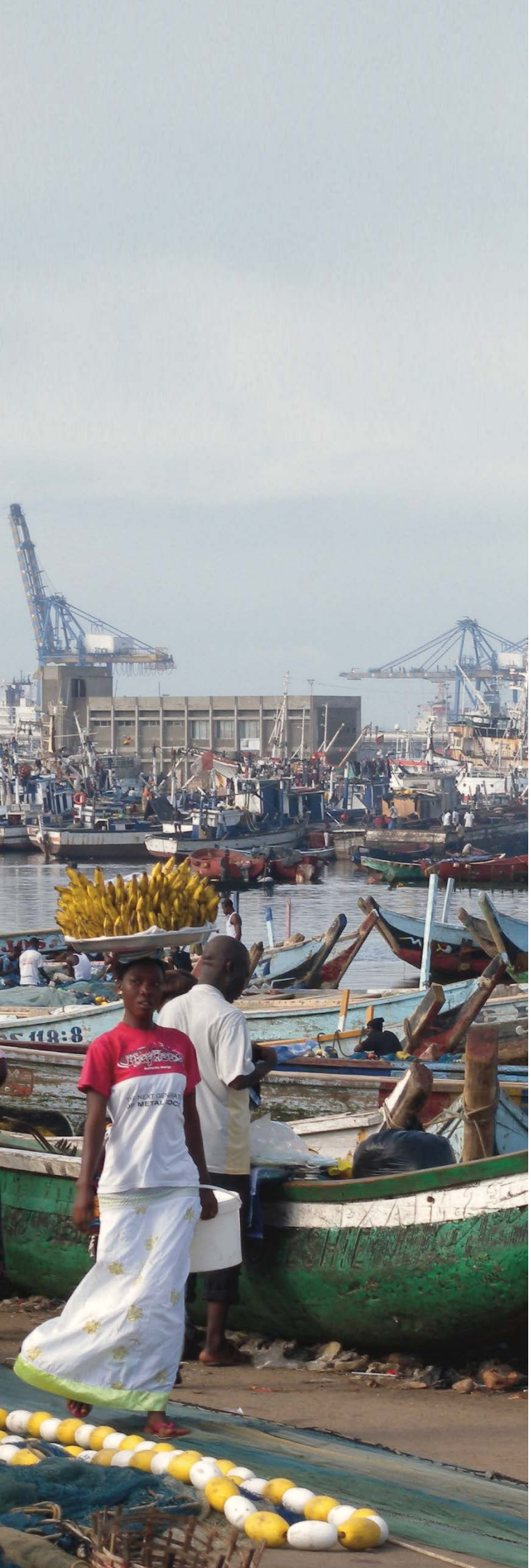

Universität Trier

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Featuring water infrastructure, provision and access in the Greater Accra Metropolitan Area

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The authors appear in alphabetic order and should not be taken to indicate lead-authorship. Both authors contributed equally to the work.

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Abstract

As in many other cities of the Global South, in Accra and its Greater Metropolitan Area (GAMA) water provision for drinking, domestic and productive uses is coproduced by multiple provisioning and delivery modalities. This paper contributes to the overall understanding of socio-spatial conditions of urban water (in)security in GAMA. By looking at the geography of infrastructure and inequalities in water access, it seeks to identify patterns of uneven access to water. The first part provides an overview of urban water supply in GAMA, focusing on water infrastructure and the perspective of water providers. In the second part, households' access strategies are discussed by combining both quantitative and qualitative perspectives. The paper brings together literature research and empirical material collected during fieldwork in the Ghanaian capital city.

Featuring water infrastructure, provision and access in the Greater Accra Metropolitan Area

Rossella Alba, Lara Esther Bartels

1 Introduction

In the Greater Accra Metropolitan Area, the piped water network covers only a limited part of the urban and peri-urban agglomerate: roughly, about half of the residents have access to a piped water connection provided by the water utility Ghana Water Company Limited (GWCL; Adank, Darteh, Moriarty, & Osei, 2011: v). However, having a connection in the house or yard does not guarantee regular water supply (Stoler et al., 2012). Due to an ongoing water rationing scheme, piped water supply is restricted to particular days and times per week (Peloso & Morinville, 2014; Stoler et al., 2012). Given the limited and uneven water supply through the piped water network, multiple water provisioning systems have emerged (Adank, Darteh, Moriarty, & Osei, 2011). Meanwhile, many households have developed multiple strategies to ensure regular access to water for both domestic and drinking uses. Although these multiple water providers initially emerged as a measure to 'fill the gap', today they serve a considerable part of the (peri-) urban population, becoming a central feature of contemporary urbanization processes (Ahlers, Cleaver, Rusca, & Schwartz, 2014; Alba & Bruns, 2016; Bartels & Bruns, 2016).

