Official Journal of the World Water Council
Water Policy

Water Policy Vol 24 No 6, 1073 doi: 10.2166/wp.2022.079

Water and sanitation services in India and Ghana: an assessment of implications for rural health and related SDGs

Martin Kofi Kanyagui [a,*] and P. K. Viswanathan [b]

[a] Amrita School for Sustainable Development, Amrita Vishwa Vidyapeetham, Amritapuri, India
[b] Amrita School of Business, Amrita Vishwa Vidyapeetham, Amritapuri, India
*Corresponding author. E-mail: martinkanyagui@gmail.com

MKK, 0000-0002-6107-8878; PKV, 0000-0002-1064-5051

ABSTRACT

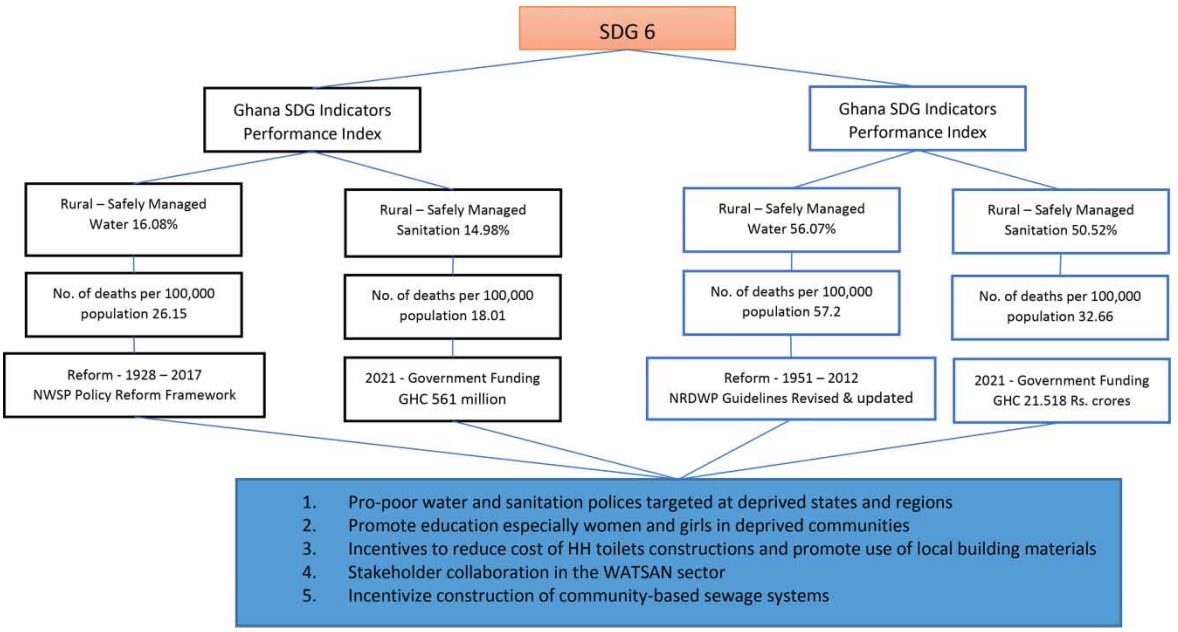
Provisioning of water and sanitation services has become one of the key determinants of SDGs. This review focuses on the trends in water and sanitation services and reforms in India and Ghana over the last two decades. The findings reveal that access to water has improved in India and Ghana at 81.5 and 92.7%, respectively. However, access to sanitation continues to be a challenge in both countries, with the currently reported coverage being 59.5% and 18.5%, respectively. The index of sustainable development goal (SDG) performance of Ghana and India stands at 65.4 and 61.9 with global rankings of 100 and 117, respectively. The adverse impacts of poor access to sanitation increasingly reflect on rising numbers of population suffering from water-borne diseases. From the policy perspective, the paper highlights the need for framing pro-poor water and sanitation policies; focusing on women and girls' education; promoting affordable water and sanitation services; promoting collaboration of stakeholders involved in the rural water and sanitation sectors; and increasing budgetary allocations by local governments.

Key words: India, Ghana, Rural health, SDGs, Water and sanitation, Water delivery services

HIGHLIGHTS

- The review compares the water and sanitation situation in India and Ghana. The urban–rural situation in the two countries is compared to ascertain the similarities and differences.
- The review also compares the various reforms in the two countries in the water and sanitation sectors and the lessons learned.
- Policy implications and recommendations have been made to enhance the achievement of SDG6 targets by 2030.

GRAPHICAL ABSTRACT



1. INTRODUCTION

Water and sanitation are critical for the sustenance of life, and their contamination and scarcity or absence has adverse implications on health and livelihood outcomes (Omotayo *et al.*, 2021). UN data show that freshwater on the planet is abundant and sufficient to meet human needs (WHO/UN, 2017; United Nations, 2018). Yet, access to water resources continues to be a global challenge (WHO/UN, 2017; United Nations, 2018). One of the factors accounting for the crisis in water access is the global climate change, which has increased the demand for water manifold and also made it difficult for farmers to predict weather patterns for farming purposes. This has led to overexploitation of underground water resources (Liu *et al.*, 2017; Tfwala *et al.*, 2021) and subsequent shortage or deterioration in the quality of available water. The implications of these are that many children and vulnerable people consume contaminated water and eventually die due to water-borne diseases, especially in sustainable areas. Hence, availability and access to water has a direct bearing on sanitation with positive outcomes on health and livelihoods (UN, 2017). Also, reliable, sufficient, and sustainable supply of drinking water is one of the keys to global sustainable development (Sinha & Chaudhry, 2019). Therefore, the global community has committed time and resources to meet water and sanitation targets by 2030 (UNCG & CSO, 2017).

Globally, it is estimated that access to drinking water and sanitation services has doubled. It increased from 315 million in 2017 to 700 million in 2020. More than 23 countries have witnessed a reduction in open defecation rates below 1% during the same period (WHO/UNICEF, 2019). Despite these positive outcomes, many people, especially in developing countries, continue to die of water-borne diseases (Prüss-Üstün *et al.*, 2014). A majority of the victims live in rural areas, while most urban centers are provided with better water and sanitation facilities (Baur & Woodhouse, 2009; WHO/UN, 2017; United Nations, 2018).

1.1. Context of the study

There is ample evidence from research on the impact of an efficient water and sanitation delivery system on sustainable development, as revealed by several studies carried out assessing water and sanitation services across countries. Studies have also focused on the performance of water and sanitation services at the national, regional, as well as local contexts in many countries. However, there is a dearth of research in terms of international comparisons of key indicators of water and sanitation, including levels of service delivery, types of services available, funding, and policy reforms. In this regard, this review assesses the approaches that India and Ghana have adopted over past decades in their efforts to achieve sustainable water and sanitation services targets in a comparative perspective. As the two countries are from different continents, Asia and Africa respectively, where water and sanitation services need significant improvements, the findings, lessons, and policy implications emerging from the study are very crucial for both, besides helping the other developing nations design appropriate strategies and actions toward achieving the sustainable development goal (SDG)6 targets by 2030.

1.2. Objectives, data and methodology

This paper addresses the following objectives:

- To undertake an assessment of the rural water and sanitation situations in a historic context and health implications in India and Ghana in a comparative perspective;
- To attempt a review of the evolution of national water and sanitation policies and reforms in the two countries;
- To examine the status of national expenditure and investments in achieving improved quality of water and sanitation services and their alignment with SDGs in the two countries; and
- To discuss the key learnings and suggest policy imperatives emerging from the study.

The paper relies on secondary data from WHO/UNICEF JMP, Global Burden of Disease Collaborative Network, UN Statistics, and Ghana Health Service. A literature analysis is also done by collating the appropriate literature published in peer-reviewed journals and publications, including government reports and policy documents pertaining to the two countries.

An analysis of the literature was carried out using the scientific database (Scopus), Google scholar, and papers published on the subject were gathered. The search focused on the theme, 'safe water and sanitation services' impact on health in rural communities in India and Ghana.' The keywords used for literature search included 'water and sanitation services,' 'water and sanitation effect on health,' 'government reforms in water and sanitation services,' and 'financing water and sanitation.' Some of the studies relied upon were documents that contained information on the provision of water and sanitation services, especially in India and Ghana, governmental progress on SDG6, and the impact on health. Furthermore, the analysis also involved reviewing the cross-references of the articles relied upon in the analysis.

2. RURAL WATER AND SANITATION CONDITIONS IN GHANA AND INDIA: A COMPARISON

2.1. Key social indicators of India and Ghana

Even though India and Ghana differ in terms of geophysical features and population size, their socioeconomic characteristics are similar. This forms the basis for selecting the two countries for the purposes of this review.

India's total population is estimated to be 1,403 billion in 2022 with 65.53% being rural-based, most of whom are poor and lack basic services to sustain their livelihood (Himanshu *et al.*, 2013; UN, 2022). Ghana, on the other hand, has a total estimated population of 30.8 million, of which almost 43% are rural-based, and a vast majority of them do not have access to basic water and sanitation services, leading to serious implications on their livelihoods (Ghana Statistical Service, 2018).

2.2. Water delivery services in India and Ghana

Access to improved sources of drinking water includes water provided directly in homes, yards, and plots through the pipe system, community water points or standpipes, tube well, hand-dug wells, springs, and rainwater harvesting. Water is considered to be safe and affordable when it is provided directly in homes, always available with an acceptable quality (WHO/UNICEF JMP, 2019).

Generally, there has been an improvement in access to drinking water in the two countries over the last 5 years. Access to basic and self-managed drinking water increased from 80.5 to 90.5% and 63.8 to 85.8% in India and Ghana, respectively (WHO/UNICEF JMP (2020), washdata.org/data). The level of access within both countries differs in terms of state/region, as shown in Figures 1 and 2.

2.2.1. State/regional situations of access to water and sanitation services in Ghana and India

Figure 2 shows that generally access to water in regions in Ghana is good, except in the Northern region, which stands at 50%, and in the Volta region, which stands at 59%. However, the sanitation scenario in all regions is far below SDG targets, with the Northern, Upper East, Upper West, and Volta presenting the worst situations. It is worth noting that the least-performing regions for sanitation are the same for water as well.

In the case of India, as of today, all states are doing relatively better than before in terms of access to basic water services. The sanitation situation is also good across states/union territories (UTs), except across Ladakh and Bihar, with less than 50% of the population having access to sanitation. Among the various states, it is evident that sanitation service is higher than that of water in Meghalaya and Lakshadweep. Cultural factors contribute significantly to this result. It is also important to note that the water supply figures reported refer to the formal Public Water Services (PWS) and does not cover the self-provisioning by households in these states. Figures 3 and 4 further compare the access to water services in rural and urban communities in Ghana and India, respectively.

