confidence in the evidence, rather than as exclusion criteria.

The systematic review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) prior to data extraction (registration number: #CRD420251039139, https://www.crd.york.ac.uk/PROSPERO/view/CRD420251039139).

RESULTS

The search identified 19,395 records from bibliographic databases, with 270 duplicates removed. There were an additional 119 studies identified through expert referral and citation searches. Titles and abstracts of 19,244 studies were screened against the inclusion and exclusion criteria, of which 19,077 did not meet the criteria and were excluded. A total of 167 full-text articles were assessed for eligibility. Following full-text screening, 17 studies met the inclusion criteria and were retained for synthesis in the final review. These stages are set out below in Fig. 2.

Study characteristics

The 17 included studies were published between 2005 and 2024 and represented a diverse geographic spread across Bangladesh, Bolivia, Brazil, Burkina Faso, Cambodia, Ecuador, Ghana, India, Mali, Mexico, Mozambique, Myanmar, Nepal, Papua New Guinea, Tanzania, and Uganda. Included countries are shown below in Fig. 3. Studies were conducted in a range of contexts, including rural, urban, and peri-urban settings, as well as at watershed, municipal, national, and multi-country programme scales.

The scale of interventions varied widely, ranging from household to national levels. Intervention duration ranged from short-term pilots to multi-year initiatives, programmes of work and policy reforms. The follow-up duration marked the time between intervention implementation and outcomes. This period ranged from 6 months to 10 years.

Study approaches were heterogeneous and included qualitative (N = 5), quantitative (N = 1), and mixed methods approaches (N = 9). Qualitative methods commonly employed interviews, focus group discussions, workshops, questionnaires, observations, and ethnographic methods. The quantitative study analysed household survey data. Mixed-methods studies integrated various qualitative and quantitative approaches, with study designs stated as action research, community mapping exercises, author experiences, project documentation, and analysis of national statistics, waterpoint census data and financial records.

Quality of included studies

The methodological quality of included studies varied across study designs. Qualitative studies scored between 5–8 out of 10 on the CASP checklist, the quantitative study scored 7/8 on the JBI tool and mixed-methods studies scored between 2–5 out of 5, although the criteria on addressing divergence between components was commonly missing. Overall, studies generally had a strong rationale for the choice of methods, clear statement of findings and valuable contribution. Quality aspects such as researcher reflexivity, ethical issues addressed and integrated interpretation of results were often lacking. Full details of the quality assessments are provided in Supplementary Material 2.

Study Interventions and WASH System Building Blocks

The 17 included studies examined a diverse set of interventions intended to strengthen WASH systems across multiple building blocks. Below, Table 1 shows how many studies targeted each building block.

Table 1
Number of studies in which WASH systems building blocks were targeted by system strengthening interventions.

WASH System building block targeted	Number of studies
Service Delivery and Infrastructure	8
Monitoring	7
Planning	7
Community Engagement	6
Institutional Arrangements	6
Finance	5
Regulation and Accountability	3
Water Resources Management	2
Learning and Adaptation	1

The building blocks targeted most frequently were service delivery and infrastructure (N = 8), monitoring (N = 7), and planning (N = 7). This reflects the common focus of WASH interventions across the included studies. The building blocks with the least attention were learning and adaptation (N = 1), water resources management (N = 2), and regulation and accountability (N = 3). These aspects are under researched and indicate specific areas for further research.

Outcomes of WASH Systems Strengthening Interventions

Outcomes reported across the 17 studies spanned multiple domains along the logic model. In reporting results, we synthesised findings along the logic model chain and by outcome domain. Below, Table 2 details the included studies, with descriptions of interventions, building blocks targeted, context, scale and duration. Following the tables, we summarise outcomes by group and go on to discuss emergent themes.

Table 2
Included studies and descriptions of the interventions evaluated.

Citation	Author, year	Country	Context	Scale	Duration	Intervention description	Targeted building blocks
30	Baud and Dhanalakshmi, 2007	India	Urban	City	1992	Urban sanitation reform enabled by 1992 legislation allowing multi-stakeholder partnerships for underground sewerage investment. The intervention involved restructuring governance arrangements between municipal authorities, private actors, and civil society to mobilise finance and improve service delivery in city-level sanitation systems.	Financing; Institutional Arrangements; Regulation and Accountability; Service Delivery
31	Burgos et al. 2013	Mexico	Rural	Regional (also described as basin level). 3 medium-sized watersheds.	3 years (2010–2012)	Community-based environmental water quality monitoring programme implemented across three watersheds under the Bajo Balsas initiative. It built local capacity to test and interpret water quality data, strengthened community organisation around watershed management, and established feedback loops between communities and basin-level institutions to improve governance and accountability in water resource management. Specific activities undertaken in the 3-year timeframe were 6 water quality sampling exercises and 1 training for data management.	Community Engagement; Learning; Monitoring; Water Resources Management;
32	Cairns, 2018	Bolivia	Rural	Community	2 years (dates not specified)	Introduction of household water metering within a newly implemented/expanded town water supply scheme (Sapecho), as a mechanism to manage allocation/payment and shape household–provider relations; examined as part of broader infrastructure and service changes affecting access and governance of potable water provision.	Financing; Service Delivery; Water Resources Management