Several authors underline the importance of fostering an understanding of urban water supply as the combination of both the heterogeneity of delivery configuration and the everyday negotiations of water access. Ahlers et al. (2014) draw attention to the coproduction of water supply; Schwartz, Tutusaus Luque, Rusca, and Ahlers (2015) argue for looking at water supply as a meshwork of service provisioning that works in between formal and informal arrangements. Jaglin (2014:345) calls for "reconceptualising the relationship between urban heterogeneity and socio-technical diversity […] as an integral part of the material fabric of southern cities". In agreement with the views expressed by these authors, this paper seeks to provide an integrated understanding of urban water provision by bringing together the providers´ and the households´ perspectives in urban water supply. A combined reading of both provision and access provides a comprehensive understanding of water supply and gives insights into the multiple coexisting socio-material configurations that allow water to flow within and beyond the city.

The paper focuses on water provision and accessibility within Greater Accra Metropolitan Area (GAMA). GAMA commonly refers to the urban concentration that developed around the Accra Metropolitan Area (AMA) following rapid population growth and the expansion of the built-up area from AMA towards the peri-urban fringe. The population within GAMA grew from 827,983 in 1970 to 3,656,423 in 2010, with a growth rate of 3.8 between 2000 and 2010 (Owusu and Oteng-Ababio, 2015).

Currently, GAMA is made up of 12 administrative units comprising Metropolitan, Municipal and Districts Assemblies (MMDAs; see figure 1, p.2). MMDAs are local government authorities responsible for the overall development of the districts (Local Government Act (Act 462), 1993). The Local Government Act of 1993 (Act 462) classifies MMDAs based on population

and settlement characteristics: a Metropolitan Assembly is a local government unit with a minimum of 250,000 people, a Municipal Assembly with a minimum of 95,000 people and a District Assembly with a minimum population of 75,000.