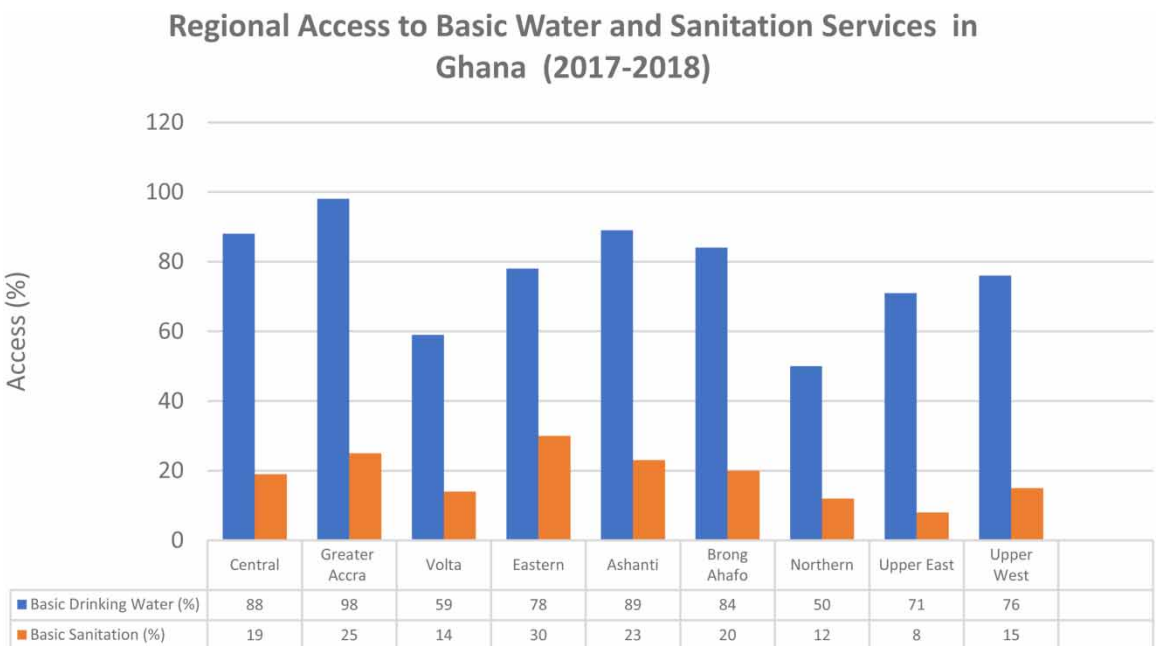
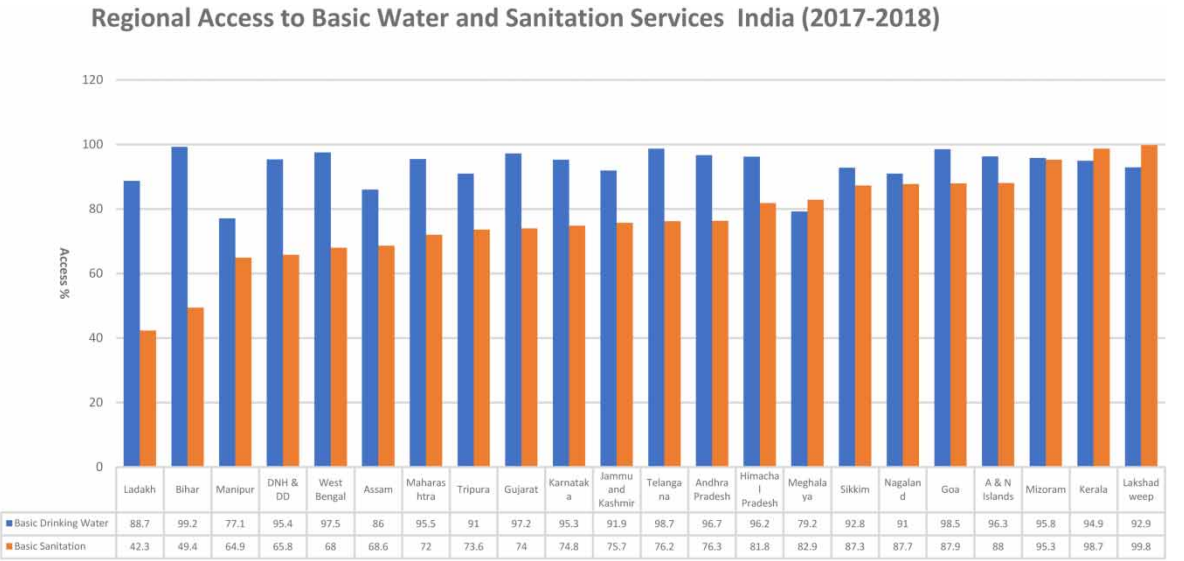


Fig. 1 | Regional access to basic water and sanitation services in Ghana. *Source*: Ghana (GSS, 2018, MICS 2017–2018).

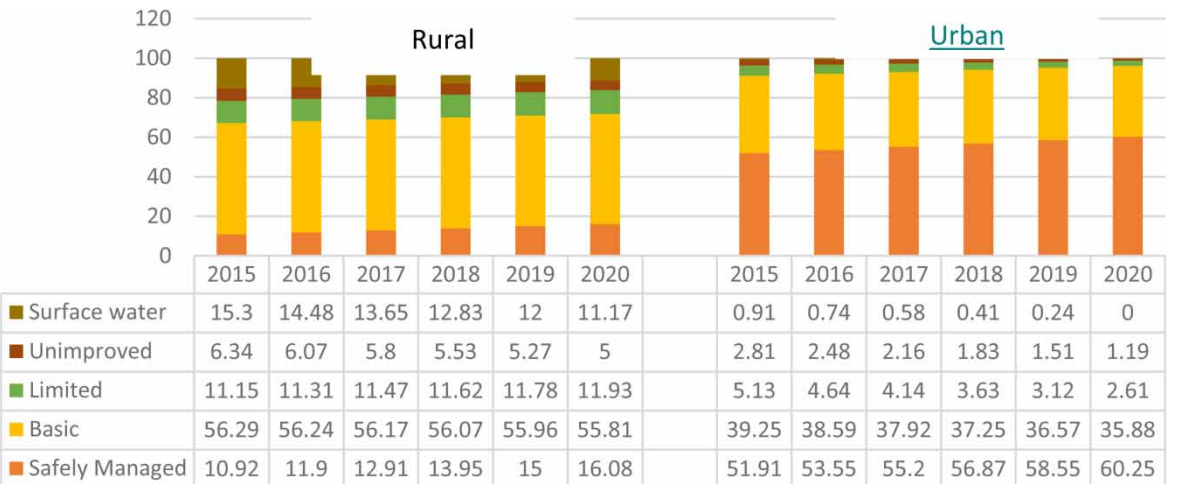


	Ladakh	Bihar	Manipur	DNH & DD	West Bengal	Assam	Maharashtra	Tripura	Gujarat	Karnataka	Jammu and Kashmir	Telangana	Andhra Pradesh	Himachal Pradesh	Meghalaya	Sikkim	Nagaland	Goa	A & N Islands	Mizoram	Kerala	Lakshadweep
Basic Drinking Water	88.7	99.2	77.1	95.4	97.5	86	95.5	91	97.2	95.3	91.9	98.7	96.7	96.2	79.2	92.8	91	98.5	96.3	95.8	94.9	92.9
Basic Sanitation	42.3	49.4	64.9	65.8	68	68.6	72	73.6	74	74.8	75.7	76.2	76.3	81.8	82.9	87.3	87.7	87.9	88	95.3	98.7	99.8

Fig. 2 | State access to basic water and sanitation services in India. *Source*: NFHS-5, 2019–2020.

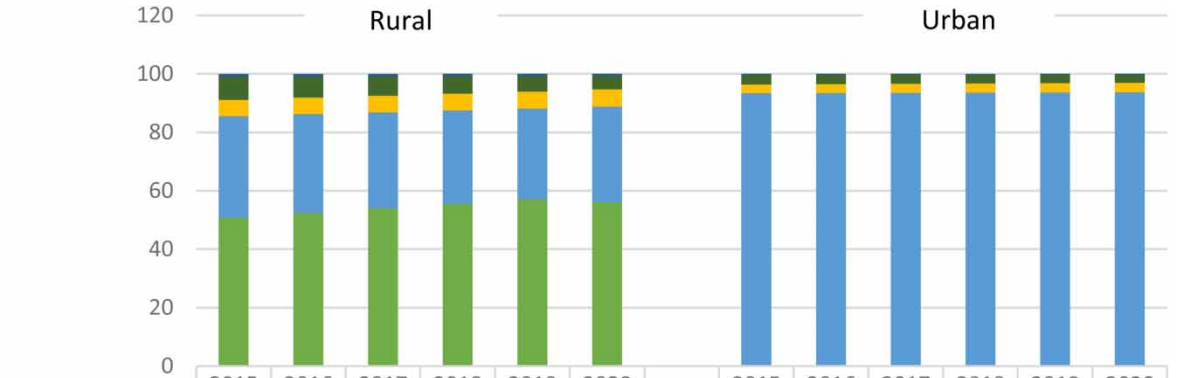
2.2.2. Access to water services in rural Ghana and India

Apparently, the extent of improvement in water service delivery varies between urban and rural areas in Ghana and India. In 2020, Ghana and India recorded 71.8 and 88.14% in rural areas and 96.13 and 93% in urban areas, respectively. It is also notable that there was a reduction in the percentage of piped water as compared to non-piped water in both countries. In India, for instance, non-piped water supply increased from 39% in 2000 to 51% in 2020, while piped water supply declined marginally from 44.40 to 43.69% within the same period. In the case of Ghana, while non-piped water supply increased from 33.29 to 57.67%, piped water supply reduced from 40.52 to 34.70% during the same period (WHO/UNICEF JMP (2020), washdata.org/data). This indicates that despite



	Rural 2015	Rural 2016	Rural 2017	Rural 2018	Rural 2019	Rural 2020	Urban 2015	Urban 2016	Urban 2017	Urban 2018	Urban 2019	Urban 2020
Surface water	15.3	14.48	13.65	12.83	12	11.17	0.91	0.74	0.58	0.41	0.24	0
Unimproved	6.34	6.07	5.8	5.53	5.27	5	2.81	2.48	2.16	1.83	1.51	1.19
Limited	11.15	11.31	11.47	11.62	11.78	11.93	5.13	4.64	4.14	3.63	3.12	2.61
Basic	56.29	56.24	56.17	56.07	55.96	55.81	39.25	38.59	37.92	37.25	36.57	35.88
Safely Managed	10.92	11.9	12.91	13.95	15	16.08	51.91	53.55	55.2	56.87	58.55	60.25

Fig. 3 | Rural and urban supply of water services in Ghana. *Source*: JMP (washdata.org).



	2015	2016	2017	2018	2019	2020		2015	2016	2017	2018	2019	2020
Surface water	1	0.95	0.9	0.85	0.79	0.74		0.25	0.25	0.24	0.24	0.24	0.24
Unimproved	7.88	7.22	6.56	5.9	5.24	4.58		3.41	3.28	3.17	3.05	2.94	2.82
Limited	5.54	5.61	5.68	5.76	5.83	5.9		2.95	3.01	3.08	3.14	3.21	3.27
Basic	34.82	33.88	32.92	31.95	31.03	32.71		93.4	93.46	93.51	93.56	93.62	93.67
Safely Managed	50.75	52.33	53.93	55.55	57.11	56.07		0	0	0	0	0	0

Fig. 4 | Rural and urban supply of water services in India. *Source*: JMP (washdata.org).

the increase in non-piped water supply, the level of investment in the sector in both countries has not matched the level of water demand and supply.