Citation	Author, year	Country	Context	Scale	Duration	Intervention description	Targeted building blocks
33	Cardoso Castro et al. 2024	Brazil	Urban and rural	Regional	2003–2014	Large-scale community rainwater harvesting initiative ("One Million Cisterns") in Pará, combining social mobilisation, household cistern construction, and state support. The intervention aimed to strengthen water security in semi-arid regions through decentralised infrastructure, community participation, and integration into national rural development policy.	Monitoring; Planning; Service Delivery
34	Etongo et al. 2013	Uganda	Rural	Parish (one step up from village level)	5 years	Community participation and capacity development intervention through the "Water is Life" programme, focusing on establishing and strengthening water user committees for management of rural water systems. The later WaterSPOUTT programme assessed and reinforced committee functionality, governance capacity, and local ownership of service delivery.	Community Engagement; Financing; Water Resources Management
35	Gosling et al. 2022	Nepal, Ghana, Mali, Burkina Faso	Urban and rural	Nepal (district focus, national advocacy components); Ghana (district-level focus); Burkina Faso (national); Mali (rural community level and municipality level)	Nepal, June 2017 to December 2019; Ghana, 2015–2019; Burkina Faso, 2017–2020; Mali, 2016–2019.	Multi-country implementation of human rights-based approaches (HRBA) to WASH through WaterAid programmes. Interventions included institutional capacity strengthening, embedding rights language in national policy, integrating WASH into district health planning, targeted inclusion of marginalised groups, and advocacy to improve accountability and equitable service delivery at community, district, and national levels. In Nepal, the HSBC Water Programme II aimed to research service barriers faced by marginalised communities and to enshrine human rights into the Nepali constitution. In Ghana,	Community Engagement; Planning; Regulation and Accountability

Citation	Author, year	Country	Context	Scale	Duration	Intervention description	Targeted building blocks
						the WASH for Public Health project was designed to improve the health outcomes using an integrated approach to public health, incorporating improved WASH into district-wide development and health service delivery. In Burkina Faso, the 'Mission Fas'Eau' project aimed to support WASH access and enshrining rights language into Ministry policy. In Mali, the 'Ji Ni Beseya' project aimed to increase safe water and sanitation access in rural communities and support behaviour change initiatives.	
36	Huston et al. 2021	Uganda	Rural	National	2017–2019	Nationally coordinated transition from community-managed rural water systems to utility-managed service delivery. The intervention involved institutional reform, asset transfer, tariff restructuring, and expansion of professionalised utility governance into rural districts.	Financing; Institutional Arrangements; Planning Service Delivery
37	Jiménez and Pérez-Foguet 2010	Tanzania	Rural	District	2006–2025	District-level implementation of enhanced water point mapping as a governance and information systems strengthening intervention. The programme developed and tested simplified procedures for large-scale water point inventory and functionality monitoring, aiming to improve evidence-based district planning, transparency, and allocation of resources in rural water supply systems.	Institutional Arrangements; Monitoring; Planning

Citation	Author, year	Country	Context	Scale	Duration	Intervention description	Targeted building blocks
38	Kimbugwe et al., 2022	Cambodia, Myanmar, Papua New Guinea, and Uganda	Urban and rural	National (WaterAid contributed to national WASH sector initiatives involving government ministries in all 4 countries)	Not specified	WaterAid-supported national WASH monitoring system strengthening initiatives, including data system reform, integration of monitoring into government structures, and promotion of evidence-informed decision-making within ministries and sector coordination platforms. In Cambodia, improved availability of data in centralised management systems enabled greater data sharing between governance levels and political prioritisation for monitoring data collection was improved. In Myanmar, indicators were harmonised and data needs at different governance levels were mapped which led to adoption of best practice indicators, derived from SDG 6 and the JMP. In Papua New Guinea, technical working groups were set up at the national level, along with new management information systems and training, which supported the development of the first national monitoring framework. In Uganda, sector coordination groups were convened, monitoring roles and responsibilities were defined, and the Joint Sector Review platform was used to disseminate data, leading to improvements in monitoring and evaluation at sub-national levels	Learning and Adaptation; Monitoring; Planning
39	Kresch, 2020	Brazil	Urban and rural	National	2005–2007	National legislative reform (Bill 5.296/2005; enacted 2007) clarifying municipal authority over water and sanitation services. The intervention restructured sector governance, regulatory roles, and intergovernmental responsibilities,	Finance; Institutional Arrangements; Regulation and Accountability

Citation	Author, year	Country	Context	Scale	Duration	Intervention description	Targeted building blocks
						influencing investment flows and service provision incentives.	
40	Leal et al. 2022	Global	Various	Global	12 months	A free e-learning platform developed by international NGO (IRC WASH) with the aim of capacity building WASH actors with systems thinking knowledge and skills, in any global context. The platform is used to support a range of learning approaches through 'Massive Open Online Courses'.	Learning and Adaptation; Planning
41	Mahmud et al., 2007	Bangladesh	Rural	Community	Feb-Nov 2005 (10 months)	Development and implementation of Water Safety Plans (WSPs) for small community-managed water supplies. The intervention introduced structured risk assessment, hazard identification, operational monitoring, and community training to improve water quality management and system reliability.	Community Engagement; Planning; Monitoring; Service Delivery
42	Moreno et al. 2020	Ecuador	Urban and rural	National	2016–2019	Strengthening national WASH monitoring by integrating microbiological water quality testing (E. coli), household surveys (2016 and 2019), with expanded SDG-aligned indicators and institutional support to operationalise sample collection/analysis and incorporate results into national monitoring of drinking-water services.	Monitoring; Planning
43	Myers et al. 2026	Mozambique	Rural	District	Feb-Nov 2023	Two peer learning workshops were facilitated by researchers from the UK and Mozambique between government staff members in Open Defecation Free (ODF) Districts and non-ODF Districts in Mozambique to support capacity development and assess the enablers and barriers to change. Follow up interviews were conducted 9 months later to assess what changes had taken place after the workshops.	Learning and Adaptation; Planning

