

Review Paper

Beyond the MDG water target to universal water coverage in Ghana: the key transformative shifts required

Isaac Monney and Prince Antwi-Agyei

ABSTRACT

Ghana achieved its Millennium Development Goal water target about a decade before the 2015 deadline. However, as the world shifts focus to achieving sustainable universal water coverage, there is the need for redoubled efforts to keep up this feat. This paper examines the success drivers and the major transformative shifts required to sustain efforts in Ghana's water sector. The findings indicate that the successes chalked in Ghana's water sector have been largely fuelled by strong donor support and a well organised institutional and policy framework. About 90% of funding for the sector has been contributed by donors and creditors while actual government expenditure remains below 0.5% of GDP. The country has a strong policy and institutional framework guiding developments in the water sector. Nevertheless, the dwindling donor support, poor cost recovery mechanisms in the sector, ineffective strategies for ensuring human right to water, unbridled pollution of freshwater resources, poor borehole construction, and poor environmental sanitation across the country threaten to unwind the progress made in the sector. Without a paradigm shift, these could potentially derail efforts at achieving and sustaining universal water coverage. The paper discusses how these issues can be addressed to ensure universal access to potable water in the country.

Key words | climate change, drinking water, financing, Ghana, sustainable water supply, universal water coverage

Isaac Monney (corresponding author)
Department of Environmental Health and
Sanitation Education,
University of Education Winneba,
P.O. Box M40, Mampong-Ashanti,
Ghana
E-mail: monney.isaac@gmail.com

Prince Antwi-Agyei
NHance Development Partners Limited,
P.O. Box ST 46, Stadium-Kumasi,
Ghana

INTRODUCTION

Ghana has an estimated population of about 27 million people growing at an annual rate of 2.5% (Ghana Statistical Service 2013; The World Bank Group 2016). At this growth rate, the country's population is expected to double by 2050. It has an almost equal proportion of urban (51%) and rural (49%) population. However, the surge in urbanization in recent years is expected to increase the urban share of

the national population to about three-quarters by 2050 (Government of Ghana 2012). The World Bank's estimates put the country's gross domestic product at US\$38 billion with a 3.9% annual growth rate (The World Bank Group 2016). With the recent oil discoveries in the country, revenue from commercial oil production is expected to generate additional and significant fiscal resources to boost the economy of the country (The World Bank 2010).

The combined effect of population and economic growth would spur on increased demand for water, thereby making drinking water supply crucial. According to figures provided by the UNICEF/WHO Joint Monitoring Programme (JMP), Ghana's Millennium Development Goal

This is an Open Access article distributed under the terms of the Creative Commons Attribution Licence (CC BY-NC-SA 4.0), which permits copying, adaptation and redistribution for non-commercial purposes, provided the contribution is distributed under the same licence as the original, and the original work is properly cited (<http://creativecommons.org/licenses/by-nc-sa/4.0/>).

(MDG) target for potable water supply was achieved in 2008, with 82% of the population having access to improved drinking water sources as against a 2015 target of 77% (WHO/UNICEF 2015). Currently, access to improved drinking water is estimated at 89%; 93% urban coverage and 84% rural coverage (WHO/UNICEF 2015). Undoubtedly, if current efforts are sustained, Ghana will achieve universal access to potable water by the year 2030 as required by Target 6.1 of the UN Sustainable Development Goal (SDG) 6. However, this will require new policy, financing and management approaches. One crucial target under Goal 6 of the SDGs is to protect water resources from pollution and halve the proportion of untreated wastewater discharge (Target 6.3). Thus, although Ghana has enormous surface and groundwater resources, achieving sustainable universal water coverage will depend on how well it protects these resources from pollution by toxic chemicals, pathogens, and other biological contaminants arising mainly from anthropogenic activities.

This paper examines the success drivers and potential challenges that need to be addressed to sustain efforts in Ghana's water sector. It takes a retrospective look at how the sector has evolved over the years and how this has contributed to increasing access to potable water countrywide. Additionally, it examines efforts and challenges to achieving and sustaining universal access to potable water supply and water resource protection, vis-à-vis, institutional, policy and financing frameworks. This is based on an in-depth review of policy documents, institutional frameworks, and project

reports from key sector stakeholders in Ghana including government institutions, donor agencies, international non-governmental organisations, the private sector and civil society groups.

Status and trends in drinking water coverage in Ghana

Despite being endowed with enormous water resources, not everyone across the country can boast of having access to potable water. This notwithstanding, over the years, Ghana has made tremendous efforts at improving access to potable water supply for its populace across the country. Although, figures provided by service providers (SPs) (Figure 1) on access to potable water are somewhat higher than that of the UNICEF/WHO JMP (Figure 1), there has generally been a significant improvement in water coverage since 1990. The national MDG target of 77% drinking water coverage was achieved in 2008, seven years ahead of schedule (Figure 1).

The disparity in water coverage figures is attributed to the source of data used for estimation. The JMP relies on data from the Ghana Living Standards Survey (GLSS) and the Multiple Indicator Cluster Survey collected by the Ghana Statistical Service. These are multi-purpose household surveys which collect information on many different aspects of living conditions based on a representative sample. Conversely, the service providers use actual data based on the number of people having access to the improved water sources they provide. The service providers

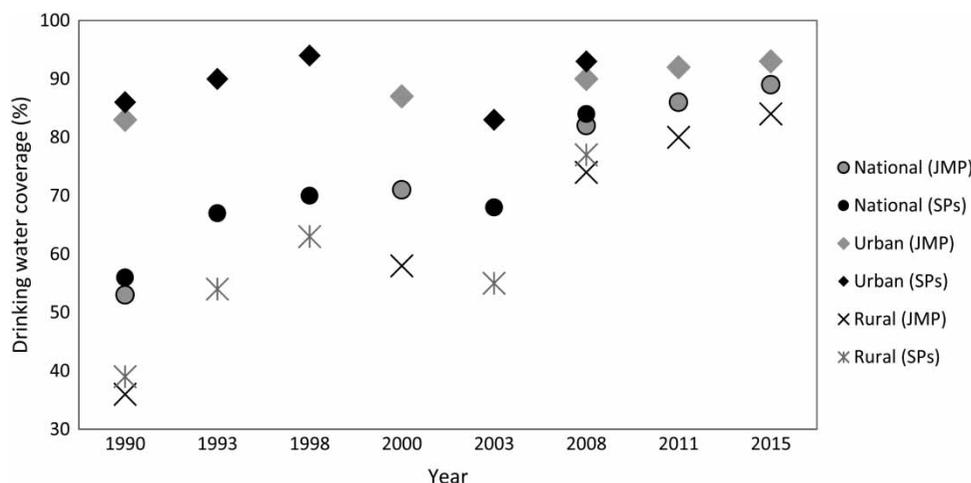


Figure 1 | Disparities in drinking water coverage figures in Ghana. (Sources: WHO/UNICEF 2010, 2015; UNDP Ghana & NDPC/GOG 2012).

possibly have more reliable first-hand data which can be used to accurately monitor and report progress towards universal water coverage in the country. Despite these discrepancies, if the current trend is sustained, it is more likely that Ghana can achieve universal drinking water coverage five years before the 2030 deadline set by the SDGs.