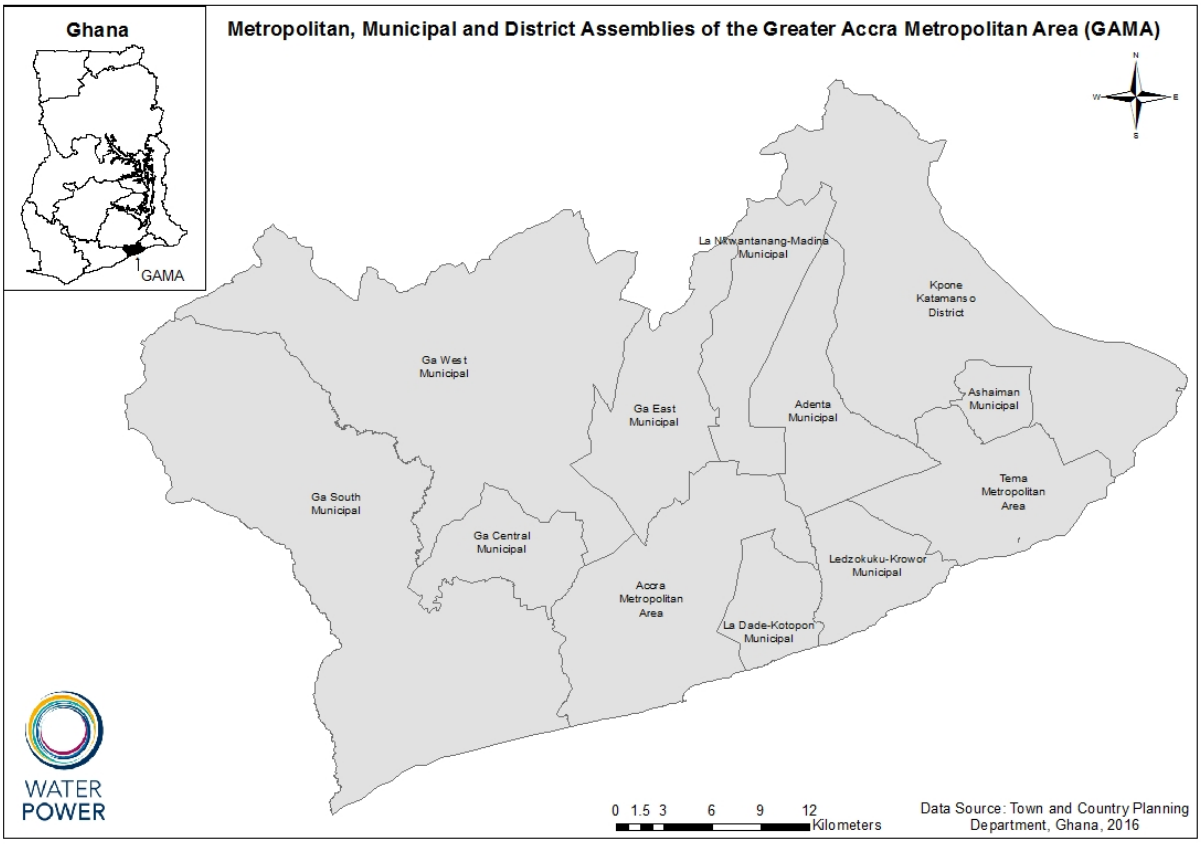

Figure 1: Metropolitan, Municipal and District Assemblies (MMDAs) that make up Greater Accra Metropolitan Area.

The paper builds on literature relating to water supply in Accra, secondary data and empirical qualitative data collected during fieldwork carried out in GAMA by the authors in 2015. During the fieldwork, multiple research methods were employed including interviews, participatory observation and mapping exercises. Interviews were held with actors involved in the multiple water provision modalities including officials of the Ghana Water Company Limited (GWCL), Community Water and Sanitation Agency (CWSA), members of community-based small town water supply systems, representatives of NGOs and companies that manage water kiosks in GAMA. Officials responsible for water supply in different MMDAs and private water providers operating in different areas within GAMA were also interviewed. In addition, household interviews were conducted in two peri-urban localities of GAMA. Field visits were carried out to the two main water treatment plants that supply water through the piped network in GAMA (Weija and Kpong) and to decentralized small systems and kiosks.

Figure 2 (see p.3) depicts the integrated framework on water provision and access modalities in relation to domestic water supply in GAMA. The figure can be read from both sides, the top and bottom. Reading it from the bottom shows how water is provided or flowing to a household; starting from the upper part (the household) shows how households access water in GAMA. We identified four main water access/provision configurations: i) self-supply including privately financed household water supply (i.e. groundwater abstraction via private borehole), ii) bucket-access, which is access to small quantities of water provided by an intricate chain of water providers, iii) storage facility access, namely access to large quantities of water provided in bulk by tankers, and iv) direct in-house connection.

In the rest of the paper, these configurations are described further. Starting from the water provision perspective, we illustrate the key features of the main provision modalities including infrastructure, regulatory mechanisms and spatial aspects of operation. We then discuss available quantitative data on water access and enhance this data with a qualitative perspective on multiple strategies households employ to access water, for instance by resorting to different water sources and providers. In the last section, we discuss the implications of a combined analysis of water provision.