Citation	Author, year	Country	Context	Scale	Duration	Intervention description	Targeted building blocks
44	Nhim and Mcloughlin, 2022	Cambodia	Rural	Province	2013–2022	Civic Champions leadership training programme designed to strengthen local governance, political engagement, and accountability in WASH systems. The intervention built the capacity of community leaders to engage with local authorities, advocate for improved services, and influence decision-making across eight provinces.	Institutional Arrangements; Community Engagement
45	Portal Carús and Paltán, 2024	Mexico	Urban	City	2019–2024	Results-based financing scheme to scale up decentralised rainwater harvesting under the “Cosecha de Lluvia” programme across Mexico City. The intervention incentivised installation of household rainwater harvesting systems to diversify urban water supply, reduce pressure on centralised systems, and strengthen resilience through alternative service delivery models.	Financing; Monitoring; Service Delivery
46	Prokopy, 2005	India	Rural	Village	Karnataka (phase 1–1993-998; phase 2 2002-13) UP (1997–2003)	Establishment and institutionalisation of village water and sanitation committees (VWSCs) within rural water supply programmes. The intervention decentralised decision-making authority to village level, aiming to improve accountability, maintenance, financial management, and sustainability of rural water schemes.	Community Engagement; Institutional Arrangements; Service Delivery

Table 3
Included studies and descriptions of the outcome(s) recorded, associated with study interventions.

Citation	Author, year	Study design and sample size (N)	Follow up duration	Quality score	Outcome category	Outcome description
30	Baud and Dhanalakshmi, 2007	Qualitative case study. N not specified.	10 years	5/10	Participation	Civil society participation was more limited under multi stakeholder arrangements compared to government-led models. Household participation was limited to financial contributions and oversight and were not invited to participate in design or implementation. However, this improved when external funding organisations mandated participation from civil society in loan terms.
					Political	Multi-stakeholder partnerships improved formal accountability among institutional actors, including local government, to service users. However, access was limited to property-tax-registered households. Households in slum areas had no access to the scheme.
					Process and system output	Through multi-stakeholder arrangements, each participating organisation contributed time, money, and political capital. The arrangement outcomes were designed to be beneficial for all partners, which provided a clear rationale for participation.
					Socioeconomic	Service expansion excluded households in informal settlements, reinforcing existing inequalities in access.
31	Burgos et al., 2013	Longitudinal mixed-methods case study. N = 326 people, 47 water points.	3 years	4/5	Governance	Community members reported increased self-organisation and formation of new social networks supporting collective decision making on water quality.
					Process and system output	Increased awareness and knowledge (“active thinking”) of water quality issues among participating community members. Community-based warning systems were developed for water quality.
					Service quality	Reported reductions in water quality degradation during the study period.
32	Cairns, 2018	Mixed-methods study. N = 11 development professional interviews, N = 32 community member interviews, N = 4	Not directly stated. Appears to be at least 10 years.	4/5	Behavioural	Household water metering aggregated water use at household level, obscuring intra-household water behaviours and the needs of individuals in the home.

Citation	Author, year	Study design and sample size (N)	Follow up duration	Quality score	Outcome category	Outcome description
		focus groups, N = 138 surveys, N = 7 participatory mapping exercises.			Political	Renters were excluded from formal participation, as they had not bought into the town water supply system, and were ineligible to join water governance structures.
					Socioeconomic	Affordability constraints disproportionately affected large families and renters, due to high water use and landlord control over water supply. Some households reported reverting to river water use. This ingrained inequalities in access, induced stress and re-introduced a contaminated water source into daily life. Additionally, it affected community cohesion when there was differential access within the town.
					Service quality	Household water metering was associated with more rapid reporting and repair of leaks, though maintenance benefits were not attributed solely to metering design.
33	Cardoso Castro et al., 2024	Qualitative case study. N = 109 end users.	4 years	6/10	Process and system output	Monitoring data and information flows were generated at the household and local governance levels, but remained weakly integrated into higher-level planning processes, weakening effective allocation of resource and contributing to administrative burden at the local governance level.
34	Etongo et al., 2018	Cross-sectional mixed-methods case study. N = 1726 households, 8193 people	10 years	2/5	Financing	User committees mobilised household financial contributions to water supply systems, and reliability of water points was associated with regular contributions. Contributions were often ad hoc, limiting preventive maintenance.
					Political	Local politicisation of water management was reported as a barrier to transparent and accountable management, which in turn influenced financial contributions of households.
					Sustainability	Ten years post-implementation, approximately 50% of water points remained functional. Lack of maintenance was associated with the high rate of non-functionality.
35	Gosling et al. 2022	Qualitative case study. N not specified.	2 years minimum	6/10	Political	Increased awareness among rights holders (the public) regarding the human rights to water and sanitation, associated with greater civic