In Ghana, disaggregating the national drinking water coverage into only urban and rural is inadequate as it masks the huge spatial disparities that exist countrywide. Therefore, there is the need to also assess the variation in drinking water coverage on a spatial scale across the country to map vulnerable areas and ensure that resources can be equitably allocated to improve the water supply situation in these areas moving forward. A spatial representation of figures provided by the 2010 Ghana Millennium Goals Development Report (UNDP, Ghana & NDPC/GOG 2012) shows that the Brong Ahafo Region has the least proportion of rural drinking water coverage (Figure 2(a)) while the Upper West Region lags far behind in urban drinking water coverage (Figure 2(b)). Huge disparities therefore exist among the regions countrywide in terms of access to drinking water. Since most of the funding for the water sector is contributed by donors (WHO 2015), the regional

disparities in access to drinking water can be attributed to a disproportionate donor support across regions in the country. A previous study by Monney *et al.* (2015) observed a weak donor support in the Brong Ahafo Region while the 2015 Ghana MDGs report by UNDP/NDPC (2015) indicated a strong support for the Greater Accra and Ashanti Regions for water supply and sanitation. To address this, the Central Government and development partners need to develop and implement a sector strategic plan that ensures equitable distribution of funding for water projects across the country. Additionally, the government needs to progressively increase domestic funding for the water sector, so it can sustain developments even with little or no donor fund inflows in the years ahead.

The water coverage figures represent the proportion of the population with access to improved drinking water sources without regard to the quality of water consumed. According to the WHO/UNICEF Joint Monitoring Programme (2010) improved sources of drinking water are those protected from outside contamination, particularly faecal matter, by the way it is constructed (WHO/UNICEF 2010). However, several studies have argued that improved water sources are not entirely free from contamination

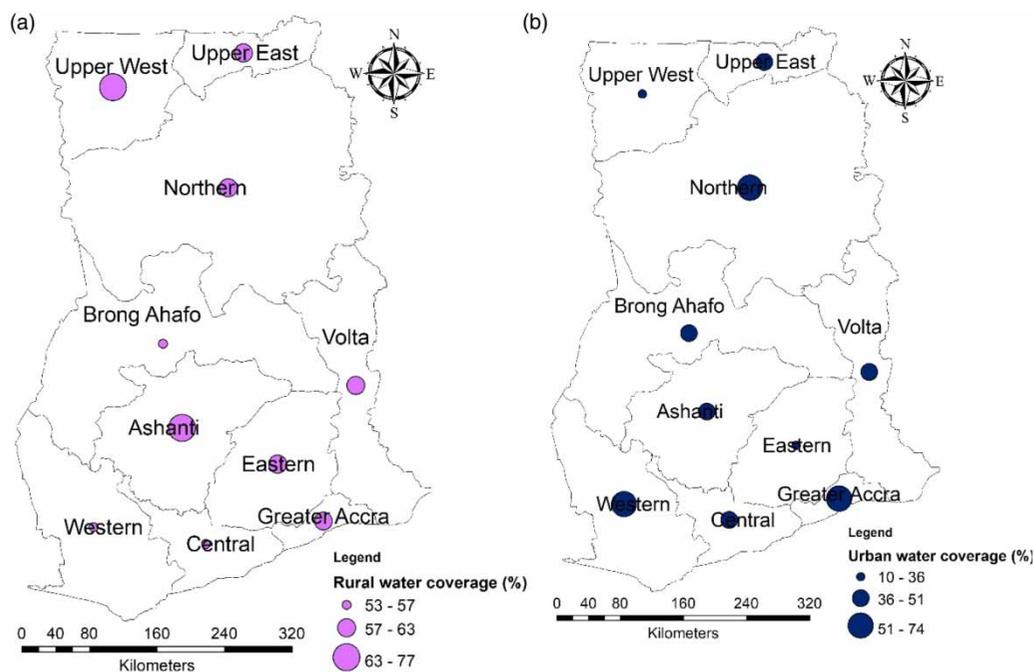


Figure 2 | Spatial variation of (a) rural and (b) urban drinking water coverage in Ghana as of 2010. (Source: Adapted from UNDP Ghana & NDPC/GOG 2012).

and unsafe storage of water from these sources at the household level can further contaminate drinking water (Hunter *et al.* 2009; Obiri-Danso *et al.* 2009; Bain *et al.* 2014). In Ghana, this assertion has been corroborated by findings from the GLSS Round 6 (Ghana Statistical Service 2014a). The survey indicated that about half (44%) of improved drinking water sources ($N=919$) had detectable *E. coli* whilst close to two-thirds (62%) of household drinking water samples ($N=2,157$) contained *E. coli* (Ghana Statistical Service 2014a). For boreholes, the *E. coli* contamination is more likely due to poor construction methods and not necessarily the groundwater resource since samples were not taken from monitoring wells. Similarly, in Ethiopia, about 45% of boreholes and protected wells ($N=764$) were found to be contaminated with thermotolerant coliform while in Nigeria about a quarter (24%) of these water sources ($N=949$) are contaminated (Onda *et al.* 2012). Contamination of improved water sources is not a rare phenomenon. Globally, available studies have shown that boreholes can be contaminated by onsite sanitation facilities (common in Ghana) and poor construction methods (Howard *et al.* 2003; Dzwireo *et al.* 2006; Galadima *et al.* 2011; Graham & Polizzotto 2013). Ingress of contaminants into pipelines running through wastewater-carrying channels have also been linked to pipe-borne water contamination (Monney *et al.* 2013) while poor transportation and storage methods have been shown to cause water contamination at the household level (Parker 2000). This shows that, although there is a high proportion of drinking water coverage, there is still the risk of pathogenic contamination of water consumed at the household level.

To improve drinking water quality, construction of boreholes should be improved to ensure that they are totally sealed from surface runoff and onsite sanitation facilities should not be sited near to boreholes and wells. Distribution systems for drinking water supply should be properly maintained to avoid water quality from being compromised. Households must be educated to adopt safe storage methods for drinking water and disinfect water storage tanks periodically.

The poor environmental sanitation across the country is, without doubt, a key contributory factor to pollution of drinking water sources. Only 15% of Ghana's population currently have access to an improved sanitation facility,

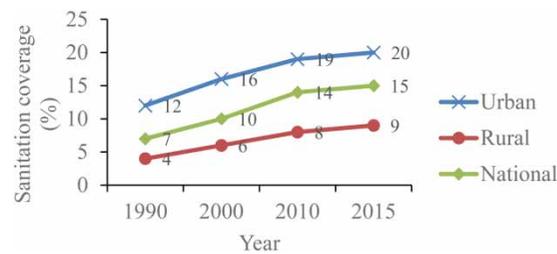


Figure 3 | Improved sanitation coverage in Ghana. (Source: adapted from WHO/UNICEF 2012, 2015).

defined as one that hygienically separates human excreta from human contact (Figure 3), and 20% defecate in the open (WHO/UNICEF 2015). Again, less than 5% of all households in Ghana are connected to piped sewerage systems that are linked to sewage treatment plants (Ghana Statistical Service 2012), while 84% of all public-owned and public-managed sewage treatment plants are reported to be non-functional in major cities in Ghana (MLGRD 2010). Surface runoff and untreated liquid waste discharge into open spaces could easily flow into wells especially during the wet seasons where recharge water carries contaminants along (Akple *et al.* 2011). Treatment facilities for faecal sludge are very rare across the country and therefore disposal of human excreta into watercourses and open spaces is the norm (Boot & Scott 2008, 2009). Unbridled disposal of untreated wastewater into watercourses causes surface water pollution (Foster 2001). Moreover, infiltration of these contaminants in surface water into the ground or wastewater discharged directly on the ground surface can compromise groundwater quality (Foster 2001).