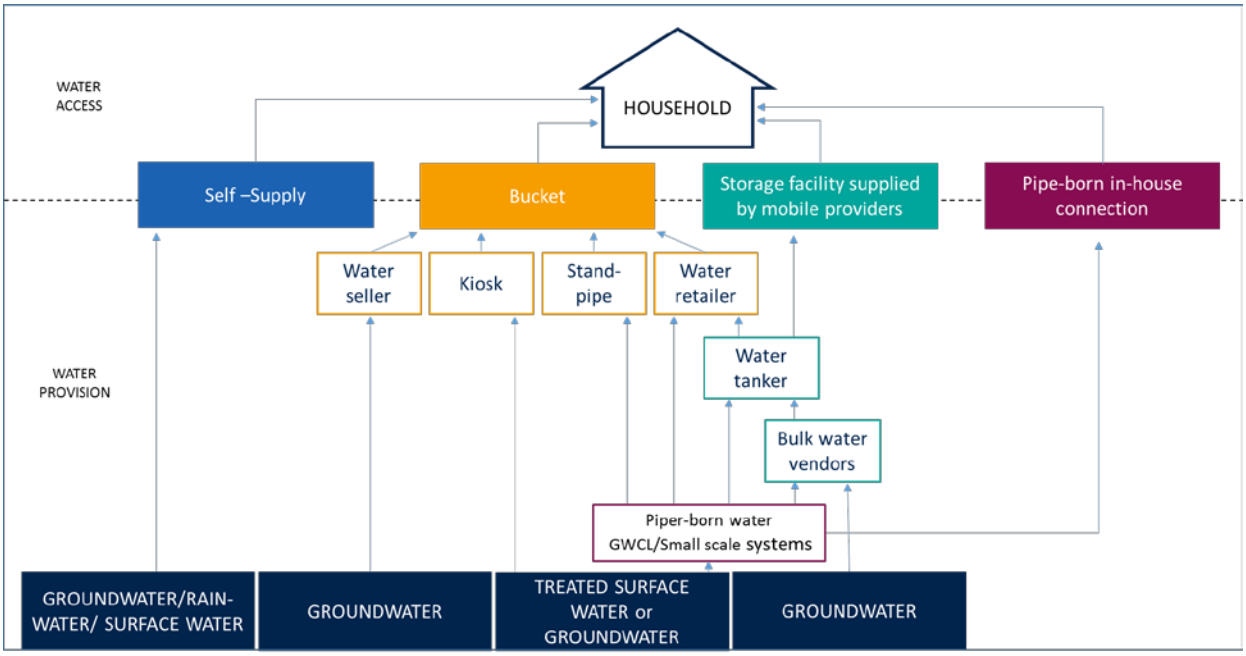

Figure 2: Water access/provision in GAMA.

2 The provision perspective

Urban water supply in Accra involves a whole range of service provision modalities and access strategies that contribute to serve the daily water needs of residents (Ahlers et al., 2014). Overall, one can identify and distinguish between five different water provision modalities: 1) utility managed water supply of Ghana Water Company Limited (GWCL), 2) community managed small town water supply systems, 3) water kiosks, 4) mobile water providers, and 5) domestic vendors. These often operate in an intertwined and complementary manner involving a meshwork of infrastructure, formal and informal delivery practices and regulatory modalities (Schwartz et al., 2015). This section provides an overview of water provision modalities in GAMA in relation to water infrastructure firstly and secondly in relation to management and regulation of water providers. The features of each provision modality are summarized in Table 1 at the end of the section, while illustrative pictures are included in Appendix A.

2.1 Infrastructure

Infrastructure mediates the flow of water within the city from source to households. As Monstadt (2009, pp. 1933–1934) notes, "these durable technical artefacts not only directly shape resource flows for long time periods, but also (…) shape individual interactions, and the socioeconomic, institutional, and spatial structures that regulate these resource flows". Given its longevity, large-scale networked infrastructure physically embodies successive socio-technical regimes – i.e. phases of management, investment and social, technical and political choices (Bakker, 2010, p. 110; Graham & Marvin, 2001).

Urban water supply infrastructure commonly refers to the network of pipes, mains, booster stations and reservoirs that make up the piped water network (Jaglin, 2014). Yet the piped water network is not the only water supply infrastructure present in GAMA; buckets, tanker trucks, small towns systems, kiosks are also part of the infrastructure that allows residents to access water in the Metropolitan Area (Peloso & Morinville, 2014). This water infrastructure includes multiple heterogeneous systems that operate at multiple scales, from the large piped water network managed by GWCL to small scale decentralized systems and compound systems. Water infrastructure is thus conceptualized as a dynamic combination of technological arrangements and residents´ actions that make it possible for water to flow through the city (Alba and Bruns, 2016).

Ghana Water Company Limited (GWCL) provides water to GAMA through a large-scale distribution network, which takes water from Kpong Water Treatment Plant (KWTP) and Weija Water Treatment Plant (WWTP). The KWTP is located in the Eastern Region about 70 km from Accra. The plant draws water from the Volta River and as of 2007, it had an average capacity of about 220,454 m^3/day for supplying the Accra-Tema Metropolitan Area

system. The WWTP draws water from the Densu River and as of 2007, the plant had an average capacity of about 170,000 m3/day (Adank et al., 2011). The GWCL supply system and piped network have recently been extended. The Kpong WTP capacity and the distribution networks were upgraded under the Kpong Water Supply Expansion Project (KWSEP) (Andoh, 2014). Furthermore, in April 2015 a desalination plant was set up to provide water to some localities including the Teshie-Nungua area in Accra close to the sea. The plant operates through a public private partnership arrangement between the GWCL and the Spanish company Abengoa (Ogawa, 2016). Plans for eventual network expansion are included in the on-going Greater Accra Metropolitan Area Sanitation and Water Project financed by the World Bank (World Bank, 2013). Despite current investments, the supply capacity of the GWCL system does not meet the demand for water in urban and peri-urban Accra. In order to deal with the mismatch between demand and supply, the GWCL has implemented a rationing scheme that was first introduced in the 1980s. Several years after its inception, the rationing scheme is unevenly implemented following the "interplay between household billability and local 'infrastructure ecology' ", which refers to the pressure in the piped system and the size and elevation of the neighbourhood (Stoler et al., 2012, p. 251).