Citation	Author, year	Study design and sample size (N)	Follow up duration	Quality score	Outcome category	Outcome description
						engagement and advocacy. In Burkina Faso, rights language for water and sanitation was incorporated into the constitutional reform process.
					Process and system output	Strengthened engagement between communities and authorities leading to increased political commitments and resource mobilisation. Increased integration of human rights language into policy and legal frameworks and reported improvements in accountability mechanisms for provision of inclusive services, especially to marginalised groups.
36	Huston et al., 2021	Mixed methods and participatory action research	2 years	4/5	Governance	National Water Utility-managed models scored higher across governance performance indicators, compared to the Umbrella utility, community-managed and self-supply models.
					Service delivery	National Water Utility-managed taps demonstrated highest reliability and functionality (75%) compared to Umbrella (49%) and community managed taps (38%).
37	Jiménez and Pérez-Foguet 2010	Mixed-methods case study with action research elements. N = 840,000 people and 2509 water points.	2 years (for the case study, action research took place throughout the intervention)	4/5	Governance	Water point mapping was strengthened district-level record keeping and planning processes, enabling local governments to prioritise underserved populations. Resource constraints limited updating of records.
					Process and system output	Implementation of participatory mapping process involving local stakeholders and political leaders.
38	Kimbugwe et al., 2022	Qualitative case study	Cambodia (1-year increments from 2018, 2019, 2020); Myanmar (3 years); Papua New Guinea (2 years); Uganda (no date specified)	8/10	Process and system output	National monitoring reforms contributed to a culture of 'reporting upwards', data sharing, and collaborative indicator development across contexts.
39	Kresch, 2020	Longitudinal quantitative study	6 years	4/5	Financing	Legislative reform reduced regulatory ambiguity and was associated with increased municipal financial investment in water and sanitation infrastructure. Post reform, municipalities with 'self-run' sanitation and water utilities almost doubled their network investment.

Citation	Author, year	Study design and sample size (N)	Follow up duration	Quality score	Outcome category	Outcome description
					Governance	The reform bill clarified municipal authority over service provision, which previously permitted companies to attempt the takeover of municipal service delivery systems.
					Health	Post-reform period was associated with a 7% reduction in under-one child mortality, associated with increased investment in the water and sanitation sector and subsequent access expansion.
					Service delivery	Legislative reform and increased investment coincided with expanded service coverage of water and sanitation services.
40	Leal et al. 2022	Mixed methods. N = 624 evaluation survey participants	10 months	4/5	Process and system output	Participants reportedly changed the ways they worked – actions and activities – and changed the elements of work that they prioritised.
41	Mahmud et al., 2007	Mixed-methods case study	10 months	2/5	Participation	Water point caretakers played an active role to motivate communities to carry out safe water handling and maintaining links to community participation in safe WASH practices.
					Process and system output	Uptake of water safety plans were adopted and iteratively refined by NGOs and local stakeholders.
					Service quality	Implementation of water safety plans was associated with reported reductions in sanitary risk and improvements in microbial water quality.
42	Moreno et al., 2020	Longitudinal quantitative survey. N = 4442 households in a subsample of 2016 national survey; N = 7331 households in 2019 survey subsample.	3 years	7/8	Process and system output	Integration of household-level microbiological testing into national surveys enabled analysis of water quality along the supply chain and identified deterioration at the point of consumption associated with household handling practices.
43	Myers et al. 2026	Longitudinal mixed methods study with Survey participants N = 66	9 months	5/5	Governance	Small scale replication of peer-learned practices: Sanitation forums were replicated in N = 9 non-ODF districts.
					Political	Small scale replication of peer-learned practices: Engaging community leaders was replicated in N = 7 districts. Active engagement of administrators and directors in N = 5 districts. Introducing district directors of different departments to sanitation and

Citation	Author, year	Study design and sample size (N)	Follow up duration	Quality score	Outcome category	Outcome description
						being made "Godparents/sanitation sponsors" in N = 4 districts.
					Process and system output	Learning from colleagues at other administrative levels. Learning from peers in other districts with successful practices. Increased motivation to improve practice. Identification of useful, replicable practices.
					Resilience	Small scale replication of peer-learned practices: approaches to resilient technology using locally available materials to improved sanitation options and pit linings.
44	Nhim and Mcloughlin, 2022	Cross-sectional mixed-methods study. N = 234: 121 from the Civic group and 113 from the non-Civic (control) group.	10 months	3/5	Governance	Civic Champions participants reported higher self-reported leadership abilities, confidence and engagement with local institutional structures, compared to non-participants. Additionally, the programme encouraged localisation. Leaders built relationships with local council members, village committees, and volunteers rather than external aid agencies.
					Political	Effective local leadership was associated with working through and strengthening pre-existing institutional arrangements.
					Process and system output	The training programme attracted attention from motivated female civic leaders who, overall, outperformed male counterparts in self-reported leadership skills measures.
45	Portal Carús and Paltán, 2024	Qualitative case study. N = 28 interviewees.	4 years	8/10	Process and system output	Allocation of programme resources prioritised installation over monitoring and user training; interviewees reported challenges in sustained household adoption of rainwater harvesting systems.
46	Prokopy, 2005	Mixed-methods study	At least 6 months.	4/5	Service delivery	Decentralised decision making at the village level was associated with project success, defined by both service access and long-term sustainability.
					Financing	Transparency of committee operations was associated with household tariff payment compliance.
					Sustainability	Transparency of committee operations was associated with

Citation	Author, year	Study design and sample size (N)	Follow up duration	Quality score	Outcome category	Outcome description
						community perceptions of long-term system.