This partly explains why despite the tremendous improvement in drinking water coverage countrywide, cholera is still in the ascendency. Figures provided by the Ghana Health Service depict that between 2007 and 2014, cholera cases increased from just 179 in four regions to 28,975 in all ten regions across the country (Ghana Health Service 2007, 2014). In the 2014 cholera outbreak which claimed 243 lives, the Greater Accra Region recorded the highest number of cases (20,199 cases) although the region has a high drinking-water coverage. Undoubtedly, ensuring access to safe drinking water cannot be achieved without concurrently focusing on sanitation. There is therefore an urgent need to focus also on improving environmental sanitation and incorporate water quality data into drinking water coverage figures in the future to provide a

holistic picture of access to safe drinking water. Commendably, Ghana has developed a National Drinking Water Quality Management Framework to 'guide all water supply agencies on effective drinking-water quality management and public health protection' (Government of Ghana 2015a). The framework however failed to explicitly define what access to improved water source refers to thereby leaving a key puzzle in the water sector yet unsolved.

Water coverage and the health indicators

Along with the improvement in water coverage, infant and child mortality rates in Ghana have also shown significant decline over the past two decades (Figure 4). While infant mortality rates reduced by as much as 66% between 1993 and 2014 to meet the target of 19 deaths per 1,000 live births, child mortality rates reduced by more than a third (38%) within the same period. Overall, under-five mortality reduced by almost half between 1990 and 2014: from 122 to 60 deaths per 1,000 live births as against a 2015 target of 53 deaths per 1,000 live births (UNDP/NDPC 2015). Globally, poor water, sanitation and hygiene (WASH) have been linked to under-five mortalities due to diarrheal diseases; increase in access to improved drinking water source reduces child mortality (WHO 2015). This explains the sharp decline in under-five mortalities with increased water coverage in the country.

Evolution of water resources management and potable water supply in Ghana

Over the years, regulation of the use of water in Ghana has greatly evolved from being guided by customary laws to

fragmented state-backed ordinances, legislations and most recently a national water policy. Prior to the 20th century, water resources management was based on traditional laws made obligatory by fetish priests and priestesses (Odame-Ababio 2003). This has since the 1900s been succeeded by series of ordinances and reforms as chronicled in Table 1. Particularly the paradigm shifts in policies and institutional frameworks between 1990 and 2010 (Table 1) had a significant influence on water supply across the country. This undoubtedly contributed to the achievement of the national MDG water target within this period.

Institutional arrangements for Ghana's water sector

Ghana has a strong and well-organised institutional framework for the management of water resources and supply of potable water. The framework defines institutional roles and responsibilities for national and sector-specific policy formulation and planning, regulation and service delivery in the sector (Figure 5). At the national level, the development agenda is driven by the Central Government through the National Development Planning Commission (NDPC). The Commission develops both the short- and long-term development frameworks together with Development Partners who provide financial and technical support. The National Development Framework informs policy development and planning at the sectoral level. At this level, the Ministry of Water Resources, Works and Housing (MWRWH) is directly responsible for drawing up the policies and plans for the water sector (Ministry of Water Resources Works and Housing 2007). It does so in close

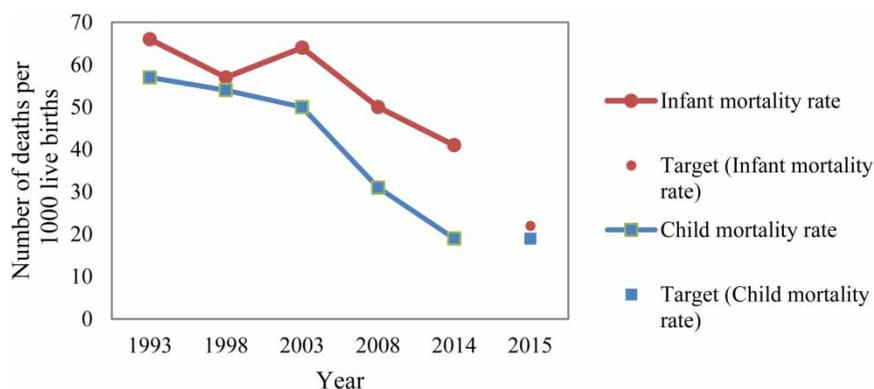


Figure 4 | Trends in infant and child mortality rate in Ghana (UNDP/NDPC 2015).

Table 1 | Evolution of Ghana's water sector

Year	Key sector event
1903 ^a	The Rivers Ordinance (Cap 226 of 1903) was passed to regulate the use of surface water resources
1927 ^a	Forestry Ordinance of 1927 contained sections for catchment protection and control of water withdrawal in forest reserves
1948 ^b	The Department of Rural Water Development was established to provide potable water to rural communities
1953 ^a	Land Planning and Soil Conservation Ordinance of 1953 was passed to, among others, to check soil erosion and control watercourses
1958 ^b	Department of Water Supplies Division formed under the Ministry of Works and Housing for urban and rural water
1965	Ghana Water and Sewerage Corporation (GWSC) established by Act of Parliament (Act 310 of 1965) for urban water supply and wastewater treatment
1992	1992 Constitution of Ghana vested control of all water resources in Ghana in the President on behalf of, and in trust for the people of Ghana
1993 ^c	National Community Water and Sanitation Programme (NCWSP) was formed to increase drinking water coverage in rural areas and small towns
1994	Community Water and Sanitation Department created within GWSC to provide potable water and sanitation for rural communities
1994	EPA established by Act 490 of 1994 to set effluent standards for discharges into waterbodies
1996	The Water Resources Commission (WRC) established by an Act of Parliament (Act 522 of 1996) to be responsible for overall regulation and management of water resources utilization
1997	The PURC established to regulate tariffs and quality standards for the operation of public utilities including water
1998	CWSA was established by Act 564 of 1998 to replace CWSD and to be responsible for management of rural and small water supply systems, hygiene education and provision of sanitary facilities
1999	GWSC was converted to a state-owned limited liability company, GWCL under Act 461
2001	L.I. 1692 Water Use Regulations passed by the WRC to regulate water use
2004	Processes for the formulation of a consolidated national water policy was initiated
2006	Management of GWCL operations contracted to Aqua Vitens Rand Limited (AVRL) for 5 years to improve performance
2007 ^d	Convention on the status of the Volta River and the establishment of the Volta Basin Authority (VBA) signed by all six riparian countries. The VBA is to manage the water resources and other related resource in the Volta Basin in a holistic manner
2007	National water policy was launched to provide an effective interface among key stakeholders, integrate and harmonize their activities
2007	CWSA launches the Strategic Investment Plan, 2008–2015 and The Medium-Term Plan, 2008–2012 for the rural water supply sector
2010 ^e	The Ghana Compact on Sanitation and Water for ALL: A Global Framework for Action (SWA) was launched by the Government of Ghana. This was to assert the Government's resolve to improve efforts towards improving sanitation and sustaining gains in water delivery. The Government resolved to allocate US\$350 million annually to sanitation and water
2011	Management contract abrogated and urban water supply was managed by GWCL and Ghana Urban Water Limited (GUWL)
2011	Launch of Riparian buffer zone policy for managing freshwater bodies in Ghana to ensure sustainable management of buffer zones along freshwater bodies
2012 ^f	National IWRM launched by the WRC to, among others, 'guide and urge the different stakeholders involved in water resources management at different levels to incorporate IWRM in their plans'
2013 ^g	Ghana National Climate Change policy was launched with the vision to 'ensure a climate-resilient and climate-compatible economy while achieving sustainable development through equitable low-carbon economic growth for Ghana'
2013	GWCL and GUWL merged into a single national utility company to manage urban water supply services

Notes: ^aOdame-Ababio (2003).

^bAdombire (2007).

^cFuest *et al.* (2005).

^dWelling *et al.* (2012).

^eGovernment of Ghana (2010).

^fWater Resources Commission (2012).

^gMinistry of Environment Science Technology and Innovation (2013).