According to Agapitova *et al.* (2017), access to potable water in rural India remains constrained, and Kumar *et al.* (2021) identify these constraints as caused by three key factors, namely (a) the inability of households to access water due to poverty; (b) the poor quality of water supplied, because it is untreated; and (c) the unreliability of water sources throughout the year. Although the national government has taken several steps to address the gap between demand and supply, the challenge still exists (Lalitha & Siromony, 2014). The lack of very strong institutional frameworks and inadequate financing are seen as factors constraining the task of providing improved access to water (Sridhar & Reddy, 2018). The overdependence on ground water for multiple uses, including for irrigation and household use, is becoming unsustainable due to the high level of contamination by various chemical contaminants (Kumar *et al.*, 2021). Furthermore, there is evidence of depletion of underground water due to over exploitation for irrigation, as was observed by Bahinipati & Viswanathan (2019) in the state of Gujarat as well as others. Narendran *et al.* (2017) note that apart from the fast depletion of underground water in India, the increasing food requirements (local and outside) further aggravates the overextraction of groundwater for agricultural purposes. One way to resolve the water scarcity situation for food production in particular, is by using water saving technologies, such as sprinkler and drip irrigation, which help reduce drinking water shortage or any other competing water demands (Bahinipati & Viswanathan, 2019).

There is also evidence that certain marginalized groups do not have equal access to potable water in India (Singh, 2009). For instance, people of lower castes are often deprived of good water facilities and are prevented from accessing them (Singh, 2009). Water quality is yet another challenge. It is estimated that, out of the 1.42 million villages in India, 195,813 villages rely on contaminated water sources, such as boreholes and wells, as most of these sources are contaminated by fertilizers used by farmers, septic tanks, and sewage tanks (Lalitha & Siromony, 2014, Ridzuan, 2021). Some of the states experiencing groundwater contamination include

Maharashtra, Punjab, and Tamil Nadu, where water contains considerable traces of nitrates (Ministry of Water Resources, India, 2014).

In 2011, the National Rural Drinking Water Program (NRDWP) was launched, which achieved a coverage of 78% households with a water supply of 40 liters per capita per day (LPCD). Through this program, communities could access grants to construct water schemes, rainwater harvesting, and groundwater measures (MoF, 2018). In 2017, the NRDWP was restructured to fund water projects at advanced stages of completion (MoF, 2018). The National Water Quality Sub Mission (NWQSM) was also constituted to tackle the problem of quality with a special focus on marginalized groups such as low castes. Under this mission, 22% of the budget was allocated to scheduled castes (SCs) and 10% to scheduled tribes (STs) (Ministry of Drinking Water & Sanitation, 2017).

In 2018, the Government of India launched the Swajal Project aimed at empowering village communities by involving women and other socially disadvantaged members of rural villages through water services provision and management (MoF, 2018). However, Cronk & Bartram (2018a) notes that due to the unique cultural setting of India, women participation in Rural Water Supply Services (RWSS) projects has not been feasible but rather tokenistic, which adversely affects the sustainability of such interventions as women are directly impacted by such interventions. Transforming the RWSS system to be gender-responsive requires behavioral and cultural changes in India, which needs to be supported by context-specific policy measures (Sinha & Chaudhry, 2019). Furthermore, the NRDWP, a major initiative by the government, has been successful in raising the level of access to potable water (40 LPCD) to rural households to the extent of 81.07%, with 16% having partial access by 2022. The government also aims to ensure piped water connection to all by 2024 under the recently launched Jal Jeevan Mission (UN, 2020).

In Ghana, there exists a disparity between urban and rural access to water, even though much progress has been achieved on this front (GSS, 2018). It is observed that if the current progress in the water sector is sustained, Ghana will be well placed to achieve SDG6 by 2030 (Monney & Antwi-Agyei, 2018). However, challenges remain in the water sector, unreliable supply, water losses due to damage of the pipe network, which is not repaired on time, and low water pressure, thus making it difficult for water to reach all rural communities. Other problems include poor water quality due to poor monitoring and high water tariffs due to technical issues with water meters. In the light of these challenges, the government widened the scope of the operation of the Community Water and Sanitation Agency (CWSA) to include the management of piped water systems. This initiative was operationalized through the establishment of the National Community Water and Sanitation Policy Reform Framework (NCWSPRF) in 2018. Through this initiative, 89 water systems in small towns are now managed by the CWSA across the country, and the government has invested in these water systems to improve their performance to achieve optimum operational efficiency (CWSA, 2018).

2.3. Sanitation services in India and Ghana

Sanitation means different things to different people, but generally, it can be referred to as providing the facilities and services that make it possible to safely dispose of human urine, feces, and waste (Fewtrell *et al.*, 2005).

The SDG Indicator 6.2 focuses on ending open defecation by 2030 by ensuring that women and girls especially and other vulnerable groups get equitable access to better sanitation and hygiene (UN, 2017). In what follows, we discuss some of the important aspects of safely managed sanitation services in India and Ghana.

Figure 5(a) shows that the southern regions of Ghana have better access to sanitation services, while open defecation is more prevalent in the Northern regions. However, in India, access to basic sanitation is good in most states, except in a number of districts that lag behind their state counterparts, including Gujarat, Karnataka, Bihar, Northern and Western parts of Maharashtra, and West Bengal.

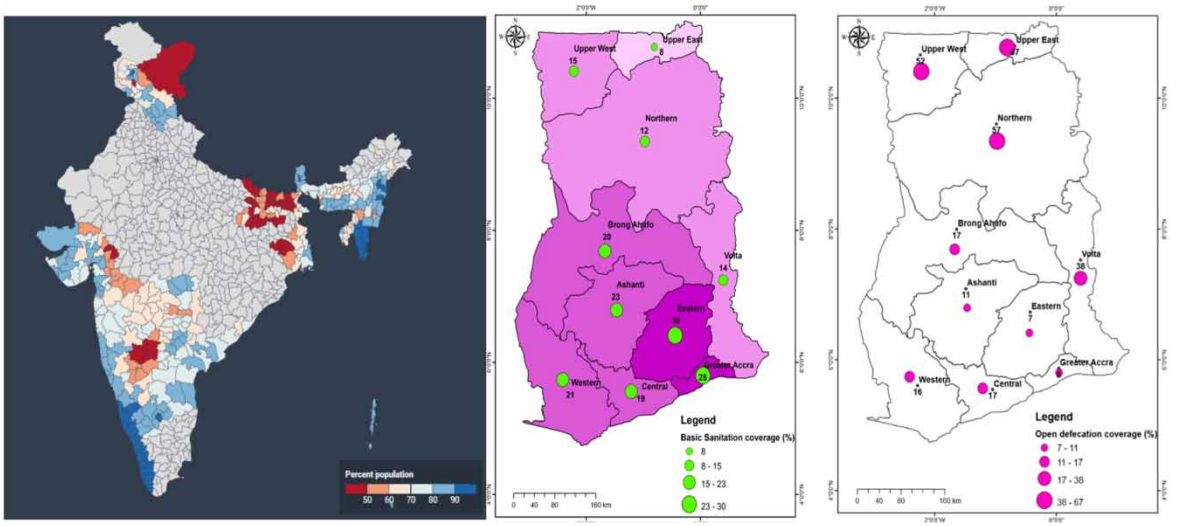


Fig. 5 | Region/state-wise sanitation services coverage in India and Ghana. (a) Spatial distribution of basic sanitation coverage and open defecation in Ghana (*Source*: adapted from GSS, 2018). (b) People living in households that use an improved sanitation facility in the districts of India, 2019–2020 (%) NFHS-5 (*Source*: NFHS-5 Phase-I, 2019–2020).

2.3.1. Sanitation services in Ghana

The progress toward achieving sanitation targets as defined in SDG6 has been slow and limited in Ghana. The percentage of self-managed sanitation services increased from 4.37 to 13.32%, while open defecation reduced from 21.67 to 17.78% between 2000 and 2020. Access to basic sanitation increased from 3.04 to 10.38%. There was no treatment of fecal waste in the country (WHO/UNICEF JMP, 2020, washdata.org/data). Figure 6 provides a comparative assessment of the urban and rural sanitation scenarios in Ghana.

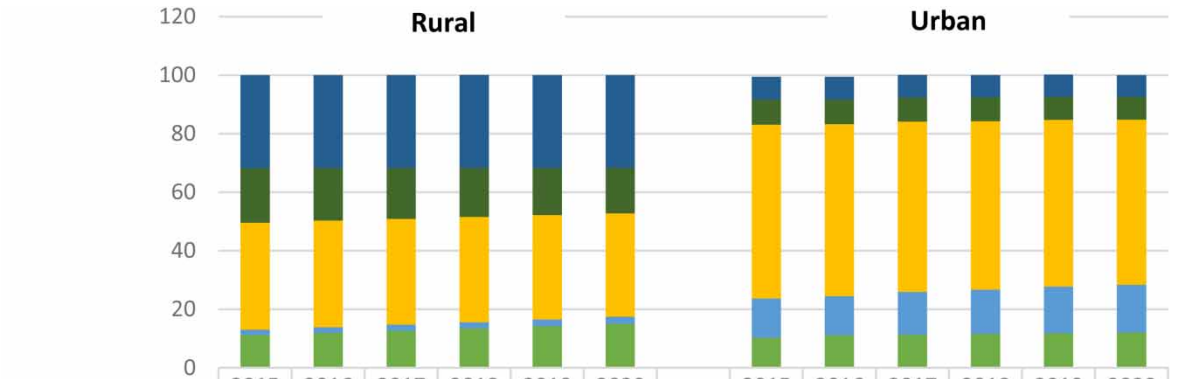
On the other hand, India has a positive trajectory to show in the sanitation sector, even though rural areas are still lagging behind the urban areas in this basic need. Nationally, the percentage of households with self-managed sanitation services increased from 6.58 to 45.91%, while open defecation significantly reduced from 74 to 14.93% between 2000 and 2020. In 2020, 3.69% of fecal waste was treated (WHO/UNICEF JMP, 2020, washdata.org/data). Table 1 provides details of sanitation services in urban and rural India.

2.3.2. Sanitation services in India

While the percentage of rural dwellers practicing open defecation was 31% in Ghana in the 20-year period, India's rural population indulging in this practice dropped from 39 to 22% during the above period. The percentage of rural dwellers relying on safely managed toilet facilities in Ghana increased over the review period from 11.2% in 2015 to 14.98% in 2020. India, on the other hand, experienced an increase from 30.82% in 2015 to 50.52% in 2020 in this aspect.

2.3.3. Types of sanitation facilities in India and Ghana

An improved sanitation service comprises a flush to a piped sewer system, a functioning septic tank, a pit latrine fitted with a slab, and a composting toilet (World Health Organization and UNICEF, 2013). Accordingly, Figure 8 provides information on the types of facilities utilized in India and Ghana.