In peri-urban areas where the GWCL piped network is (still) not present, one finds small-scale decentralized water supply systems. These include **community managed small town water supply systems** and **water kiosks**. The former constitutes in-situ plants where groundwater is abstracted and distributed through a combination of public standpipes and direct household connections (Community Water and Sanitation Agency, 2010). Generally, one system provides water to several communities located in the vicinity. For instance, the Pantang small town water supply system covers twelve communities, 3 located in Pantang and 9 in surrounding areas (Pantang Area Water and Sanitation Board, 2015). As of September 2015, the system served 25 standpipes and a total of 1,379 households with an in-house or yard connection (ibid.). Within GAMA, small town systems are located in Abokobi, Pantang, Oyibi and Azhaaladza. Another system in Mayera-Adusa has recently been inaugurated (not shown in Figure 3, p.6), but as of August 2015, no water was flowing (field visit, August 2015). **Water kiosks** also operate at a small-scale, generally communal level. They consist of a decentralised purification system in which surface water is locally treated and sold to users in buckets or smaller containers (Safe Water Network, 2013). Both community managed small town water supply systems and kiosks are forms of decentralized infrastructure that depend on local water sources (surface or groundwater). As with the GWCL, water flows in these systems are irregular, mostly due to the continuous and common energy blackouts that affect the Ghanaian capital.

The map below illustrates the extent of the piped water infrastructure of the GWCL together with the location of community managed systems and water kiosks visited during fieldwork (Figure 3).

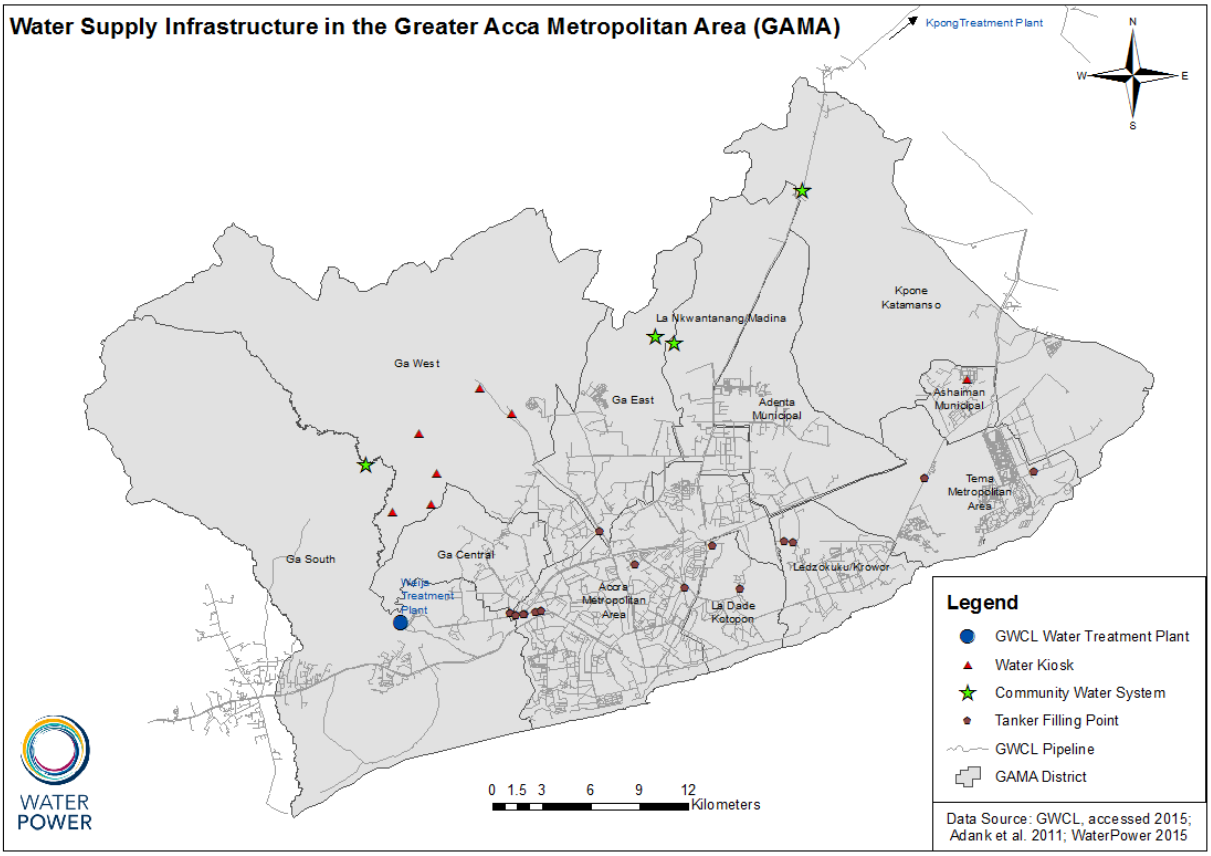

Figure 3: GAMA water infrastructure.