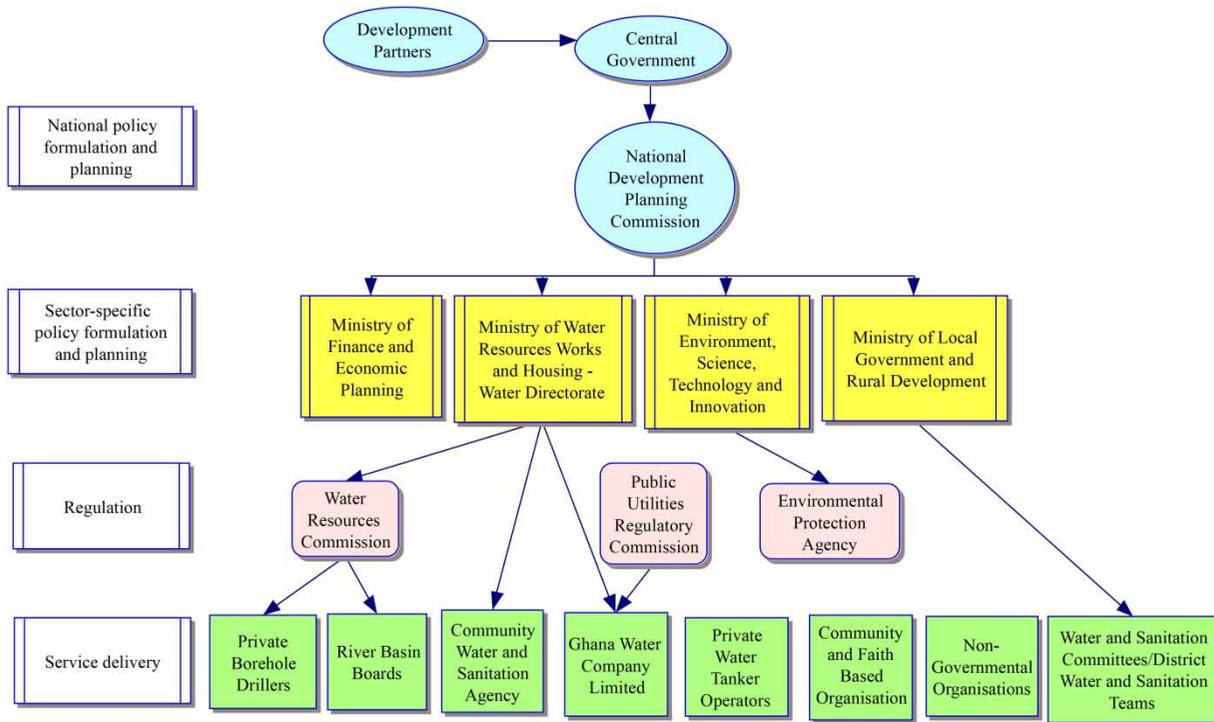


Figure 5 | Institutional framework for Ghana's water sector. (Source: Adapted from Oduro-Kwarteng *et al.* 2015).

consultation with the Ministry of Finance and Economic Planning which prepares the national budget to inform annual expenditure nationwide. Under the MWRWH, the Water Directorate coordinates water service provision in rural and small towns delivered by the Community Water and Sanitation Agency (CWSA) and urban water service delivery by the Ghana Water Company Limited (GWCL). It also oversees the activities of the Water Resources Commission which, among others, is responsible for regulating water resources abstraction across the country. The Commission has River Basin Boards across the country overseeing developments in river basins to ensure protection of water resources. The Public Utilities Regulatory Commission (PURC) is an independent public body which regulates the provision of utility services in the electricity and water sectors. It works in close consultation with utility providers to set tariffs for consumers.

Policies and plans regarding environmental protection are developed by the Ministry of Environment, Science, Technology and Innovation and this has a direct bearing on water resources. Under the Ministry, the Environmental

Protection Agency (EPA) is the regulatory body responsible for managing, protecting and enhancing the country's environment. The Ministry of Local Government and Rural Development oversees development at the local administrative levels in metropolitan, municipal and district assemblies across the country. At this level, Water and Sanitation Committees and District Water and Sanitation Teams are tasked with overseeing delivery of water and sanitation services. Water service delivery at the local level by the public sector is complemented by numerous international and local non-governmental organisations, private organisations, community and faith based organisations. Private borehole drillers lend their services to both individuals and organisations for the provision of water in homes or communities through mechanised or hand-operated wells. This is however, regulated by the Water Resources Commission. In urban communities without access to the urban water supply system, private water tanker operators supply water in water tankers for a fee and their operations are regulated by the PURC (PURC 2008).

Policy framework for Ghana's water sector

The 1992 constitution of Ghana unambiguously set the tone for the ownership and management of Ghana's water resources. As per the constitution, water resources throughout Ghana are vested in the President on behalf of and in trust for the people of Ghana. In line with this, the Central Government, through the NDPC, develops the blueprint for sustainable utilisation of water resources in its near- and long-term National Development Frameworks. The National Water Policy developed in 2007 is therefore a reflection of the national aspirations for water resources management and water supply enshrined in the national development framework (Figure 6). The policy has a complementary implementation framework: the Water Sector Strategic Development Plan (WSSDP) 2012–2025. This plan comprises three distinct strategic planning components, namely: the national Integrated Water Resources Management Plan (IWRM); the Urban Water Supply Strategy; and the Rural Water Supply and Sanitation Strategy. Whilst the national IWRM plan charts the course for sustainable management of all the river basins and related natural resources, the Urban Water Supply Strategy and the Rural Water Supply and sanitation strategy define the strategies for supply of potable water in both urban and rural communities. The Water Use Regulation also gives the legal mandate to the Water Resources Commission to regulate abstraction of water resources. Additionally, in a timely effort to proactively address issues of climate change, Ghana has developed a National Climate Change Policy which provides the blueprint for dealing with the

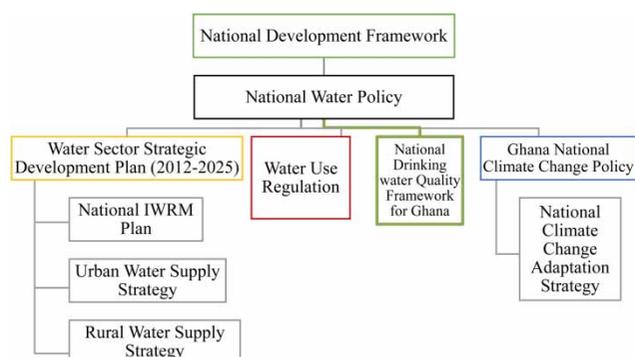


Figure 6 | Water sector policy framework in Ghana.

challenges presented by climate change both in the near- and long-term including water scarcity (Ministry of Environment Science Technology and Innovation 2013). It is complemented by an implementation framework: the National Climate Change Adaptation Strategy, to guide the implementation of the policy.

Financing mechanisms and human right to water in Ghana's water sector

Sustainable financing is crucial for the water sector to provide new infrastructure and sustain existing services. While the provision of new infrastructure requires long-term resources, sustaining existing services requires effective cost recovery mechanisms to support operational expenses as well as maintenance and rehabilitation (Kolker *et al.* 2015). But how exactly has Ghana funded developments in the water sector and what are the arrangements to sustain and expand existing water infrastructure?

An assessment of financing mechanisms in the water sector over the years shows that Ghana has enjoyed the support of external support agencies in funding developments in this sector. This has been a major factor that has fuelled the accelerated improvement in access to drinking water across the country. External funding has been in the form of commercial loans and grants from development partners and constitutes about 90% of the total financing for the sector (WaterAid 2012). Domestic expenditure towards providing potable drinking water represents less than 0.5% of Ghana's gross domestic product in contrast to the eThekwinini commitment (WaterAid 2013; WHO 2015). This is corroborated by Ghana's 2014 budget which indicated that 81% of the GH¢435 million (US\$111 million) allocated to the water sector is expected to be financed by development partners (PricewaterhouseCoopers Ghana 2013).