	Rural						Urban					
	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
Open Defecation	31.67	31.66	31.65	31.64	31.62	31.61	7.79	7.73	7.67	7.61	7.55	7.49
Unimproved	18.71	18.08	17.45	16.83	16.2	15.57	8.6	8.43	8.26	8.08	7.91	7.74
Limited	36.58	36.38	36.16	35.92	35.67	35.39	59.41	58.82	58.22	57.62	57.01	56.4
Basic	1.84	1.95	2.07	2.19	2.31	2.44	13.37	13.39	14.51	15.09	15.86	16.28
Safely Managed	11.2	11.93	12.67	13.43	14.2	14.98	10.3	11.09	11.37	11.6	11.85	12.09

Fig. 6 | Rural and urban sanitation services in Ghana. *Source*: JMP (washdata.org).

Table 1 | Performance of India and Ghana on SDG6-related sub-indicators.

SDG6 indicators	LMIC	Ghana	India
Access to basic water services, 2017 (%)	88.1	81.5	92.7
Access to basic sanitation services, 2017 (%)	59.8	18.5	59.5
Percentage of available freshwater resources (LMICs – 2015, Ghana – 2015, India – 2010)	54.7	6.1	66.5
Anthropogenic wastewater treatment, 2018 (%)	3.6	0.0	2.2
Embodiment of scarce water consumption in import, 2013 (m^3/capita)	2.1	0.7	2.9

Source: Sachs *et al.* (2020).

Generally, a majority of households in Ghana rely on public latrines, and this has remained so for the last two decades. The use of septic tank facilities has, however, increased over the years in line with the government policy of promoting household toilets. Even though Ghana has committed to achieving universal access to sanitation by 2030, open defecation is still on the higher side in the rural areas (GSS, 2018; Monney & Antwi-Agyei, 2018; Water Aid, 2021). A recent study by Yeboah *et al.* (2022) on the quality of drinking water and health risk assessment of intake and point-of-use water sources in Tano North Municipality in the Tano South district Ghana revealed increased water contamination due to poor sanitation leading to incidence of water-borne diseases. For Ghana to achieve SDG6, the government needs to be innovative in its approaches to resolving the sanitation issue in the rural areas (Alhassan, 2018). In this regard, the government's National Environmental Sanitation Strategy and Action Plan (NESSAP, 2010–15) implemented the Community-Led Total Sanitation (CLTS) program. Through this program, 212 out of 333 communities stopped practicing open defecation and constructed household toilet facilities using local materials that were both accessible and cost-effective. The intervention

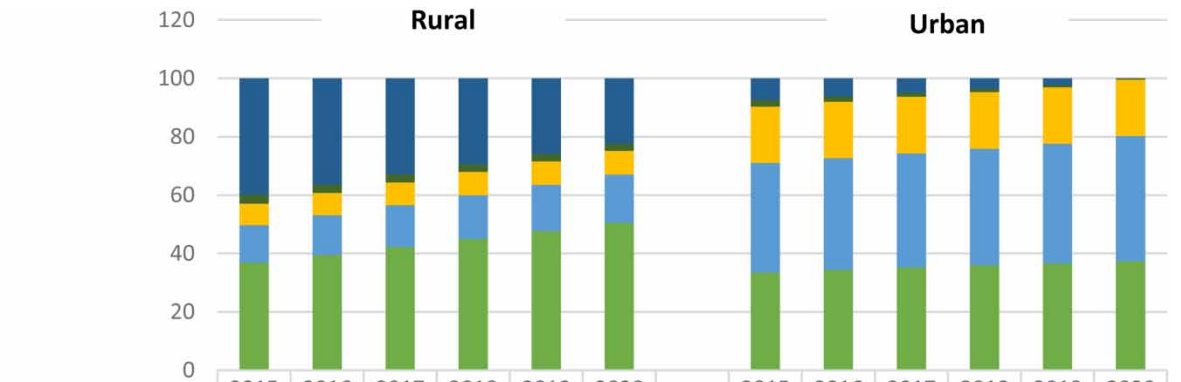
led to a reduction of water-borne diseases in the communities (UNICEF, 2015; Ghana Statistical Service, 2017). Figure 7 shows access to sanitation services in India between 2015 to 2020.

In India, the usage of sewer, latrines, and septic tanks increased over the years, with septic tank being the dominant. One of the government programs that has made a significant impact in recent years is the Swachh Bharat Mission (SBM). Under the SBM (Gramin), over 102 million toilets have been built in the rural areas across 36 states/UTs. During the first phase of the program, a total of 603,175 villages were declared open defecation-free (ODF). The program incorporated the aspect of behavioral change as one of its major strategies, and over 300 million people benefited from the 'behavior change' campaigns. (Ministry of Jal Shakti, 2021). Phase II of the program was launched in 2020 to sustain the gains of the first phase and also ensure that villages have access to solid and liquid waste management (SLWM) arrangements. Awareness was also created in all villages on hygiene behavior and waste management (SBM Management Information System, 2019).

2.4. SDG6 performance scenario in India and Ghana

Over past decades, both countries have undertaken a number of interventions, including projects and reforms, to improve water access and quality. These measures have led towards meeting various milestones as defined by the millennium development goals (MDGs) and SDGs. It is observed that the overall SDG6 index score for Ghana stands at 61.9 today as compared to 65.4 for India (Sachs *et al.*, 2020). To understand the status of the two countries with respect to SDG6, we have examined its sub-indicators in comparison with that of the lower middle-income countries (LMICs).

Just like LMICs, both countries have challenges with sanitation and wastewater treatment, with Ghana's situation being worse. Freshwater withdrawal is higher in India than in Ghana and LMICs, and its availability is abysmally low in Ghana, reflecting an acute water scarcity situation. A detailed discussion of the status quo and its implications will be attempted in Section 3.



	Rural						Urban					
	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
Open Defecation	39.86	36.37	32.88	29.39	25.9	22.41	7.42	6.13	4.85	3.56	2.27	0
Unimproved	3.05	2.92	2.79	2.66	2.53	2.39	2.23	1.87	1.51	1.15	0.78	0.42
Limited	7.39	7.61	7.8	7.97	8.1	8.21	19.32	19.35	19.37	19.37	19.37	19.35
Basic	12.89	13.59	14.29	15.01	15.74	16.47	37.6	38.32	39.04	39.99	40.95	42.92
Safely Managed	36.82	39.51	42.24	44.97	47.74	50.52	33.43	34.33	35.24	35.93	36.62	37.32

Fig. 7 | Rural and urban sanitation services in India. *Source*: JMP (washdata.org).

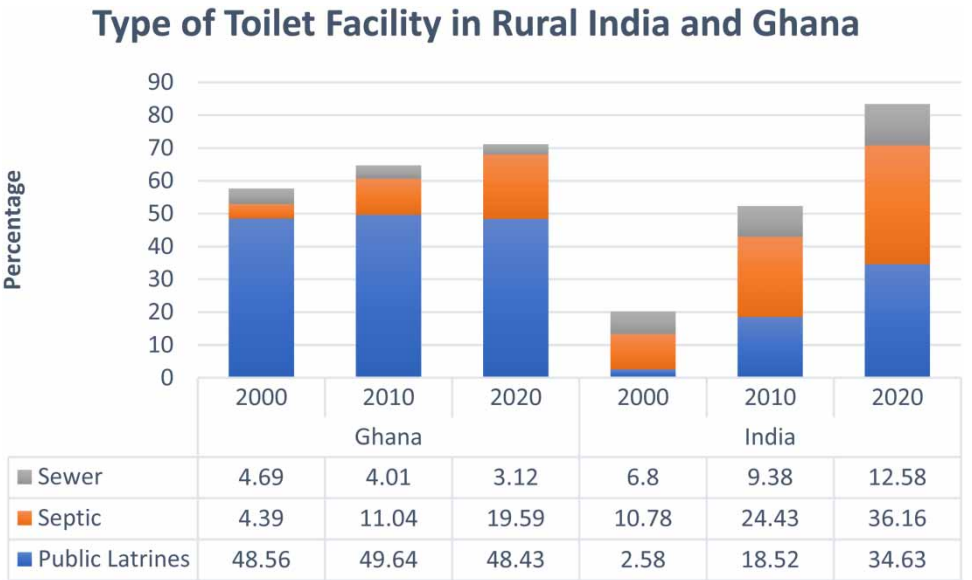


Fig. 8 | Type of toilet facility in India and Ghana. *Source*: WHO/UNICEF JMP (2020), washdata.org/data.

2.5. Funding of water and sanitation programs in India and Ghana

2.5.1. Overseas development assistance to the water and sanitation sectors

Both countries have relied historically on external support to fund the water and sanitation sectors, as shown in Figure 9.

As evident from Figure 9, Ghana has relied consistently on support from Official Development Assistance (ODA) of an annual average of $50 million from the year 2000 to 2017. This raises concerns about the

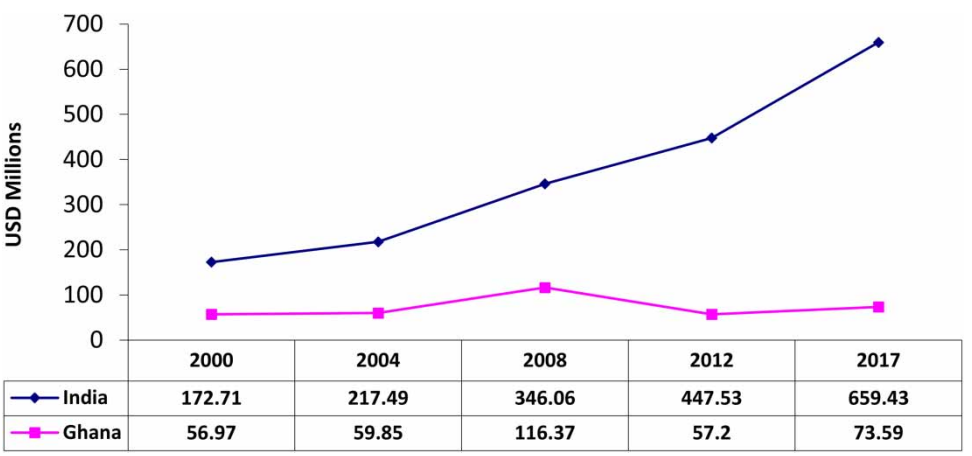


Fig. 9 | Overseas development assistance to the water and sanitation sectors in India and Ghana, 2000–2017. *Source*: UN Statistics Division, 2000–2017.

sustainability of the associated water and sanitation infrastructure, especially in the context of the decline or a withdrawal in aid to the sectors over the years (Ojomo *et al.*, 2015; ADB/OECD/UNDP, 2016).

India's reliance on ODA support has risen significantly and consistently from about $172 million to over $600 million over the review period. This can be attributed to the increasing population, which puts pressure on the limited government resources to meet the burgeoning water and sanitation sector requirements.

2.5.2. Government budgetary allocation in water and sanitation in Ghana and India

As evident from Figures 10, both countries continue to allocate significant financial resources to build the water and sanitation sectors, which have consistently grown since 2019.