Process and system-outputs

Process- and system outputs were the most frequently reported across studies (N = 12). Initiatives on water quality surveillance in Ecuador, Bangladesh and Mexico,[32,42,45] water point mapping in Tanzania,[37] and national data harmonisation in Cambodia, Myanmar, Papua New Guinea, Uganda commonly resulted in greater amounts of data, the uptake of planning approaches, and introduction of new monitoring platforms.[38] In Ecuador and Tanzania, two high-quality studies identified stages of supply chains and geographic locations in need of targeted support. [37,42]

Governance-related change also occurred through local leadership training in Cambodia,[44] peer-to-peer learning in Mozambique,[43] multi-stakeholder arrangements in India,[30] human rights-based programming in Burkina Faso, Ghana, Mali and Nepal,[35] and community monitoring in Mexico.[31] Participants of an online e-learning platform reportedly changed the ways they worked and what tasks they prioritised.[40] Most of these studies were of medium quality. Consistently, they demonstrated changes to civic and political engagement in WASH governance, as well as resource mobilisation. These proximal outputs show the potential for changes in WASH system functionality.

Intermediate outcomes

Intermediate outcomes reflected shifts in financing, governance, participation, and political processes. Three studies demonstrated financial outcomes associated with system strengthening interventions. Water and sanitation committees were found to effectively mobilise households' financial contributions in a lower-quality study in Uganda,[32] and transparent committee operations were associated with household tariff payments in a high-quality study in India.[46] In Brazil, a high-quality study found that national reform clarified the role of municipal governments in service provision – a governance outcome – and was associated with the financial outcome of increased investment in network services.[39]

Governance outcomes were reported in four additional studies, with mid- to high-quality appraisals. In Cambodia and Mexico, interventions were shown to strengthen local WASH governance structures.[31,44]. In Mozambique, a high-quality study found that capacity building led to replication of sanitation forums in 9 districts.[43] In Uganda, a national transition to professionalised service delivery models was investigated. The strongest governance performance was associated with the National Water utility, followed by the regional utility, with community management scoring the lowest on the service delivery assessment.[36]

Participation outcomes were reported in two mid-quality studies. In Bangladesh, water point caretakers were found to motivate community members to perform safe water handling.[41] In India, civil society participation was found to be more limited when multi-stakeholder arrangements were in place, compared to government provided services.[30] Political outcomes were reported in six studies. Local leaders were actively engaged with, encouraging localisation and political support for WASH in Cambodia[44] and Mozambique[43]. The exclusion of renters and households not registered for property taxes from new water and sanitation schemes was found in Bolivia[32] and India[30], respectively. Two lower-quality studies reported the politicisation of water was a barrier to household payments in Uganda[34], and increased awareness of human rights supported civic engagement in WASH in Nepal, Ghana, Mali, and Burkina Faso[35].

Service-level outcomes

Service-level outcomes captured changes in delivery performance, including changes to access, coverage, reliability, safety, and compliance with national standards or SDG 6 criteria. Increased service coverage was associated with strengthened institutional arrangements in Brazil,[38] and with increased decision-making at the lowest administrative level, in India.[46] The national utility in Uganda was associated with more reliable service delivery compared to other providers, due to its greater maturity, performance and size which supported more robust financial systems.[36] Reduced service quality over ten years was associated with a lack of system

maintenance and indicated by 50% rate of non-functionality across a rural parish in Uganda.[34] Water quality improvements were associated with implementation of water safety plans in Bangladesh[41] and with community monitoring programmes in Mexico.[31]

Longer term system outcomes

Sustainability and resilience outcomes were recorded in three high-quality studies. In Mozambique, a capacity building intervention resulted in small scale replication of peer-learned practices regarding approaches to sanitation resilience by using locally available materials to improved technology options and pit linings.[43] In India, the transparency of rural water and sanitation committee operations was associated with community belief in the long-term sustainability of the system.[45] In Bolivia, water metering reportedly had a positive impact on system maintenance, as households were inclined to fix leaks and other issues quickly, although affordability concerns were also reported.[32] Notably, all three studies recording sustainability outcomes were assessed as high quality, suggesting the scarcity of longer-term findings reflects evaluation capacity and follow-up duration as much as an absence of effect.

Distal outcomes

Distal population-level outcomes were rarely reported. In India, sewerage reforms did not reduce socioeconomic inequalities in access, since only houses assessed for property taxes had access to the underground sewer scheme.[30] In Bolivia, only 23.5% of the town's population were able to afford the price of metered water on a consistent basis. Water metering was associated with affordability constraints, particularly for households with large families or tenants. Furthermore, households who could not afford sufficient water from the piped system to meet their needs often returned to using river water.[32] In Brazil, national legislative reform strengthened governance, financing, and service delivery. This reform was associated with increased sector investment and expansion of services, alongside a reported 7% reduction in under-one child mortality following post-reform.[39]

DISCUSSION

Findings from this systematic review of the academic literature on WASH-SS in LMICs indicate that, despite growing discourse and investment in systems strengthening, the evidence base remains limited. Only 17 studies met the inclusion criteria of detailing a WASH systems intervention and reporting clear outcomes. Study quality varied from low to very high. Evidence was unevenly distributed along the conceptual logic model, with the greatest distribution of outcomes remaining at the early levels of process- and systems-outputs and intermediate outcomes, while distal health and socioeconomic outcomes were rare. This pattern mirrors findings from health systems strengthening research which has long recognised that strengthening institutions, governance and financing often produces diffuse and delayed effects.[21] Evidence of system strengthening in any sector can be difficult to attribute using conventional evaluation designs[20], where long causal pathways, context dependency and interacting reforms complicate evaluation.[47]