However, inflows from donors have generally dwindled across the African continent in recent times. Ghana, in particular, is forecasted to move out of International Development Assistance (IDA) eligibility, the heavy reliance on donor funding presents a huge challenge to sustaining the achievements in the water sector in the long term (ADB/OECD/UNDP 2016). In fact, statistics show that aid from the European Union, a major donor to Ghana, began to decline after the financial meltdown in 2008, reducing

by half by 2013 (Forson *et al.* 2015). Between 2008 and 2011, the proportion of inflows from donors towards WASH expenditure has reduced by two-thirds (Figure 7). Total expenditure on WASH is generally dominated by commercial loans and government's expenditure on WASH has not seen any significant improvement (Figure 7). Generally, it is argued that excessive levels of borrowing without productive investment can reduce a country's growth (Pattillo *et al.* 2002; Frimpong & Oteng-Abayie 2006). Ghana's total public debt has doubled in the last decade; from about 34% in 2008 (Government of Ghana 2011) to 70% at the end of 2014 (Ministry of Finance 2016) partly contributed to by increased borrowing for WASH expenditure. Ghana's public debts continue to rise and this has necessitated a request for an extended credit facility from the International Monetary Fund in 2015. To reverse this trend, the Government of Ghana has committed to mobilise domestic resources development and capitalise on concessionary loans for productive investments as per its 2016 budget statement (Government of Ghana 2015b). This commitment needs to be implemented to the letter if sustainable development in the water sector is to be achieved.

Ghana has an enviable 93% urban water coverage (WHO/UNICEF 2015). However, performance indicators show that the urban water utility; GWCL is in dire straits. The company loses about half of water produced through non-revenue water; collects at best three-quarters of its revenue; and recovers about two-thirds of its total costs (Public Utilities Regulatory Commission 2008; Awuah *et al.* 2010; Boakye & Nyieku 2010; The World Bank 2010). This is in spite of significant water tariff rises over the

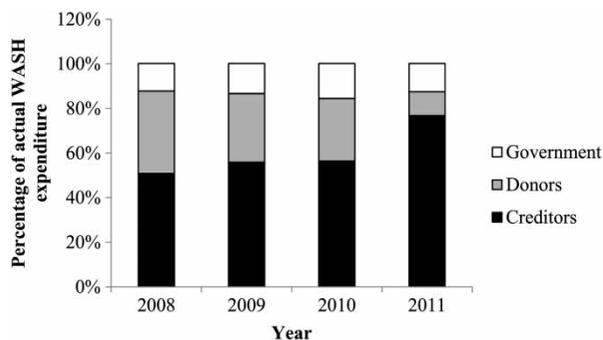


Figure 7 | Pattern of Ghana's actual WASH expenditure from creditors, donors and government. (Source: WaterAid 2012).

years, in a bid to raise more revenue towards achieving full cost recovery (Water and Sanitation Program 2011). The World Bank posits that the poor performance of Ghana's urban water utility is due to extensive leakages in the water distribution networks and extensive commercial theft of water (The World Bank 2010). Meanwhile, a fraction of the proceeds from urban water tariffs (2%) is expected to be used to support rural water supply. This makes improving revenue collection for urban water service critical, not only to sustain operations of the urban water supply systems but also to improve rural water supply.

In the rural water sub-sector, about 90% of the total funding water supply comes from donors (Community Water and Sanitation Agency 2014). However, local water and sanitation committees instituted to ensure the operational sustainability of the systems do not work effectively (CWSA 2014). Sustaining these systems has therefore become the responsibility of donors without which some water supply systems in rural areas fail to operate. There is therefore the impression that very little can be done by the Government of Ghana without the support of donor agencies in a critical sector like water supply (Entsua-Mensah *et al.* 2007).

Innovative financial arrangements are required to ensure that everyone has access to safe drinking water. According to the UN Principle of Human Right to Water, everyone has the right to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses (Office of the United Nations High Commissioner for Human Rights 2010). In line with this, Ghana has instituted various strategies to ensure the right to water across the country is met. Among them is the lifeline tariff system where domestic consumers using less water (20 m³ per month), particularly the poor, are charged lower tariffs (PURC 2005). However, because the urban poor usually live in multiple occupancy houses with a single water metering device, their consumption exceeds the lifeline tariff and thereby pay more than the rich (Nyarko *et al.* 2006). Additionally, poor households without in-house connection to water supply depend on water vendors where they purchase not only contaminated drinking water but also at prices more than 10 times the domestic rates approved by GWCL (Fiasorgbor 2013; Monney *et al.* 2013). Moreover, in utter violation of the human right to

water, disconnection from urban water supply system, especially in low-income areas, is a common practice in Ghana (Boakye 2012; Amankwaa *et al.* 2014). These suggest that the measures instituted to ensure the human right to water are currently ineffective. To overcome this requires extensive studies locally, complemented by experiences from similar countries like Kenya. This will inform adoption of appropriate strategies towards achieving the human right to water. Strategies such as bulk metering for low-income households, automated water kiosks, water bill payment by instalments, and reduced water flow for residents failing to pay water tariffs can be adopted to ensure that people are not denied water but can also pay for the service. Besides regulating water tariffs, the PURC needs to be mandated to ensure that utility service providers provide drinking water of acceptable quality and provide continuous supply of water to consumers. Practicable benchmarks for improvements consented to by both service providers and the regulator should be developed to reward service improvements or otherwise.

Environmental pollution and climate change impacts on water resources in Ghana

Across the country, both domestic and industrial wastewater generally end up entering water courses and open spaces mostly without prior treatment (Ingallinella *et al.* 2002; Taweesan *et al.* 2015). Meanwhile, Ghana has since 1994 set up the EPA which, among others, is tasked to ensure that wastewater is treated before disposal into the environment. In areas where some form of treatment for wastewater exists, the waste water is usually stored in underground septic tanks and emptied by vacuum tanks for treatment at a central location (UNU-IRNA 2014). Sewerage systems which channel wastewater through underground pipes directly to wastewater treatment plants are rarely seen across the country (UNU-IRNA 2014). Nationwide, only less than 5% of all households are connected to piped sewerage systems that are linked to sewage treatment plants (Ghana Statistical Service 2012). There is generally paucity of data on the number and operational status of wastewater treatment plants currently in Ghana. According to available literature, most wastewater treatment facilities in Ghana are in the national capital, Accra, which has

about 14 facilities (UNU-IRNA 2014). However, these facilities are mostly non-functional or in poor operating conditions culminating in the unbridled disposal of untreated human excreta into the sea at Korle Gonno popularly called Lavender Hill (Sam 2015). Uncontrolled disposal of untreated human excreta into the environment is not uncommon across the country and is mostly due to inadequate capital, inappropriate technologies and poor implementation of policies (Taweesan *et al.* 2015).