As a response to the limited coverage of the GWCL piped water network and the unreliable flow of water in both the GWCL network and small-scale community managed systems, mobile water providers (i.e. tanker trucks) and domestic vendors have emerged. These categories of water providers either buy piped water from GWCL or abstract groundwater (borehole) within their compounds and sell it. Given the dispersed locations of the vendors and constant fluctuation of the number of trucks and vendors active in GAMA, these could not be included in the above figure. However, they are an integral part of the water infrastructure of the city. These mobile water providers and vendors are described in the following paragraphs.

Mobile water providers include private individuals or organized groups who purchase, deliver and sell bulk quantities of water (minimum of 2,000 litres) to households, institutions and companies. Besides official filling points for tanker water providers established by the GWCL (see figure 1, p.2), bulk vendors also sell water to tankers. These include private individuals that either buy water from the GWCL at commercial rates and resell it to mobile tankers, or abstract and sell groundwater within their premises or in dedicated compounds (Alba & Bruns, 2016). The former are located in areas served by GWCL and have formal agreements with the utility company, the latter operate mostly in peri-urban areas where shallow groundwater is

present. In particular, ´water stations´ resembling petrol stations have emerged in peri-urban areas. Here, groundwater is abstracted from multiple points within one compound, stored in large concrete tanks (reservoirs) and sold via overhead filling systems to tankers. Water tankers deliver water in bulk quantities in both urban and peri-urban areas, sometimes covering long distances between source and customers, while tricycles operate at the neighbourhood level covering shorter distances. These are individuals delivering water with tricycles in small quantities in the areas surrounding water kiosks or domestic vendors.

Domestic vendors include individuals who sell water within their own house or compound. Broadly, we can separate between neighbourhood retailers, neighbourhood sellers and bulk water vendors. The first sell water in buckets either from pipes in households connected to GWCL systems, a piped connection from the small town supply systems, or from water tankers. The second group, neighbourhood sellers, sell water in buckets from their own source, for instance groundwater through a private borehole or well. The third group, bulk water vendors, includes private individuals who sell water in bulk quantities for commercial purposes, mainly to water tankers. However, these categories are not mutually exclusive as the same vendor can sell water both in bulk quantities and in buckets depending on the demand.

Domestic vendors have different levels of professionalization: some offer customers the opportunity to fetch water with a rope and bucket directly from their wells or storage facility, others build small compound systems. Compound systems are made up of a series of taps integrated in the outer wall of a compound that are connected to an overhead or underground water storage tank through a system of pipes. This system allows the vendor to sell water in small quantities through the taps without the customers entering the compound. In some cases, a pump with a long hose is connected with the tanks to allow water tankers to buy larger quantities (see Figure 4 below).

Figure 4: Compound water system in GAMA. © WaterPower, 2015.

Besides water vending, residents resort to self-supply to fulfil their water needs. The self-supply system involves the construction of deep wells and boreholes for abstraction of groundwater privately financed by households. Furthermore, as a way of dealing with the rationing and other interruption

in the water flow, water storage facilities are installed by institutions and residents who can afford to buy or construct them (Ainuso, 2010; Peloso and Morinville, 2014). Storage facilities include large tanks made out of concrete and smaller plastic buckets. A common facility is a round, mostly black plastic tank that is locally referred to as “polytank”. “Poly tank” is the name of a company in Ghana that produce this storage tanks in different sizes i.e. from a volume of 200 to 25.000 litres (see Figure 5 below).

Figure 5: The polytank “Rambo 250” stores 2,500 liters.

© WaterPower, 2015.