Outcomes as neutral changes

Recorded outcomes from WASH-SS were not inherently positive but had ranging effects on the actors and factors involved in the system. Most studies demonstrated early changes but did not trace these through to outcomes at the population level. For example, process-level outputs showed greater amounts of data generated and the introduction of new planning or monitoring mechanisms.[33,38,45] Two studies of interventions closely aligned to pre-existing national programmes indicated the potential for subsequent changes in resource allocation and targeting areas in need of greater support.[37,42]

The set of intermediate outcomes demonstrated changes to WASH governance, financing, political and participation processes. Two studies found a relationship between water user committees and mobilisation of household payments in community-managed systems.[34,46] Yet another study comparatively analysed the performance of different service delivery models and attributed the lowest performance with community-managed systems.[36] This demonstrated that while one type of intervention (e.g. water user committees) may have proximal outcomes that indicate positive change, the potential for longer-term outcomes such as increased coverage, sustainability and resilience is not assured.

Domestic-driven reforms

Across the included studies, there were notable differences between interventions driven by domestic actors and those driven by external actors. Six interventions were domestically driven, with three recording later-stage outcomes. Two high-quality studies on national reform showed evidence of longer-term outcomes at service delivery and distal health levels.[36,39] As seen in Uganda and Brazil, institutionally embedded reforms and changes to WASH governance occurred through professionalising service delivery and clarifying roles and responsibilities of service providers. Another domestically driven reform was studied in India, where new multi-stakeholder arrangements enabled greater funding to enter the sanitation sector.[30] However, this initiative did not reduce socioeconomic disparities among service users, but instead reinforced patterns of exclusion due to a lack of formal recognition of certain groups.[30] Both examples consistent with health systems strengthening literature, which argues that domestic ownership and institutional embeddedness are preconditions for sustained change: external actors can catalyse reform, but durable outcomes depend on whether changes are absorbed into national structures, financing flows, and political commitments.[20,22]

Similarly, a water metering scheme in Bolivia excluded renters from the user committee and produced affordability constraints that drove poorer households back to unsafe sources.[32] These two studies highlight that systems strengthening interventions do not automatically produce more equitable outcomes. They also reflect analysis of GLAAS data which found that improved sector governance at national level does not automatically translate into service improvements for the poorest and most marginalised, who require targeted policy attention and financing.[15] Included papers indicate that socioeconomic equity requires active targeting[37] and written terms into scheme agreements[30,35]. Gender programming literature conceptualises the extent to which WASH interventions can support more equitable gender-relations, often using scales such as from gender blind, or unequal, to gender aware.[49], where only the latter actively challenges unequal power structures rather than accommodating or ignoring them.

Nine studies recorded interventions driven by partnerships between domestic and external actors. Of those recording later-stage outcomes, external actors set the price of water too high in Bolivia,[32] and ongoing resourcing after projects ended was a concern in Bangladesh and Mexico.[31,41] In Uganda, high rates of non-functionality were recorded 10 years following a project carried out by local and international university and NGO partners.[34] A suite of WaterAid partnered programmes found that informing people of human rights had potential for longer-term impacts through citizen advocacy for improved services.[35]

Limitations of the evidence base

The body of evidence identified by this review is small, but comprised of 17 studies with diverse designs, contexts, intervention types and outcomes. Most studies used qualitative or mixed methods approaches, constraining causal attribution and limiting comparability across cases. Distal outcomes, including health, socioeconomic equity and resilience impacts were rarely measured, and few studies explicitly articulated theory-driven pathways across WASH system building blocks. The limited number of capacity building interventions and human resource development, despite their prominence in practice, points to a documentation gap in the peer-reviewed literature.[43] Sanitation systems strengthening is underrepresented in the evidence base, with most studies focused on water supply interventions.

Restricting inclusion to peer-reviewed literature was an intentional strategy to identify high-quality evidence, but it also led to the exclusion of relevant grey literature[26] and other academic work that did not meet all inclusion criteria[50]. The review approach may have excluded relevant peer-reviewed literature that did not use WASH-SS or intervention terminology, particularly domestically driven reforms creating incremental, complex and longer-term change. Additionally, the use of contribution analysis in evaluating outcomes from WASH-SS interventions was beyond the scope of this review but is an important area of future research. These limitations reflect both the early stage of evaluating work in WASH systems strengthening and broader methodological challenges inherent to evaluating complex systems change. It is notable that the three studies recording longer-term outcomes were all assessed as high quality. The absence of distal outcomes is likely to reflect both short follow-up periods and a genuine gap in evaluation design, rather than evidence that WASH-SS does not produce such effects. This further builds the case for applying theory-informed, longitudinal, and mixed-method evaluation approaches capable of capturing feedback dynamics and intuitional evolution through the results chain.

CONCLUSIONS

This study synthesised the peer-reviewed evidence on distinct outcomes of WASH-SS efforts. Building on prior work, we establish the current state of knowledge on the outcomes of WASH system strengthening, plotting outcomes along a conceptual logic model. Early-stage changes were most common, with longer-term outcomes rarely reported and more challenging to attribute directly to interventions due to the complex and diffuse nature of systems change.