Besides the unbridled disposal of untreated wastewater into watercourses, illegal mining activities also continue to wreak heavy environmental havoc in Ghana, as extensively reported in the literature (Amponsah-Tawiah & Dartey-Baah 2011; Appiah & Buaben 2012; Owusu & Dwomoh 2012). For instance, in Obuasi, water samples from 12 boreholes, 10 streams and 3 dug wells show arsenic levels between 10 to 38 times higher than the permissible limits by the EPA (ActionAid 2006). A study by Buamah *et al.* (2008) also identified high levels of Arsenic (>50 µg/L) in groundwater in mining areas in Ghana. They observed that, in addition to mining activities, arsenic can also be released into the aquifers naturally through reductive dissolution and desorption. In Tarkwa, extremely high levels of arsenic, lead, cadmium and mercury have been reported in drinking water sources due to mining activities (Obiri *et al.* 2016). Additionally, the activities of illegal miners have caused the shutdown of drinking water treatment systems in Tarkwa, Sekondi-Takoradi and Konongo (Sarpong 2016). Diversion of water by illegal miners from rivers feeding into the reservoirs of these treatment systems have reduced the water volumes in the reservoirs below their operational levels whilst in other instances the raw water has been extremely polluted by mining wastes making water treatment impossible.

The extensive pollution of freshwater resources in the face of climate change poses a huge threat to potable water supply. In some parts of the country, drying of some hitherto perennial rivers in the dry season, flash floods, reduced water storage capacities in major dams, and reduction in groundwater recharge are becoming commonplace as a result of climate change (Kankam-Yeboah *et al.* 2010). Worse still, climate change is predicted to hasten desertification in the northern part of the country coupled with rainfall declines between 25 to 52% and sea level rise

from 0.13 to 0.60 m (Stanturf *et al.* 2011; GSS 2014b). This will have dire consequences on agriculture – a major contributor to Ghana's GDP and thus calls for the adoption of adaptation strategies to minimise the impact. Some of these strategies have been outlined in the National Climate Change Policy and the accompanying Adaptation Strategies document. Most importantly for the water sector, the country needs to focus more attention on efficient water use and water resource protection through wastewater recycling and reuse, afforestation of catchment areas of major river basins and rainwater harvesting.

Building on the successes and overcoming challenges in Ghana's water sector

Ghana has made significant strides in the water sector with the strong support of donors. However, in the years ahead, the annual increase in drinking water coverage countrywide needs to keep pace with the exploding population in the face of a changing climate and a booming economy. This will require a paradigm shift particularly in the financing mechanisms for the water sector as the country consolidates its position as a middle-income country. Strong financial support from domestic sources rather than donor agencies will be required to support efforts in the water sector. Rural water supply still needs to be supported with more revenues from the urban water utility to progressively decouple it from donor agencies. In the short- to medium-term, GWCL needs to focus on significantly reducing non-revenue water and most importantly improving revenue collection. User tariffs may not necessarily need to be increased if non-revenue water is lowered and revenue collection rate is significantly improved. Investments towards replacement of old water infrastructure and construction of new ones should be considered. This can be achieved with private financing for the sector. To attract private investments into the water sector would require an improvement in its commercial efficiency by reducing water losses and increasing revenue collection rates. Moreover, with the recent oil discoveries in the country, the government should increase its allocation of national resources to support the water sector to gradually decouple the sector from external support.

The well-organised institutional framework and policy direction for the country's water sector and subsectors is a

commendable effort from which other countries can learn. The policies and strategic plans however, need to be implemented to the letter if indeed the requisite paradigm shift can materialise. Given the dynamic nature of the water sector, the policies need to be revised accordingly to keep up with new challenges in the future. Institutions need to have a strong capacity with the requisite resources to perform their functions effectively.

Disposal of untreated excreta into watercourse and illegal mining activities would render water resources unfit for use in the absence of a paradigm shift. Improving access to potable water should go hand-in-hand with improving sanitation. Therefore, in the years ahead, sustaining access to improved drinking water would well require investment in household toilet provision and wastewater-to-resource infrastructure through public/private partnerships and instituting an independent task force to regulate the activities of illegal miners across the country.

Promoting extensive use of compost from human excreta for agriculture in Ghana can significantly improve sanitation and crop production but would require strong private sector buy-in, intensive public sensitization and innovative business models (Impraim *et al.* 2014; Appiah-Effah *et al.* 2015). Considering that the country has very few wastewater treatment systems, it could leapfrog to installing infrastructure that generates value from wastewater rather than providing only wastewater treatment system in areas without these facilities. For example, Safi Sana Ghana generates compost and energy from faecal sludge to improve crop yields, reduce pollution and provide reliable energy (Safi Sana 2018). Expanding this and other similar waste-to-value projects to other parts of the country will ensure better wastewater management and improved health outcomes.

Development of a harmonised set of indicators to monitor progress in drinking water supply is also crucial. These indicators must, among others, be based on water quality information on drinking water sources rather than reporting only on improved or unimproved drinking water sources. Adaptation strategies such as water and wastewater recycling, rainwater harvesting, and efficient water use techniques also need to be adopted in the face of climate change.

A critical look at the strategies towards ensuring the human right to water is necessary. Among others, there is

the need to formulate national legislation to support the implementation of this international law nationwide backed by a comprehensive learning agenda which will inform the adoption of appropriate strategies.

CONCLUSION

Ghana's success in providing potable water to a good proportion of its population has been achieved on the back of strong donor support and a strong and well organised institutional and policy framework. Nevertheless, the over-reliance on donors, poor cost recovery mechanisms in the rural and urban water sub-sectors, unbridled disposal of waste into water courses, widespread illegal mining activities, and inadequate and non-functional wastewater treatment facilities threaten to unwind the progress made in the sector. Considering the rapid population growth, a booming economy and a changing climate, achieving sustainable universal water coverage would require a paradigm shift in current efforts. Most importantly, the government needs to show a strong commitment in allocation of local financial resources to support the water sector and simultaneously invest in improving sanitation. Borehole construction methods need to be improved to protect the groundwater against pollution arising from ingress of polluted surface runoff. Private sector investment in infrastructure provision should be leveraged to complement government's efforts. The urban water utility needs to focus on significantly reducing non-revenue water and improving revenue collection. This will reduce the need to regularly increase user tariffs, which have so far been fruitless in ensuring full cost recovery for the utility. Water resources also need to be protected from the onslaught of untreated wastewater discharges and illegal mining activities. To achieve this, the government should focus more on investing in wastewater treatment infrastructure across the country through public/private partnerships and instituting an independent agency to regulate illegal mining activities across the country. Extensive water-resource monitoring must be instituted to monitor quality of water from improved water sources and inform adoption of proactive measures for water resource and public health protection. A national legislation on ensuring human right to water in

the country must be developed based on extensive studies of global best practices to ensure effective implementation.

REFERENCES

- ActionAid 2006 *Gold Rush: The Impact of Gold Mining on Poor People in Obuasi in Ghana*. Retrieved from: <http://curtisresearch.org/publications/gold-rush-the-impact-of-gold-mining-on-poor-people-in-obuasi-ghana/> (accessed online 3 January 2017).
- 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>.
- Adombire, M. A. 2007 *Water Supply for the Consumer: A Concise Practical Guide*. Science Press, CSIR, Ghana.
- Akple, M., Keraita, B., Konradsen, F. & Agbenowu, E. 2011 *Microbiological quality of water from hand-dug wells used for domestic purposes in urban communities in Kumasi, Ghana*. *Urban Water Journal* 8, 57–64.
- Amankwaa, E. F., Owusu, A. B. & Owusu, G. 2014 Accra's poverty trap: analysing water provision in urban Ghana. *Journal of Social Science for Policy Implications* 2, 69–89.
- Amponsah-Tawiah, K. & Dartey-Baah, K. 2011 The mining industry in Ghana: a blessing or a curse. *International Journal of Business and Social Science* 2, 62–69.
- Appiah, D. O. & Buaben, J. N. 2012 Is gold mining a bane or a blessing in Sub-Saharan Africa: the case of Ghana. *International Journal of Development and Sustainability* 1, 1033–1048.
- Appiah-Effah, E., Nyarko, K. B., Adum, L., Ofosu, E. A. & Awuah, E. 2015 *Perception of peri-urban farmers on fecal sludge compost and its utilization: a case study of three peri-urban communities in Ashanti Region of Ghana*. *Compost Science & Utilization* 23, 267–275. doi:10.1080/1065657X.2015.1046616.
- Awuah, E., Nyarko, K. B. & Owusu, P. A. 2010 Water and sanitation in Ghana. *Desalination* 252, 43–50.
- Bain, R., Cronk, R., Wright, J., Yang, H., Slaymaker, T. & Bartram, J. 2014 *Fecal contamination of drinking-water in low and middle-income countries: a systematic review and meta-analysis*. *PLOS Medicine* 11. doi:10.1371/journal.pmed.1001644.
- Boakye, K. O. 2012 *Incentives for Water Supply to the Urban Poor*. Master's Thesis, Department of Civil Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
- Boakye, E. & Nyieku, I. E. 2010 Cost recovery analysis of Ghana Water Company Limited (GWCL): a case study of Sekondi-Takoradi Metropolis. *European Journal of Scientific Research* 46, 119–125.
- Boot, N. L. D. & Scott, R. E. 2008 Faecal sludge management in Accra, Ghana: strengthening links in the chain. In: 33rd