The water and sanitation sectors are currently the fastest growing sectors in the Ghanaian economy. Government allocation to the Water and Sanitation ministry increased by over 55% from GHS361 million in 2020 to GHS561 million in 2021. The government has invested in various water supply projects in major towns, construction of hand pump–fitted wells, and mechanized water schemes under the Rural Communities and Small Towns Water Supply Project (RCSTWSP). Ghana's expenditures on water account for more than 80% of the total Water, Sanitation, and Hygiene (WASH), with only 20% on sanitation. It is estimated that only 39% of the total expenditure on WASH is spent on rural areas as compared to urban areas, and this has contributed to a high incidence of water-borne diseases in the rural areas (WWAP, 2015).

In India, the increasing budgetary allocation to the water sector by the government can be attributed to the increasing demand for water as a result of the increasing population. As evident from Figure 8, budgetary allocation increased from Rs. 12.019 crores in 2015 to Rs. 21.518 crores in 2021. For instance, in 2021, the budgetary allocation to the Ministry of Jal Shakti increased by 17% from the previous year's allocation. Also, allocation to the Jal Jeevan Mission saw an increase of 14.9% in 2020–2021 compared with that in the previous year (Government of India, 2020–21). With budgetary allocation set to increase in future years, it is expected that the financial gap in the water and sanitation sectors will be reduced to make SDG6 target achievement possible by 2030.

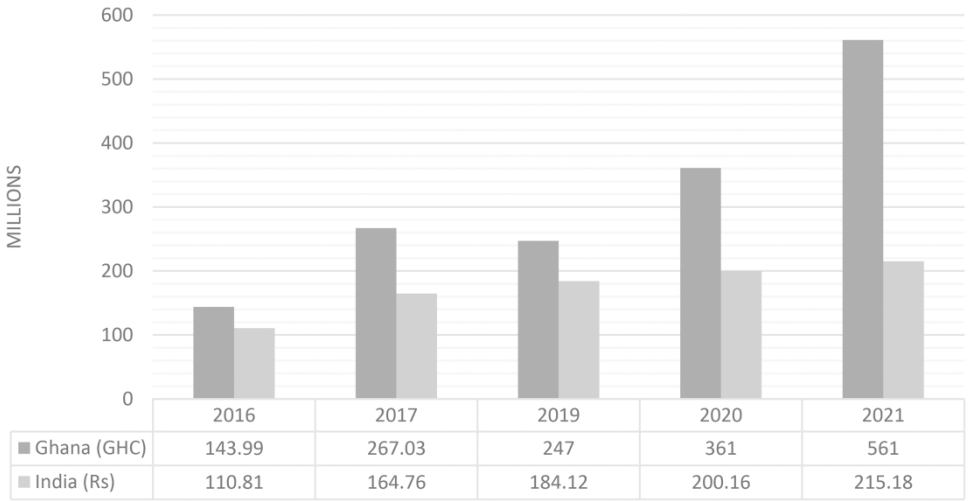


Fig. 10 | Government Budgetary Allocation to WATSAN in India and Ghana. *Source*: Ghana Statistical Service (GSS) and Centre for Budget and Governance Accountability (CBGA) from Union Budget documents, various years.

2.6. National water and sanitation policy reforms in India and Ghana

Several reforms in the water and sanitation sectors aimed at improving access have been undertaken over the past decade in both countries. Details are presented Figure 11.

In India, the RWSS had to a large extent contributed toward achieving a number of SDG targets like poverty eradication (SDG1), food/nutritional security (SDG2), and health security (SDG3) (Jiménez & Pérez-Foguet, 2010; Jonah *et al.*, 2015; Chaudhuri & Roy, 2016; Kabir *et al.*, 2016). Sampat (2007) notes that the Swajaldhara program has not been very effective as it is affected by income inequalities and socio-cultural differences. For instance, the marginalized groups including the lower castes are yet to realize the full benefit of the RWSS (Srivastava, 2012). It is estimated that 30% of the RWSS experience scheme failure/abandonment due to economic constraints. As per 2017–2018 estimates, a little over 10% RWSS schemes were planned but never took off, 17% remained incomplete, and 23% lacked status reports. The RWSS is also constrained by increasing operation and management weaknesses in the various government agencies at various levels and the lack of effective coordination of agencies in the sector (Chaudhuri *et al.*, 2020). WaterAid (2021), reporting on the challenges of drinking water in India, indicates that the fragmentated nature of institutions in the water sector at both national and state levels makes it difficult to achieve effective coordination between the relevant agencies. This has led to a duplication of certain key functions and neglect of other important responsibilities.

Ghana, on the other hand, has embarked on many reforms aimed at improving water and sanitation services, as illustrated in Figure 12.

Reforms in the water and sanitation sectors in Ghana started in 1965 when the Ghana Water and Sewerage Corporation (GWSC) was set up as a legal entity to provide water services as well as managing sewerage systems. In 1986, under the structural adjustment program, the operational subsidy on water supply was removed. Since the 1990s to date, a number of reforms have been introduced with more attention on rural water and sanitation, while ensuring operational efficiency in urban areas. Reforms have also led to the creation of independent

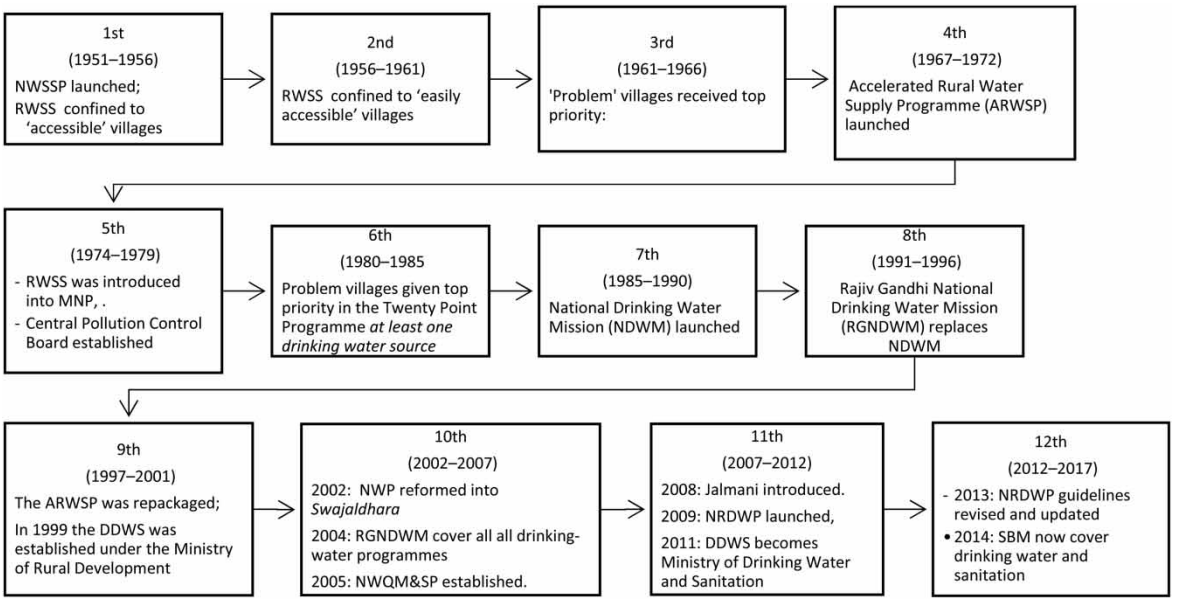


Fig. 11 | Key RWSS policy reforms in India, 1951–2014. *Source*: Chaudhuri & Roy, (2016).

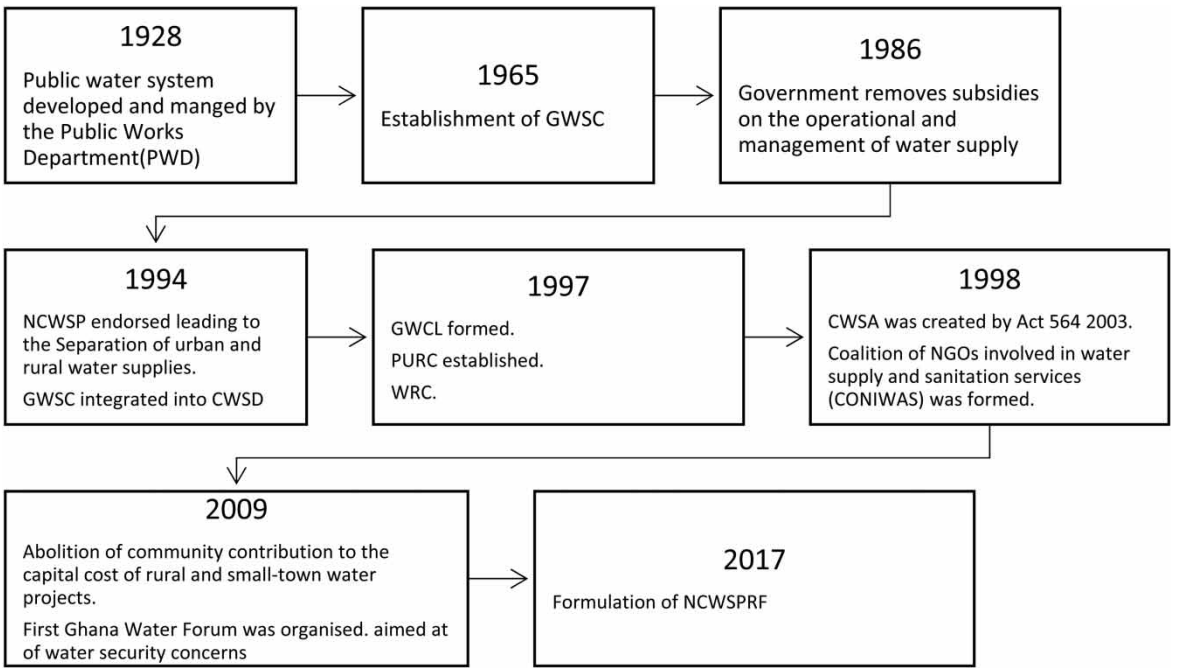


Fig. 12 | Major reforms in the water and sanitation sectors in Ghana, 1928–2017. *Source*: Ghana News Agency (2011), CWSA (2020).

agencies to regulate the two sectors and promote private sector participation to meet the national and international targets such as the MDGs and SDGs.

One of the major reforms was in 1999, when the Ghana Water Company Limited (GWCL), a publicly owned entity, was established to replace the GWSC as Metropolitan, Municipal and District Assemblies (MMDAs) took responsibility for sanitation. MMDAs and district assemblies were mandated to manage rural water and sanitation. Furthermore, for the purposes of regulation of water services, the Public Utilities Regulatory Commission (PURC) and the Water Resources Commission (WRC) were established in 1997. In 2008, due to problems of lack of coordination between the various agencies, the government launched the National Water Policy (NWP), which focused on efficient management of water resources, reliable urban water supply, and community water and sanitation.

By 2018, significant progress had been achieved, including the formulation of the NCWSPRF, which guides the implementation of the reform program. Under this new framework, the CWSA assumes direct management of 89 small town water systems. Also, the government invested in water systems that relied on their performance to optimize operational efficiency, and the outstanding electricity bills on water systems were paid by the CWSA (GLAAS, 2016; CWSA, 2018, 2020).