An important signal from this review is that embedded, domestically driven reforms are more closely associated with sustained, long-term outcomes. Notably, the three domestic reforms were able to leverage substantial financing from private and public sources.[30,36,39] Building on this, the evidence also shows that equitable service provision cannot be assumed as a co-benefit of stronger WASH systems, with both positive and negative outcomes reported for some interventions.[30,32]

The small and methodologically heterogeneous evidence base is itself a notable finding, reflecting both the early stage of formal research into WASH-SS and the difficulty of evaluating complex interventions against multifactorial outcomes. This points to the need for greater investment in theory-informed, longitudinal evaluation to underpin the growing discourse around WASH-SS with robust evidence. A promising route for building such approach could be developing the replicable logic model for classifying WASH-SS outcomes which was developed as part of this review. Taken together, these insights highlight both the progress to date and the substantial work still required to understand what truly drives lasting, equitable WASH systems change.

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Figures

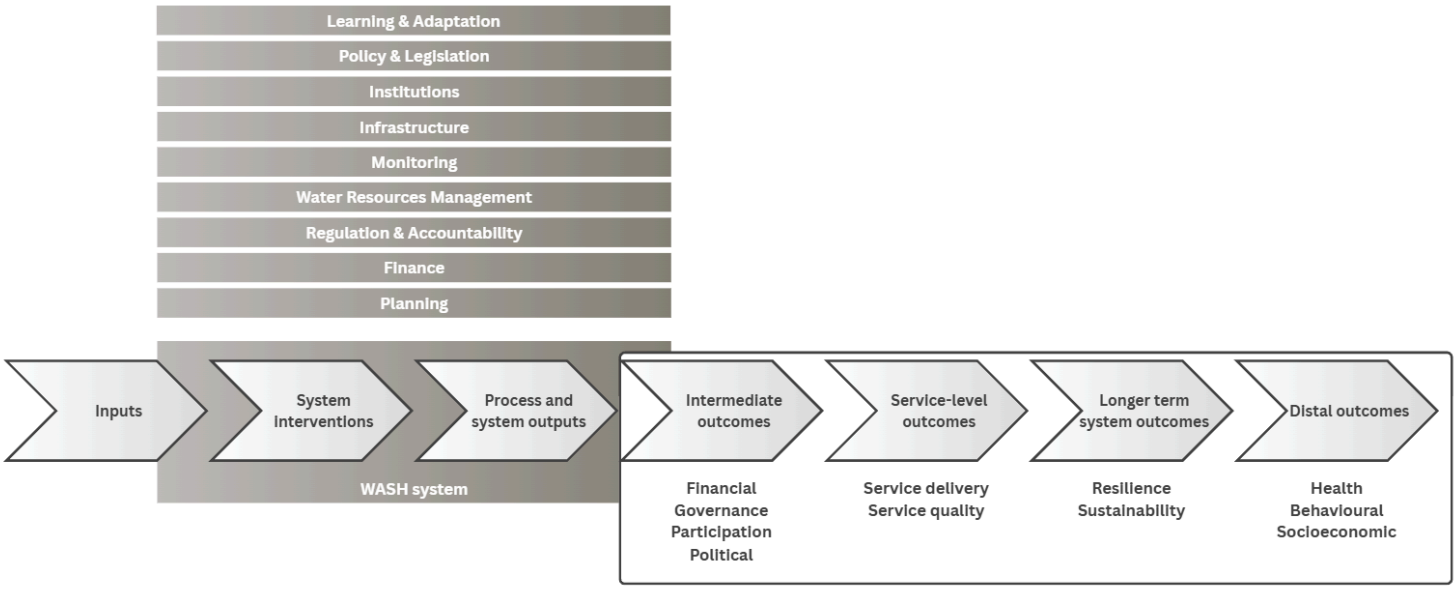


Figure 1

Conceptual logic model of WASH systems strengthening interventions and the process of measuring outcomes. Adapted from WASH systems building blocks and results chain.[3,26]