In addition, beyond the scope of this paper, it is worth mentioning that **sachet water** has recently emerged as a source of drinking water in GAMA (Osei, Newman, Mingle, Ayeh-Kumi, & Kwasi, 2013; Stoler et al., 2012; Stoler, 2014; Stoler, Tutu, & Winslow, 2015). Sachet water refers to water packaged in 500 ml sealed plastic bags. Locally referred as ´pure water´, it is mostly used as a drinking water source due to the general perception of better water quality. ´Pure water´ is sold almost everywhere in GAMA on the open street and in so-called ´water depots´ (Amankwaa, 2015). The sachet water business involves both individuals and companies in the packaging and selling of the plastic water bags.

2.2 Regulations and Management

After describing the ´meshwork of water provision´ (Schwartz et al., 2015) from an infrastructure perspective (see section above), we here delve into the regulations and management practices that govern water provision in

GAMA. First, we describe the providers that are formally recognized by regulatory frameworks such as national and local legislations and policies (water utilities, small-scale systems and water kiosks). We then look at others whose presence has little or no formal recognition at the policy level (water vendors and mobile providers). Here we do not intend to highlight the distinction between formal and informal water providers, in fact as Ranganathan (2016, pp. n.d.) notes, "informality pervades the entire water system from utility and private supply to "last mile" service, including metering, maintenance, and street-level distribution". Rather, looking at the different levels/types of regulation and management practices contributes to further understanding the urban water ´meshwork´ (Schwartz et al., 2015).

The GWCL is the sole urban water provider formally recognized by Ghanaian legislation that is responsible for water supply in major urban centres. Since 1999, the GWCL has operated as a limited liability company under the Ministry of Water Resources, Works and Housing. After a 5 year partnership (2006-2011) with Aqua Vitens Rand Ltd. (AVRL), a private operator, today the GWCL is a fully public water utility service provider (for detailed history see Alba, 2015). The Public Utility Regulatory Commission (PURC), established in 1997 as an independent agency for the regulation of public utilities, is in charge of monitoring GWCL operations, setting water tariffs and ensuring consumer protection (Adank et al. 2011).

In rural communities and small towns, the provision of water is facilitated by the Community Water and Sanitation Agency (CWSA) (Community Water and Sanitation Agency Act (Act 564), 1998). The CWSA is a national agency with regional offices operating under the Ministry of Water Resources, Works and Housing since 1998 (Community Water and Sanitation Agency Act (Act 564), 1998). It supports Municipal, Metropolitan and District Assemblies in the formulation and implementation of District Water and Sanitation Plans (DWSP) (Adank & Tuffuor, 2013, p. 31). According to the Local Government Act of 1993 (Local Government Act (Act 462), 1993), MMDAs are responsible for the overall development of the districts among other aspects water supply and sanitation. MMDAs and CWSA facilitate the establishment of community managed small town water supply systems. Small towns are defined as communities between 2,000 to 50,000 residents (Community Water and Sanitation Agency, 2010).

Community managed small town water supply systems are owned by MMDAs but run directly by community members elected in Water and Sanitation Development Boards (WSDBs) (Adank & Tuffuor, 2013). The WSDBs are in charge of the actual management of the systems including tariff setting (which has to be approved by the respective MMDAs) and decisions of future investments. At the community level, Water and Sanitation Committees (WATSAN) are responsible for community mobilization, sanitation and the management of water points (i.e. public standpipes) (Adank & Tuffuor, 2013). Community managed small systems are mainly financed by third party funding such as international donors. Within GAMA, community managed systems are currently located in formerly rural areas surrounding Ac-

cra Metro, which today are peri-urban areas that are part of the GAMA concentration but are currently not covered by the GWCL network infrastructure.

Besides small-scale systems, water kiosks have emerged as another water provision modality in peri-urban areas. They are supported by the non-profit organization Safe Water Network and the company WaterHealth. The water kiosk model targets communities that are willing to pay for a safe source of water (Safe Water Network, 2013). Kiosks are initially managed by the two organizations on behalf of the local communities and, after eight years, are to be handed over to the communities. These organizations work in collaboration with local administrations and CWSA.

Private sector participation in urban water supply (and sanitation) is promoted in policy documents, such as the National Water Policy 2007, and in practice – e.g. the urban water utility joined a public-private partnership between 2006-2011 and water kiosks are at times privately managed and owned. However, other forms of private participation, namely vendors and providers, are given little or no recognition at policy level. They are often mentioned in project reports, studies on urban water supply and in a few policy documents. For instance, guidelines for water tankers were previously developed by the Public Utility Regulatory Commission (PURC), but remained in draft version only (Alba and Bruns, 2016).