- WEDC International Conference, 7–11 April, 2008, Accra, Ghana.
- Boot, N. L. & Scott, R. E. 2009 **Faecal sludge in Accra, Ghana: problems of urban provision**. *Water Science and Technology* **60** (3), 62331.
- Buamah, R., Petrusovski, B. & Schippers, J. C. 2008 **Presence of arsenic, iron and manganese in groundwater within the gold-belt zone of Ghana**. *Journal of Water Supply: Research and Technology – AQUA* **57**, 519–529.
- Community Water and Sanitation Agency 2014 *Annual Report*. Ministry of Water Resources Works and Housing, Accra, Ghana.
- Dzwireo, B., Hoko, Z., Love, D. & Guzha, E. 2006 **Assessment of the impacts of pit latrines on groundwater quality in rural areas: a case study from Marondera district, Zimbabwe**. *Physics and Chemistry of the Earth* **31**, 779–788.
- Entsua-Mensah, R. M., Essegbey, G., Frempong, G. & Engmann, C. 2007 *Assessment of Community Water and Sanitation in Ghana*. African Technology Policy Studies Network (ATPS), Working Paper Series 45, Nairobi, Kenya.
- Fiasorgbor, D. A. 2013 **Water and sanitation situation in Nima and Teshie, greater Accra Region of Ghana**. *Journal of Toxicology and Environmental Health Sciences* **5**, 23–28. doi:10.5897/JTEHS12.054.
- Forson, J. A., Buracom, P., Baah-Ennumh, T. Y., Chen, G. & Carsamer, E. 2015 **Corruption, EU Aid inflows and economic growth in Ghana: cointegration and causality analysis**. *Contemporary Economics* **9**, 299–318.
- Foster, S. S. D. 2001 **The interdependence of groundwater and urbanisation in rapidly developing countries**. *Urban Water* **3**, 185–192.
- Frimpong, J. M. & Oteng-Abayie, E. F. 2006 **The impact of external debt on economic growth in Ghana: a cointegration analysis**. *Journal of Science and Technology* **26**, 121–130.
- Fuest, V., Ampomah, B., Haffner, S. A. & Tweneboah, E. 2005 *Mapping the Water Sector of Ghana: An Inventory of Institutions and Actors*. The GLOWA Volta Project, Center for Development Research, Germany.
- Galadima, A., Garba, Z. N., Leke, L., Almustapha, M. N. & Adam, I. K. 2011 **Domestic water pollution among local communities in Nigeria – causes and consequences**. *European Journal of Scientific Research* **52**, 592–603.
- Ghana Health Service 2007 *Annual Report*. Ghana Health Service, Accra, Ghana.
- Ghana Health Service 2014 *Annual Report*. Ghana Health Service, Accra, Ghana.
- Ghana Statistical Service 2012 *2010 Population and Housing Census*. Ghana Statistical Service (GSS), Accra, Ghana.
- Ghana Statistical Service 2013 *2010 Population and Housing Census Report. Children, Adolescents and Young People in Ghana*. Ghana Statistical Service, Accra, Ghana.
- Ghana Statistical Service 2014a *Ghana Living Standards Survey Round 6*. Ghana Statistical Service, Accra, Ghana.
- Ghana Statistical Service 2014b *Gross Domestic Product 2014*. Ghana Statistical Service, Accra, Ghana.
- Government of Ghana 2010 *The Ghana Compact. Sanitation and Water For All: A Global Framework for Action*. Government of Ghana, Accra, Ghana.
- Government of Ghana 2011 *Joint Review of Public Expenditure and Financial Management*. Government of Ghana, Accra, Ghana.
- Government of Ghana 2012 *National Urban Policy Framework*. Government of Ghana/Ministry of Local Government and Rural Development, Accra, Ghana.
- Government of Ghana 2015a *National Drinking Water Quality Management Framework for Ghana*. Ministry of Water Resources, Works and Housing, Accra, Ghana.
- Government of Ghana 2015b *The Budget Statement and Economic Policy of the Government of Ghana for the 2016 Financial Year*. Ministry of Finance, Accra, Ghana.
- Graham, J. P. & Polizzotto, M. L. 2013 **Pit latrines and their impacts on groundwater quality: a systematic review**. *Environmental Health Perspectives* **121**, 521–530.
- Howard, G., Pedley, S., Barrett, M., Nalubega, M. & Johal, K. 2003 **Risk factors contributing to microbiological contamination of shallow groundwater in Kampala, Uganda**. *Water Research* **37**, 3421–3429.
- Hunter, P. R., Zmirou-Navier, D. & Hartemann, P. 2009 **Estimating the impact on health of poor reliability of drinking water interventions in developing countries**. *Science of the Total Environment* **407**, 2621–2624.
- Impraim, R., Nikiema, J., Coffie, O. & Rao, K. 2014 **Value from faecal sludge and municipal organic waste: fertilizer cum soil conditioner in Ghana**. In: *37th WEDC International Conference, Briefing Paper 2035*, Hanoi, Vietnam.
- Ingallinella, A. M., Sanguinetti, G., Koottatep, T., Montangero, A. & Strauss, M. 2002 **The challenge of faecal sludge management in urban areas – strategies, regulations and treatment options**. *Water Science and Technology* **46**, 285–294.
- Kankam-Yeboah, K., Amisigo, B. & Obuobi, E. 2010 **Climate change impacts on water resources in Ghana**. Ghana National Commission for UNESCO. In: *Proceeding of the Pan-African Workshop on ‘Decision-Making Support for Coastal Zone Management, Water Resources and Climate Change in Africa’*, 15–17 February 2010, Cotonou, Benin.
- Kolker, J., Kingdom, B. & Bradley, A. K. I. 2015 *Innovative Finance in the Water and Sanitation Sector*. *The World Bank at World Water Week 2015*. Retrieved from: blogs.worldbank.org/water/innovative-finance-in-the-water-and-sanitation-sector (accessed online 13 August 2016).
- Ministry of Environment Science, Technology and Innovation 2013 *Ghana National Climate Change Policy*. Ministry of Environment, Science, Technology and Innovation, Accra, Ghana.
- Ministry of Finance 2016 *End of Year Report on the Budget Statement and Economic Policy of the Republic of Ghana for the 2015 Financial Year*. Government of Ghana, Accra, Ghana.