Nevertheless, the several reforms to remedy the water and sanitation situation in Ghana have not significantly yielded the expected health outcomes (Obeng *et al.*, 2015). In the case of rural water, one of the major challenges confronting the effective implementation of reform is the erratic power supply to run pumps used to operate community-based water systems. Another issue is the inability to pay for water due to the high level of poverty in the rural areas. The third constraining factor is the poor maintenance culture, which often leads to a breakdown of water infrastructure in the rural areas (Kheni & Braimah, 2014).

In the case of sanitation, one of the major constraints is the lack of affordability of sanitation technologies and increasing dependence on public latrines, which have contributed to the continuous high incidence of open defecation, especially in the rural areas (Duku, 2017; WSUP, 2017). Sijbesma (2011) notes that households are expected to take care of their sanitation in Ghana. Also, under the National Environmental Sanitation Policy (NESP), households are made responsible for financing household facilities (MLGRD, 2010). Households have also been responsible for most of the spends in the water and sanitation sectors between 2010 and 2014 (GLAAS, 2016; WHO, 2017).

Furthermore, the lack of clarity of guidelines for sanitation service delivery has resulted in poor coordination between the relevant implementing agencies (Appiah-Effah *et al.*, 2019). Even though the government has set out the NESP and strategy that set ambitious guidelines for the management of water and sanitation services, it fails to clarify how liquid waste or fecal sludge is to be managed (WSUP, 2017). This has resulted in MMDAs and district assemblies focusing only on solid waste management services (Appiah-Effah *et al.*, 2019).

The two sectors also lack the technical expertise to effectively manage the services required (Oduro-Kwarteng *et al.*, 2015). Oduro-Kwarteng *et al.* (2015) note that 75% of expertise in the water sector is engaged in water services, while sanitation services are dominated by social development personnel with only 2% technical personnel. Thus, the lack of the relevant technical expertise stands out as a major constraining factor even in achieving the MDGs in low-income countries (Morgan *et al.*, 2005).

Ampadu-Boakye *et al.* (2011) note that government over-reliance on hygiene education and subsidies as a way of promoting the patronage of household latrines under the Rural Water Supply Program IV (2005–2009) did not meet the set targets due to poor response owing to a lack of understanding of the local context of the beneficiary communities (Ampadu-Boakye *et al.*, 2011).

3. DISCUSSION

3.1. Implications of water and sanitation on health in India and Ghana

The lack of access to potable water and sanitation has an adverse effect on the health of many people in developing countries (UN, 2017; Adelodun *et al.*, 2020), including India and Ghana. The implication is that many people, especially the rural poor living in these countries suffer from water-borne diseases (Binka *et al.*, 2011; Adelodun *et al.*, 2020), and diarrhea accounts for 1.73 million deaths every year in them. Other water-related diseases include trachoma, schistosomiasis, ascariasis, trichuriasis, hookworm disease, and malaria (Boschi-Pinto *et al.*, 2008; Adelodun *et al.*, 2020). According to the United Nations (2018), the rural poor are the most affected by the lack of adequate water and sanitation services and are prone to many water-borne diseases. Yang *et al.* (2020) note a strong relationship between poor water quality and sanitation and the incidence of water-borne diseases. Relying on data from various developing countries, a strong relationship was established between water and sanitation and the incidence of water-borne diseases, especially among socially disadvantaged communities.

The impacts of improved water and sanitation services on health and their implication on mortality rates in India and Ghana are illustrated in Figure 13.

Even though the mortality rate attributable to water and sanitation situation had consistently declined in both countries between 2000 and 2017, the actual numbers are still very high and falls short of the SDG6 2030 targets. While access to water and sanitation has improved in India *vis a vis* other developing countries, including Ghana, the number of deaths of children aged 0–5 years caused by water-borne diseases, such as diarrhea, is still higher than many others. For instance, in 2015, India recorded the highest percentage of deaths (20%) in the 0–5 year age group, out of which 10% was attributed to diarrhea. This percentage was higher than that of other low-income countries like Myanmar (by 7%) and 9% more than that of Kenya (UNICEF, 2015). According to Adichwal

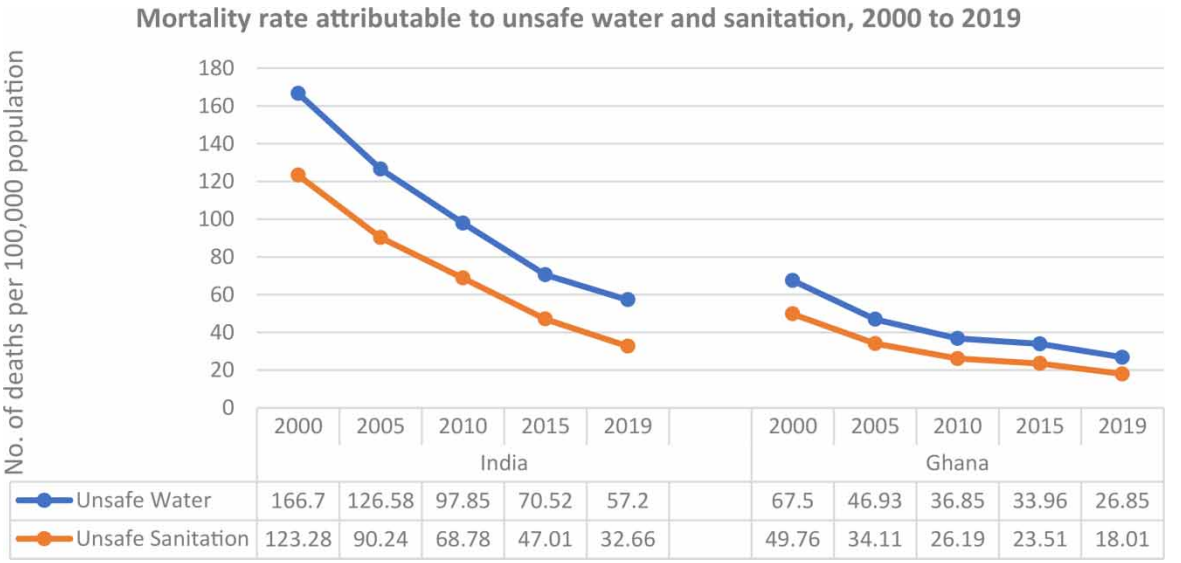


Fig. 13 | Mortality rate attributable to unsafe water and sanitation, 2000–2019 (India and Ghana). *Source*: GBD (2019).

(2016), the high mortality rate among children aged 0–5 years in India is a reflection on the inefficiency of India's health system. An estimated 300,000 children in India die of diarrhea annually due to poor water and sanitation services (Prüss-Ustün *et al*., 2014; Lakshminarayanan & Jayalakshmy R, 2015).

The current water and sanitation situation in India has significant implications for the health conditions of the urban and rural poor, most of whom suffer from diarrhea and various skin ailments (Cunha, 2015). The World Bank estimates that unsafe water usage accounts for 21% of communicable diseases in India (Reddy & Dev, 2006).

The water and sanitation reforms implemented in Ghana and India, the increasing budgetary allocation to the two sectors, and the national programs launched over past decades, as analyzed in this review, clearly demonstrate a positive impact on water and sanitation services delivery. However, the regional and urban/rural disparities underscore the need for a more focused approach to deal with the challenges being faced by deprived communities and regions to make the 2030 SDG6 target achievement a reality.

This review has further highlighted how socioeconomic conditions influence peoples' choices of water and sanitation services. Hirai *et al.* (2018) note that factors such as literacy levels, income levels, number of children aged under 5 years, and social classification of households play a key role in determining household choices of sanitation services (Tiwari *et al.*, 2022). This is because, increased household income makes it possible for households to build their own toilets, as the high cost of construction acts as one of the impeding factors of household toilet ownership (Sara & Graham, 2014). Also, literate households are more likely to acquire toilets due to their social status and better appreciation of the implications of poor sanitation (Guiteras *et al*., 2015; Hirai *et al*., 2018). This review shows high ownership of household toilets in urban areas, where literacy and income levels are high, as compared to low household toilet ownership in rural areas, where literacy and income levels are low.

A relationship between access to water and household toilet ownership has also been established. Hirai *et al.* (2018) note that where households have access to water, they are more likely to build their own toilets as water is essential to run toilets (Tiwari *et al.*, 2022). This review shows that even though access to water has improved in

both India and Ghana, the rural areas in these countries rely on public water points (non-pipe) for household purposes, whereas the urban areas rely mainly on pipe systems for their domestic consumption. Considering the time people have to spend to fetch water to run household toilets, those with no access to household piped water will rather prefer to use public toilets or resort to open defecation, a practice that is still widespread in the rural areas (Guiteras *et al*., 2015; Hirai *et al*., 2018).

It is evident that the reforms implemented in the two countries over the past decades reflect a clear response to the changing scenarios in the water and sanitation sectors. Both countries have been pragmatic and innovative in their approaches to meet the challenges and changes in the socioeconomic situation. However, what is missing is the lack of long-term plans for the two sectors to serve as a blue print for future reforms.

4. CONCLUSIONS AND POLICY IMPLICATIONS

This paper raises several policy issues that are worth considering for achieving clean water and sanitation (the SDG6) targets in Ghana and India. There is a need for formulating water and sanitation policies that focus on the poor and the marginalized sections of society and on deprived regions and states. In both countries, water and sanitation policies need to be designed to bridge the resource gap between deprived rural communities and more-resourced urban communities. One of the ways of doing this is providing support for techno-institutional support systems, whereby poor communities will have access to affordable appropriate technology to access potable water and appropriate sanitation facilities.

The importance of formal education, especially of women and girls in rural areas, cannot be ignored anymore. Although improved water and sanitation infrastructure facilities, such as piped water closets or private latrines, contribute to reducing the incidence of water-borne diseases, the education of women and girls increases their awareness and influences the choices that they make in terms of accessing appropriate sanitary toilet types and water treatment options for achieving better health outcomes.

The high cost of providing sanitation facilities has been identified as a major constraining factor in achieving sanitation targets in India and Ghana. There is a need to introduce polices that encourage the use of local building materials for the construction of household toilets using local artisans. This will significantly cut the cost of providing household toilet facilities locally, while creating employment for local artisans. Local artisans also need to be trained to maintain installed water systems in the communities and to read water meters within the communities to ensure the efficient running and maintenance of these water systems. Also, training more technical experts in the sanitation services sector is critical in ensuring efficiency in the sector.

The effective collaboration of local state institutions and other non-state actors involved in water and sanitation services in the rural communities in the two countries is critical for achieving SDG6 targets through effective planning and execution of reforms and thereby reducing the adverse impacts of the lack of potable water and good sanitation. Some of these institutions, *inter-alia* includes the Water and Sanitation Committees, Water Boards, and the District Water and Sanitation Agencies in Ghana and the Village Water and Sanitation Committee (VWSC), the Water & Sanitation Support Organization (WSSO), and the District Water Sanitation Mission (DWSM) in India. It is, however, important to ensure that such local institutions are given a reasonable level of autonomy to manage water and sanitation in villages so as to avoid undue interference from central regulatory institutions and bureaucratic service agencies in their day-to-day operations. Furthermore, in India, the Mahatma Gandhi National Employment Guarantee (MGNREG) scheme, which is a national employment guarantee program, can be leveraged to train rural youth, including women, to engage in various activities related to water and sanitation provision, as this will further enhance community ownership of local initiatives.