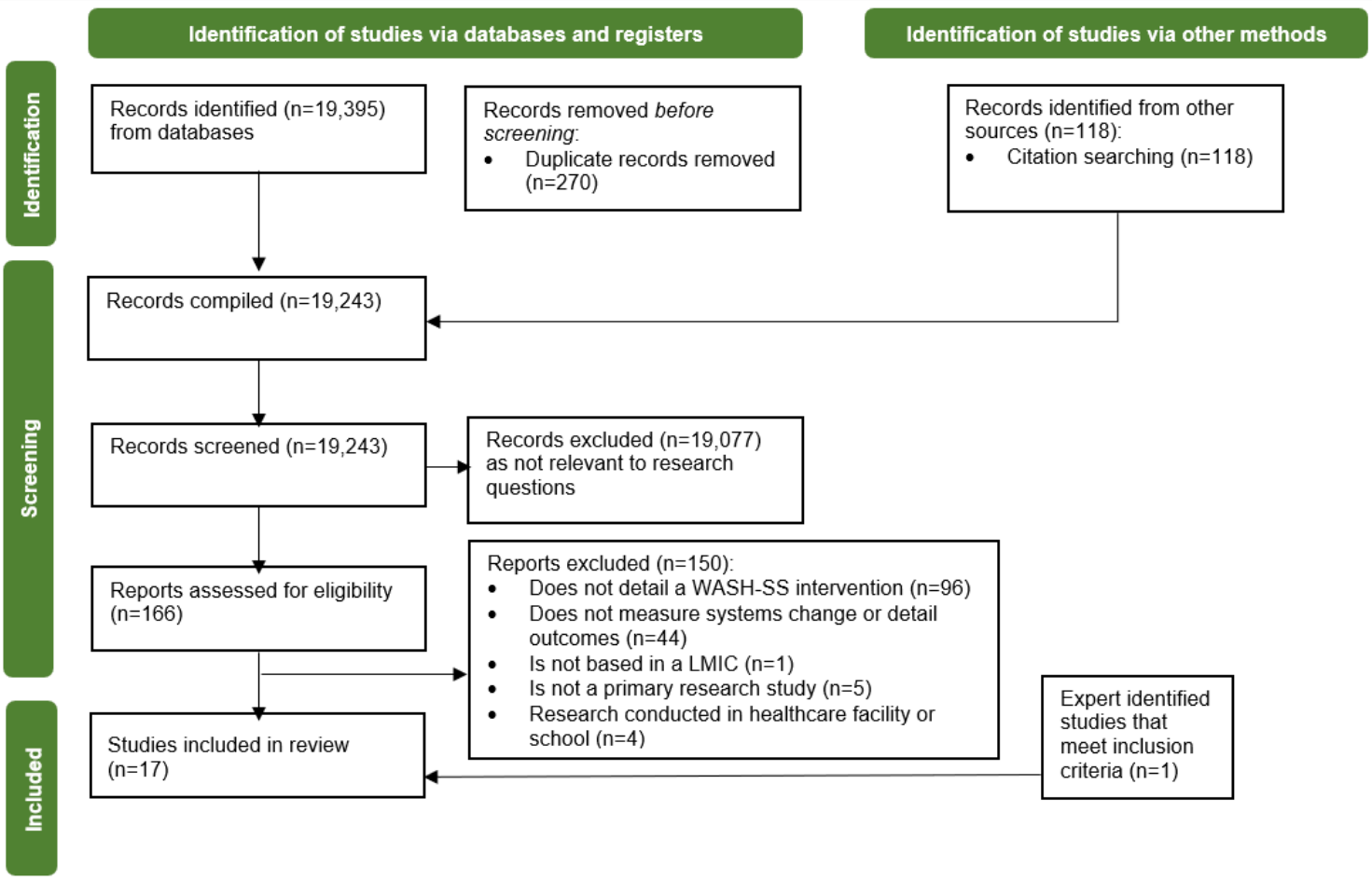


Figure 2

PRISMA flow diagram of included studies

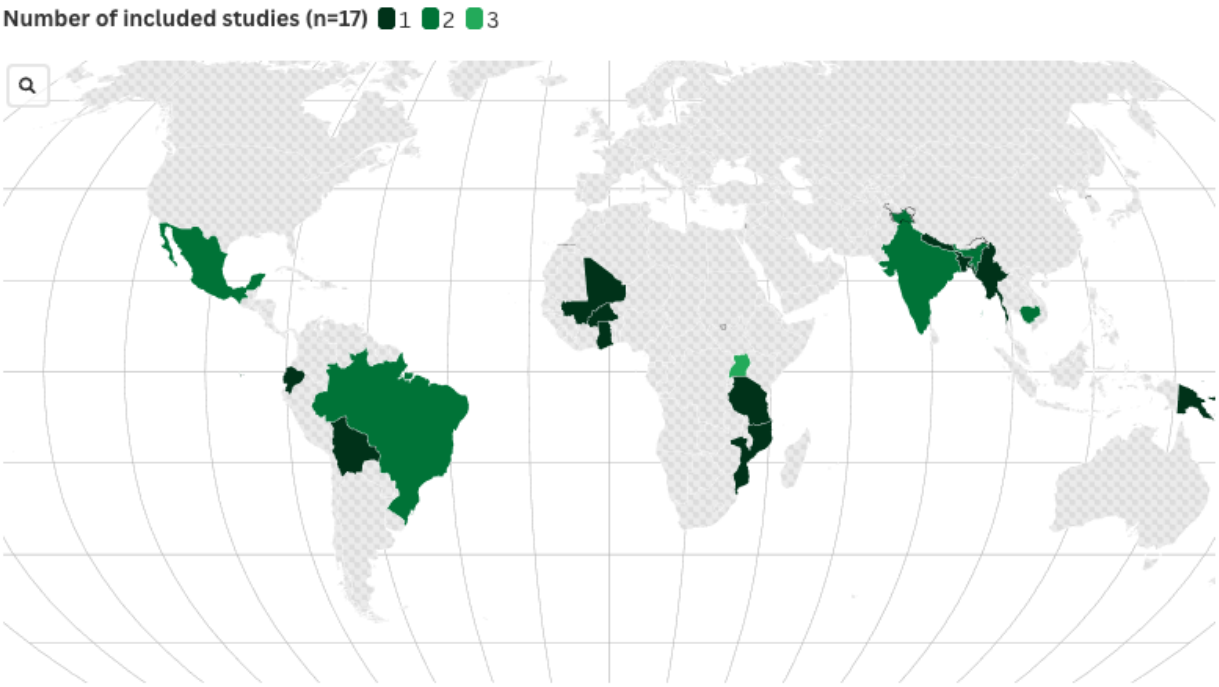


Figure 3

Geographical distribution of included studies

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- S1DataExtractionTableWASHSSSR.xlsx
- S2QualityAppraisalScoresWASHSSSR.docx