- Ministry of Local Government and Rural Development (MLGRD) 2010 *National Environmental Sanitation Strategy and Action Plan (NESSAP)*. Environmental Health and Sanitation Directorate, Accra, Ghana.
- Ministry of Water Resources, Works and Housing 2007 *National Water Policy*. Government of Ghana, Accra, Ghana.
- Monney, I., Buamah, R., Odai, S., Awuah, E. & Nyenje, P. M. 2013 Evaluating access to potable water and basic sanitation in Ghana's largest urban Slum Community: old Fadama, Accra. *Journal of Environment and Earth Science* **3**, 72–80.
- Monney, I., Baffoe-Kyeremeh, A. & Amissah-Reynolds, P. K. 2015 Accelerating rural sanitation coverage in Ghana: what are the speed bumps impeding progress. *Journal of Water, Sanitation and Hygiene for Development* **5**, 531–543.
- Nyarko, K. B., Odai, S. N. & Fosuhene, K. B. 2006 Optimising social inclusion in urban water supply in Ghana. In: *1st SWITCH Scientific Meeting*, University of Birmingham, UK.
- Obiri, S., Mattah, P. A. D., Mattah, M. M. & Armah, F. A. 2016 Assessing the environmental and socio-economic impacts of artisanal gold mining on the livelihoods of communities in the Tarkwa Nsuaem Municipality in Ghana. *Int. J. Environ. Res. Public Health* **13**, 1–15.
- Obiri-Danso, K., Adjei, B., Stanley, K. N. & Jones, K. 2009 Microbiological quality and metal levels in wells and boreholes water in some peri-urban communities in Kumasi, Ghana. *African Journal of Environmental Science and Technology* **3**, 59–66.
- Odame-Ababio, K. 2003 Putting Integrated Water Resource Management Into Practice – Ghana's Experience. Proceedings of the African Regional Workshop on Watershed Management. In *FAO (2005). Preparing For the Next Generation of Watershed Management Programmes and Projects*. In *Proceedings of the African Regional Workshop*, Rome, Italy.
- 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**, 502–519.
- Office of the United Nations High Commissioner for Human Rights 2010 *The Right to Water*. United Nations, Geneva, Switzerland.
- Onda, K., LoBuglio, J. & Bartram, J. 2012 Global access to safe water: accounting for water quality and the resulting impact on MDG progress. *International Journal of Environmental Research and Public Health* **9**, 880–894. doi:10.3390/ijerph9030880.
- Owusu, E. E. & Dwomoh, G. 2012 The impact of illegal mining on the Ghanaian youth: evidence from Kwaebibirem District in Ghana. *Research on Humanities and Social Sciences* **2**, 86–92.
- Parker, K. T. 2000 *Bacterial Contamination of Drinking Water in Rural Ghana*. Master's Thesis, California State University, Sacramento, USA.
- Pattillo, C., Ricci, L. & Poirson, H. 2002 External debt and growth. *Finance and Development* **39** (2), 32–35. Retrieved from: <http://www.imf.org/external/pubs/ft/fandd/2002/06/pattillo.htm> (accessed online 28 September 2016).
- PricewaterhouseCoopers Ghana 2013 *2014 Budget Highlights. Rising to the Challenge: Realigning the Budget to Meet key National Priorities*. PricewaterhouseCoopers Ghana Ltd, Accra, Ghana.
- Public Utilities Regulatory Commission 2005 *Urban Water Tariff Policy*. Public Utilities Regulatory Commission, Accra, Ghana.
- Public Utilities Regulatory Commission 2008 *Annual Report 2008*. Retrieved from: <http://www.purc.com.gh/purc/sites/default/files/annualreport8.pdf> (accessed online 18 August 2016).
- Safi Sana 2018 *Impact & Achievements*. Retrieved from: <http://www.safisana.org/impact-and-achievements/> (accessed online 12 February 2018).
- Sam, A. 2015 *Transforming Lavender Hill Into the Pearl of Accra: Jospong Group Invest \$41.2 Million in Wealth Creation From Faecal Matter*. Retrieved from: www.graphic.com.gh/features/features/transforming-lavender-hill-into-the-pearl-of-accra-jospong-group-invests-41-2-million-in-wealth-creation-from-faecal-matter.html (accessed online 12 August 2016).
- Sarpong, J. O. 2016 *GWCL Taking Steps to Stop Illegal Mining in Konongo Area*. Retrieved from: <http://citifmonline.com/2016/05/26/gwcl-taking-steps-to-stop-illegal-mining-in-konongo-area/> (accessed online 12 August 2016).
- Stanturf, J. A., Warren, M. L. J., Charnley, S., Polasky, S. C., Goodrick, S. L., Armah, F. & Nyako, Y. A. 2011 *Ghana Climate Change Vulnerability and Adaptation Assessment*. United Nations, Washington, DC, USA.
- Taweesan, A., Koottatep, T. & Polprasert, C. 2015 *Effective faecal sludge management measures for onsite sanitation systems*. *Journal of Water, Sanitation and Hygiene for Development* **5**, 483–492.
- The World Bank 2010 *Ghana's Infrastructure: A Continental Perspective*. The World Bank, Washington, DC, USA.
- The World Bank Group 2016 *Ghana: Overview*. Retrieved from: www.worldbank.org/en/country/Ghana/overview#1 (accessed online 12 August 2016).
- UNDP, Ghana & NDPC/GOG 2012 *2010 Ghana Millennium Development Goals Report*. UNDP, Ghana & NDPC/GOG, Accra, Ghana.
- UNDP/NDPC 2015 *Ghana Millennium Development Goals. 2015 Report*. UNDP/NDPC, Accra, Ghana.
- United Nations University Institute for Natural Resources in Africa 2014 *Estimates of wastewater generation and use in urban Ghana*. In: *Harnessing Land and Water Resources for Improved Food Security and Ecosystem Services in Africa* (E. E. Oku, K. O. Asubonteng & P. Nutakor, eds). Pixedit Limited, Accra, Ghana.
- Water and Sanitation Program 2011 *Water Supply and Sanitation in Ghana: Turning Finance Into Services for 2015 and Beyond. An AMCOW Country Status Overview*. Retrieved: <https://wsp.org/sites/wsp.org/files/publications/CSO-Ghana.pdf> (accessed online: 18 August 2016).
- WaterAid 2012 *Financing of the Water, Sanitation and Hygiene Sector in Ghana: Case Study*. Retrieved from: www.wateraid.org.

[org/~ /media/files/uk/keeping-promises-case-studies/Ghana-the-financing-of-the-water-sanitation-and-hygiene-sector.pdf](#) (accessed online: 14 August 2016).

WaterAid 2013 *Keeping Promises: why African Leaders Need now to Deliver on Their Past Water and Sanitation Commitments*. WaterAid, UK.

Water Resources Commission 2012 *National Integrated Water Resources Management Plan*. Water Resources Commission, Accra, Ghana.

Welling, R., Cartin, M., Baykono, D. & Diallo, O. 2012 *Transboundary Water Management Through Multi-Level Participatory Governance and Community Projects. Ghana and Burkina Faso. Water and Nature Initiative (Wani) Case Study*. IUCN Water Programme, Volta River Basin.

WHO 2015 *UN-Water Global Analysis and Assessment of Sanitation and Drinking Water: Ghana*. WHO Press, Geneva, Switzerland.

WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation 2010 *Progress on Sanitation and Drinking-Water: 2010 Update*. WHO/UNICEF, World Water Week 5–11 September, Stockholm, Sweden.

WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation 2012 *Progress on Drinking Water and Sanitation: 2012 Update*. WHO/UNICEF, Geneva and New York, USA.

WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation 2015 *Progress on Sanitation and Drinking Water – 2015 Update and MDG Assessment*. WHO/UNICEF, Geneva and New York, USA.

First received 30 October 2016; accepted in revised form 16 February 2018. Available online 9 March 2018