As the sanitation sector is not growing at the same pace as the water sector in India, the government needs to adopt innovative economic policies aimed at incentivizing the construction of household toilets and community-

based sewerage treatment systems by local authorities. These incentives can be in the form of granting educational incentives like scholarships to low-income households who construct household toilets. In Ghana, district assemblies who commit a part of the locally generated funds for providing sewerage treatment plants may benefit from higher budgetary allocation for education or health. Incentivizing household toilet ownership will create an avenue for many, who for various reasons do not have toilets at home, to get one. The government or other agencies, on the other hand, need to ensure that appropriate water infrastructure services are provided for adequate and reliable supply of water, particularly in rural areas.

Finally, the need for adequate budgetary allocation to the water and sanitation sectors is crucial for the effective functioning of local institutions for executing reforms. This will enable local institutions to invest in water-harnessing projects and initiatives that help communities to create alternative and less capital-intensive sources of water supply systems and reduce the overdependence on groundwater as a main source of water, especially in the case of India. The continuous decline of ODA to the two sectors in the two countries highlights the need for mobilizing alternate local financial resources, including contributions from private as well as corporate sector entities and civil society organizations, to support water and sanitation services. Furthermore, capital cost-sharing between the government and the water users to promote community ownership and the maintenance and upkeep of water and sanitation infrastructure is necessary and needs to be encouraged in both countries.

With the continuous prevalence of the COVID-19 pandemic over the last 2 years and its adverse impact on government spend on the water and sanitation sectors, further research and empirical investigations on reforms instituted in the pandemic era to achieve the SDG6 targets will help the government and other relevant stakeholders better prepare for future pandemics.

ACKNOWLEDGEMENTS

This paper forms a part of the E4LIFE International Doctoral Research Program being undertaken by the first author, supported by the School of Sustainable Development, Amrita Vishwa Vidyapeetham, India. We extend our gratitude to the Amrita Live-in-Labs® academic program for providing all the necessary support. We also thank Dr M Dinesh Kumar and the anonymous reviewers of this Journal for their useful comments on the paper. The usual disclaimers apply.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

REFERENCES

ADB/OECD/UNDP (2016). *African Economic Outlook 2016. Sustainable Cities and Structural Transformation*. African Development Bank, Organisation for Economic Co-operation and Development, United Nations Development Programme. http://dx.doi.org/10.1787/aeo-2016-en.

Adelodun, B., Ogunshina, M. S., Ajibade, F. O., Abdulkadir, T. S., Bakare, H. O. & Choi, K. S. (2020). Kinetic and prediction modeling studies of organic pollutants removal from municipal wastewater using *Moringa oleifera* biomass as a coagulant. *Water 12*(7), 2052. https://doi.org/10.3390/w12072052.

Adichwal, N. (2016). *Comparative Study on Status of Sanitation Between India and Uttar Pradesh*. Vol. 92, pp. 39062–39064. Available at: https://www.researchgate.net/publication/327103483_Comparative_study_on_status_of_sanitation_between_India_and_Uttar_Pradesh/link/5b786cc6a6fdcc5f8b538d23/download

Agapitova, N., Navarrete, M. C. & Barkataky, R. (2017). Waterlife: Improving Access to Safe Drinking Water in India. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/27664 License: CC BY 3.0 IGO

Alhassan, A. & Anyarayor, B. K. (2018). Determinants of adoption of open defecation free (ODF) innovations: a case study of Nadowli-Kaleo District, Ghana. *Journal of Development and Communication Studies 5*(2), 54–69.

Ampadu-Boakye, J., Dotse, F. M., Laryea, N. O. A., Karikari, D. Y. & Gyan, E. (2011). *Improving Access to Basic Sanitation in Ghana. Lessons from a Water and Sanitation Project in Ghana*.

Appiah-Effah, E., Duku, G. A., Azangbego, N. Y., Aggrey, R. K. A., Gyapong-Korsah, B. & Nyarko, K. B. (2019). Ghana's post-MDGs sanitation situation: an overview. *Journal of Water, Sanitation and Hygiene for Development 9*(3), 397–415. https://doi.org/10.2166/washdev.2019.031.

Bahinipati, C. S. & Viswanathan, P. K. (2019). Can micro-irrigation technologies resolve India's groundwater crisis? Reflections from dark-regions in Gujarat. *International Journal of the Commons 13*(2), 848–858. http://doi.org/10.5334/ijc.888.

Baur, P. & Woodhouse, M. (2009). Enhancing private sector in rural water supply: an action-oriented study. *The International Journal of Human Resource Management 24*(8), 1671–1684.

Binka, E., Vermund, S. H. & Armah, G. E. (2011). Rotavirus as a cause of diarrhea among children under 5 years of age in urban Ghana: prevalence and serotypes/genotypes. *The Pediatric Infectious Disease Journal 30*(8), 718–720. https://doi.org/10.1097/INF.0b013e318223bd85.

Boschi-Pinto, C., Velebit, L. & Shibuya, K. (2008). Estimating child mortality due to diarrhoea in developing countries. *Bulletin of the World Health Organization 86*(9), 710–717.

Chaudhuri, S. & Roy, M. (2016). Overview of rural water supply sector in West Bengal, India: challenges on concerns. *International Journal of Innovative Research in Science, Engineering, and Technology 5*(6), 9768–9777.

Chaudhuri, S., Roy, M., McDonald, L. M. & Yves, E. (2020). Water for All (Har Ghar Jal): rural water supply services (RWSS) in India (2013–2018), challenges and opportunities. *International Journal of Rural Management 16*(2), 254–284.

Cronk, R. & Bartram, J. (2018a). Identifying opportunities to improve piped water continuity and water system monitoring in Honduras, Nicaragua, and Panama: evidence from Bayesian networks and regression analysis. *Journal of Cleaner Production 196*(2018), 1–10.

Cronk, R. & Bartram, J. (2018b). Environmental conditions in health care facilities in low- and middle-income countries: Coverage and inequalities. *Int J Hyg Environ Health 221*(3), 409–422. doi: 10.1016/j.ijheh.2018.01.004.

Cunha, J. P. (2015). *Travelers' Diarrhea: Learn About Antibiotics and Treatment*. MedicineNet.

CWSA (2018). *Ministry of Sanitation and Water Resources 2018 Annual Report Ghana*.

CWSA (2020). Available at: https://www.cwsa.gov.gh/ghana-cabinet-approves-community-water-and-sanitation-agency-policy-reform-in-the-rural-water-and-sanitation-sub-sector/

Duku, G. A. (2017). *Development and Field-Testing of a Low-Cost Latrine for Rural and Peri-Urban Communities*. *MSc thesis*, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Fewtrell, L., Kaufman, R. B., Kay, D., Enanoria, W., Haller, L. & Colford Jr., J. M. (2005). Water, sanitation and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Journal of Infectious Disease 5*, 42–55.

Ghana News Agency (2011). *NGO Criticises low Funds for Water and Sanitation Sector*. GNA, Accra.

Ghana Statistical Service (2018). Snapshots on key Findings, Ghana Multiple Indicator Cluster Survey (MICS 2017/18), Survey Findings Report. Accra, Ghana.

GLAAS (2016). *Tracking Initiative: Results From Ghana. UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water*, Vol. 81. Accra, Ghana.

Global Burden of Disease Collaborative Network. Global Burden of Disease Study (2019). *(GBD 2019) Results*. Institute for Health Metrics and Evaluation (IHME), 2021, Seattle, United States. Available at: http://ghdx.healthdata.org/gbd-results-tool (accessed 15 February 2022).

Government of India Union Budget (2020–2021). *Speech of Nirmala Sitharaman Minister of Finance February 1, 2020*. Available at: https://www.thehinducentre.com/resources/article30724527.ece/binary/Budget_Speech.pdf (accessed 3 January 2022).

GSS (2017). *Ghana Statistical Service. Multiple Indicator Cluster Survey*. Accra, Ghana.

GSS (2018). *Ghana Statistical Service. Snapshots on key Findings, Ghana Multiple Indicator Cluster Survey (MICS 2017/18), Survey Findings Report*. Accra, Ghana.

Guiteras, R., Levinsohn, J. & Mobarak, A. M. (2015). Encouraging sanitation investment in the developing world: a cluster-randomized trial. *Science 348*, 903–906. Available at: https://www.science.org/doi/10.1126/science.aaa0491

Himanshu, H., Lanjouw, P., Murgai, R. & Stern, N. (2013). Nonfarm diversification, poverty, economic mobility, and income inequality: a case study in village India. *Agricultural Economics 44*, 461–473.

Hirai, M., Kelsey, A., Mattson, K., Cronin, A. A., Mukerji, S. & Graham, J. P. (2018). Determinants of toilet ownership among rural households in six eastern districts of Indonesia. *Journal of Water, Sanitation and Hygiene for Development 8*(3), 533–545. https://doi.org/10.2166/washdev.2018.010. Available at: https://iwaponline.com/washdev/article/8/3/533/39016/Determinants-of-toilet-ownership-among-rural

Jiménez, A. & Pérez-Foguet, A. (2010). Challenges for water governance in rural water supply: lessons learned from Tanzania. *Water Resources Development 26*(2), 235–248.

Jonah, C., Maitho, T. & Omware, Q. (2015). Water access and sustainable rural livelihoods: a case study from elementaita division in Nakuru County, Kenya. *International Journal of Science, Technology and Society 3*(1), 9–23.

Kabir, Y., Niranjan, V., Bassi, N. & Kumar, M. D. (2016). Multiple water needs of rural households: studies from three agro-ecologies in Maharashtra. In *Rural Water Systems for Multiple Uses and Livelihood Security*. Kumar, M. D., Kabir, Y. & James, A. J. (eds). Elsevier, p. 322. doi:10.1016/B978-0-12-804132-1.00003-2.

Kheni, N. A. & Braimah, C. (2014). Institutional and regulatory frameworks for health and safety administration: study of the construction industry of Ghana. *International Refereed Journal of Engineering and Sciences 3*(2), 24–34.

Kumar, M. D., Bassi, N., Hemani, R. & Kabir, Y. (2021). *Management of Irrigation and Water Supply Under Climatic Extremes, Global Issues in Water Policy*. p. 25. https://doi.org/10.1007/978-3-030-59459-6_12.

Lakshminarayanan, S. & Jayalakshmy, R. (2015). Diarrheal diseases among children in India: Current scenario and future perspectives. *J Nat Sci Biol Med. 6*(1), 24–28. doi: 10.4103/0976-9668.149073.

Lalitha, S. & Siromony, M. V. (2014). *Drinking water issues in rural India: need for stakeholders' participation in water resources management, future of food. Journal on Food, Agriculture and Society 2*(1), 67–79.

Liu, J., Yang, H., Gosling, S. N., Kummu, M., Flörke, M., Pfister, S., Hanasaki, N., Wada, Y., Zhang, X. & Zheng, C. (2017). Water scarcity assessments in the past, present, and future. *Earth's Future 5*(6), 545–559.

Ministry of Drinking Water and sanitation, GoI (2017). *Har Ghar Jal by 2030. Current Status and Next Steps*. National Rural Drinking Water Programme. Available at: http://indiawater.gov.in/IMISReports/MenuItems/AboutSite.aspx

Ministry of Finance. (2018). *Water and Sanitation 31st May – June 2019. Infrastructure and Investment in Water and Sanitation in India*.

Ministry of Jal Shakti (2021). *Swachh Bharat Mission*. Available at: https://pib.gov.in/FactsheetDetails.aspx?Id=148579#:~:text=The%20Swachh%20Bharat%20Mission%20has,and%20nutrition%20have%20also%20improved. (accessed on 11 March 2022).

Ministry of Water Resources, India (2014). Concept Note on Geogenic contamination of ground water in India with a special note on nitrate. http://cgwb.gov.in/WQ/Geogenic%20Final.pdf Accessed on 11 May 2022.

MLGRD & EHSD (2010). *National Environmental Sanitation Strategy and Action Plan (NESSAP) 2010–2015*. Ministry of Local Government and Rural Development & environmental Health and Sanitation Directorate, Accra, Ghana. Available at: https://www.ircwash.org/sites/default/files/

Monney, I. & Antwi-Agyei, P. (2018). *Beyond the MDG water target to universal water coverage in Ghana: the key transformative shifts required*. *Journal of Water Sanitation and Hygiene for Development 8*(2), 127–141. https://doi.org/10.2166/washdev.2018.176.

Morgan, P., Land, T. & Baser, H. (2005). *Study on Capacity, Change and Performance. Interim Report, Discussion Paper No. 59a*. European Centre for Development Policy Management, Maastricht, The Netherlands.

Narendran, S., Pradeep, P. & Ramesh, M. V. (2017). An Internet of Things (IoT) based sustainable water management. In: *2017 IEEE Global Humanitarian Technology Conference (GHTC)*. pp. 1–6. doi:10.1109/GHTC.2017.8239320.

Obeng, P. A., Keraita, B., Oduro-Kwarteng, S., Abaidoo, R. C., Awuah, E. & Konradsen, F. (2015). *Usage and barriers to use of latrines in a Ghanaian peri-urban community*. *Environmental Processes 2*, 261–274. https://doi.org/10.1007/s40710-015-0060-z.

Oduro-Kwarteng, S., Monney, I. & Braimah, I. (2015). Human resources capacity in Ghana's water, sanitation and hygiene sector: analysis of capacity gaps and policy implications. *Water Policy 17*(3), 502–519. https://doi.org/10.2166/wp.2014.293.

Ojomo, E., Elliott, M., Goodyear, L., Forson, M. & Bartram, J. 2015 Sustainability and scale-up of household water treatment and safe storage practices: Enablers and barriers to effective implementation. *International Journal of Hygiene and Environmental Health 218*(8), 704–713.https://www.sciencedirect.com/science/article/pii/S1438463915000255.

Omotayo, A. O., Olagunju, K. O., Omotoso, A. B., Ogunniyi, A. I., Otekunrin, O. A. & Daud, A. S. (2021). Clean water, sanitation and under-five children diarrhea incidence: empirical evidence from the South Africa's General Household

Survey. *Environmental Science and Pollution Research International 28*(44), 63150–63162. doi:10.1007/s11356-021-15182-w. Epub 2021 Jul 5. PMID: 34226996. Available at: https://pubmed.ncbi.nlm.nih.gov/34226996/

Prüss-Ustün, A., Bartram, J., Clasen, T., Colford Jr., J. M., Cumming, O., Curtis, V., Bonjour, S., Dangour, A. D., De France, J., Fewtrell, L., Freeman, M. C., Gordon, B., Hunter, P. R., Johnston, R. B., Mathers, C., Mäusezahl, D., Medlicott, K., Neira, M., Stocks, M., Wolf, J. & Cairncross, S. (2014). Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: a retrospective analysis of data from 145 countries. *Tropical Medicine & International Health 19*(8), 894–905. doi:10.1111/tmi.12329. Epub 2014 Apr 30. PMID: 24779548; PMCID: PMC4255749. Available at: https://pubmed.ncbi.nlm.nih.gov/24779548/

Rathna Reddy, V. & Mahendra Dev, S. (2006). In *Water and Sanitation Institutional Challenges in India, Manohar*. van Dijik, M. P. & Sijibesma, C. (eds). IDPAD, Publishing Company, New Delhi.

Ridzuan, S. (2021). Inequality and water pollution in India. *Water Policy 23*(4), 985–999. https://doi.org/10.2166/wp.2021.057.

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. & Woelm, F. (2020). *The Sustainable Development Goals and COVID-19. Sustainable Development Report 2020*. Cambridge University Press, Cambridge.

Sampat, P. (2007). Swajaldhara or 'Pay'-Jal-Dhara: Right to drinking water in Rajasthan. *Economic and Political Weekly 42*. doi.10.2307/40277132.

Sara, S. & Graham, J. (2014). Ending open defecation in rural Tanzania: which factors facilitate latrine adoption? *International Journal of Environmental Research and Public Health 11*, 9854–9870. Available at: https://www.mdpi.com/1660-4601/11/9/9854

SBM Management Information System (2019). Available at: https://sbm.gov.in/phase2dashboard/PhaseII/home.aspx (accessed on 11 March 2022).

Sijbesma, C. (2011). *Sanitation Financing Models for the Urban Poor (Thematic Overview Paper 25)*. International Water and Sanitation Centre (IRC), The Hague, The Netherlands. Available at: http://www.irc.nl/top25.

Singh, D. (2009). Development of scheduled castes in India – a review. *Journal of Rural Development 28*(4). NIRD, Hyderabad.

Sinha, S. K. & Pradeep, C. (2019). Tackling Open Defecation and Improved Sanitation in Developing Countries: A Toilet Talk from the State of Bihar, India. *Current Research Journal of Social Sciences and Humanities 2*(1), 47–57.

Sridhar, K. S. & Reddy, A. V. (2018). *State of Urban Services in India's Cities: Spending and Financing*. Public Affairs Centre. ISBN 9780198065388 – via Google Books.

Srivastava, S. (2012). Swajaldhara: 'Reserved' realities in rural water supply in India. *IDS Bulletin 43*(2), 37–43.

Tfwala, C. M., Mengistu, A. G., Ukoh Haka, I. B., van Rensburg, L. D. & Du Preez, C. C. (2021). Seasonal variations of transpiration efficiency coefficient of irrigated wheat. *Heliyon 7*(2), e06233. https://doi.org/https://doi.org/10.1016/j.heliyon.2021.e06233.

Tiwari, P., Tirumala, R. D. & Shukla, J. (2022). Household choices of sanitation infrastructure and impact on disease in India. *Environment and Planning B: Urban Analytics and City Science*. doi:10.1177/23998083221088293.

UN (2020). *SDG India Index and Dashboard*. Available at: https://sdgindiaindex.niti.gov.in/#/

UN (2022). *Department of Economic and Social Affairs Population Dynamics, World Population Prospects (2019 Revision)*. Available at: https://worldpopulationreview.com/countries/india-population

UN Communications Group (UNCG) & CSO Platform (2017). *The Sustainable Development Goals (SDGs) in Ghana: Why They Matter & How we can Help*. Accra, Ghana. Available at: http://gh.one.un.org/content/dam/unct/ghana/docs/SDGs/UNCT-GHSDGs-in-Ghana-Avocacy-Messages-2017.pdf.

UNICEF (2015). *Progress Report 2015*. Available at: https://www.unicef.org/media/50721/file/APR_2015_9_Sep_15.pdf (accessed 17 February 2022).

United Nations (2017). *Resolution Adopted by the General Assembly on 6 July 2017, Work of the Statistical Commission Pertaining to the 2030 Agenda for Sustainable Development (A/RES/71/313 Archived 28 November 2020 at the Wayback Machine)*.

United Nations (2018). *Sustainable Development Goal 6 Synthesis Report 2018 on Water and Sanitation*. New York.

UN Statistics Division – Total Official Development Assistance (Gross Disbursement) For Water Supply and Sanitation, By Recipient Countries (Millions of Constant 2017 United States Dollars) – Dc_Tof_Washl (2000–2017). Available at: https://unstats.un.org/sdgs/indicators/database/

WaterAid (2021). *Drinking Water Quality in Rural India: Issues and Approaches*. Available at: file:///C:/Users/HP/Downloads/Drinking%20water%20quality%20 in.percnt;20rural%20India%20-%20Issues%20and%20approaches.pdf. (accessed 20 December 2022).

WWAP (United Nations World Water Assessment Programme) (2015). The United Nations World Water Development Report 2015: Water for a Sustainable World. Paris, UNESCO.

WHO/UN (2017). Drinking Water, sanitation, and hygiene: 2017 update and SDG baselines. https://www.communityledtotalsanitation.org/resource/whounicef-joint-monitoring-programme-2017 report#:~:text=The%20WHO%2FUNICEF%20JMP%20has,drinking%20water%20and%20sanitation%20services. Accessed on 11 May 2022.

WHO/UNICEF Joint Monitoring Programme (2019). *Progress on Household Drinking Water, Sanitation and Hygiene 2000–2017*. United Nations Children's Fund and World Health Organization, New York.

WHO/UN (2017). Drinking water, sanitation, and hygiene: 2017 update and SDG baselines. https://www.communityledtotalsanitation.org/resource/whounicef-joint-monitoring-programme-2017 report#:~:text=The%20WHO%2FUNICEF%20JMP%20has,drinking%20water%20and%20sanitation%20services. Accessed on 11 May 2022.

WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation. 2020 washdata.org. Accessed on 11 May 2022.

World Health Organization and UNICEF (2013). Progress on Sanitation and Drinking-Water, 2013 Update. https://apps.who.int/iris/bitstream/handle/10665/81245/9789241505390_eng.pdf;sequence=1 Accessed on 11 May 2022.

WSUP (2017). *Situation Analysis of the Urban Sanitation Sector in Ghana*. Available at: https://www.wsup.com/content/uploads/2017/09/Situation-analysis-of-the-urban-sanitation-sector-in-Ghana.pdf

Yang, D., He, Y., Wu, B., Deng, Y., Li, M., Yang, Q., Huang, L., Cao, Y. & Liu, Y. (2020). Drinking water and sanitation conditions are associated with the risk of malaria among children under five years old in sub-Saharan Africa: a logistic regression model analysis of national survey data. *Journal of Advanced Research*. doi:10.1016/j.jare.2019.09.001. Available at: https://www.sciencedirect.com/science/article/pii/S2090123219301535?via%3Dihub.

Yeboah, S. I. I. K., Antwi-Agyei, P. & Domfeh, M. K. (2022). Drinking water quality and health risk assessment of intake and point-of-use water sources in Tano North Municipality, Ghana. *Journal of Water, Sanitation and Hygiene for Development 12*(2), 157–167. https://doi.org/10.2166/washdev.2022.152. Available at: https://iwaponline.com/washdev/article/12/2/157/86263/Drinking-water-quality-and-health-risk-assessment

First received 9 April 2022; accepted in revised form 23 April 2022. Available online 10 May 2022