Private water providers mostly remain within the informal supply chain. This does not mean that domestic vendors and mobile providers work in a vacuum. On the contrary, rules and regulation are in place, for instance regarding opening hours and the fixing of water prices. Furthermore, water tankers and bulk water vendors are organized in associations and groups. As reported by Alba and Bruns (2016), these have formal regulations and organizational structures with elected representatives. Meanwhile, neighbourhood retailers and sellers are more of a “passive network” (Bayat, 1997) not linked to each other through distinct organizational structures.

The price of water sold by mobile providers and vendors varies depending on the source (i.e. piped water is generally more expensive than groundwater) and overall availability of water. For instance, during the dry seasons when water levels are lower or in areas where piped water supply is temporarily unavailable, prices tend to be higher. For tankers, the distance between the source of water and delivery point plays a role in the price setting (i.e. the further away the customer is, the higher the price). The vendor´s motivations play also an important role: those who perceive water provision as a business sell at higher prices than those who perceive it as a neighbourhood service. Furthermore, some neighbourhood vendors do not only sell water but also give water away as a gift (Bartels and Bruns, 2016).

Table 1 - Water providers GAMA.

	Organization	Water source	Infrastructure	Access modality	Payment system
GWCL water supply	Public asset company	Surface water	Large scale system	In-house connections, compound connections, standpipes	Billing
Water kiosk	NGO or private company	Mainly surface water	On-site purification facility, taps	Standpipe	Pay as you fetch
Small town water supply systems	Community managed (with support of Local Administrations and CWSA)	Mainly groundwater	Small scale system	In-house connections, compound connections, standpipes	Billing, Pay as you fetch
Water vendors	Individuals	Surface water, groundwater	Compound systems – on-site groundwater abstraction	Fetching	Pay as you fetch
Water tankers	Individuals or organized in associations and groups	Various (GWCL water, groundwater, surface water)	Vehicle, (poly-) tanks, pumps	Delivery (min. 2,500l)	Pay as you fetch

3 The access perspective

While in the previous section water supply was described from the perspective of the providers, in this section, the focus is on water access and the perspective of households. Water access can be conceptualized in its 'processual and proximate dimensions' (Ranganathan & Balazs, 2015, p. 409). The former focuses on the various socio-political relations that enable people to access water. Ribot and Peluso (2003, p. 153) conceptualize access as the "the *ability* to derive benefits from things". The emphasis on "ability" implies a broad understanding of access that allows for the consideration of social relations that enable people to access water rather than only to focus on property rights. Access to water is also mediated by spatial and technical factors (van der Woude, 2013, p. 2). Indeed, important co-determinants of water access are water availability and water technologies and infrastructures (Udas, Roth, & Zwarteveen, 2014, p. 1027). The latter relates to the

proximate dimension of water access that focuses for instance on water sources, the physical means of accessing water or the quantity and quality of water at the point of use (Ranganathan & Balazs, 2015, p. 409). Indeed, "water access" can relate to the water source (surface water, groundwater, rainwater, treated water), to the provision modality (self-provision, domestic vendors, tankers, GWCL) and to the material means that allow for access to water (buckets, poly-tank, in-house pipe connection).

In the following, we discuss the proximate dimension of water access by firstly illustrating available quantitative statistical data on access to existing water sources within GAMA. Secondly, in a qualitative discussion, we outline multiple strategies employed by households to access water. The latter is based on fieldwork observations and interviews. As discussed below, only by bringing together both quantitative and qualitative data it is possible to provide a comprehensive picture of water access strategies in GAMA.

3.1 A quantitative view on water access

The piped water network covers a relatively limited part of the built-up area. Estimations regarding the percentage of households enjoying access to piped water often vary. Adank, Darteh, Moriarty, & Osei (2011: v) refer to 51% as the percentage of population having direct access to utility water supply services in GAMA, van Rooijen, Spalthoff, and Raschid-Sally (2008: 262) mention 45% for Accra, Peloso and Morinville (2014: 121) state that GWCL meets only about 60% of the total water demands.[1] Data collected during the latest census, the Population and Housing Census of 2010, provides further insights into the different main sources of water for households for drinking and domestic uses such as washing, bathing and cooking (see figure 6, p. 13 and Annex B). Aggregated Census data for GAMA shows that the majority of households access water for drinking needs either through an in-house connection (27.2%), a compound connection (27.9%) or by resorting to sachet water (29.5%). A smaller percentage access water through public taps or standpipes (8.7%), followed by other sources. The situation is different for domestic water use, where besides pipe-born water (inside 36.5% and outside 37.5%), groundwater abstracted through boreholes and protected wells, together with tanker supply, play a bigger role: accounting for respectively 4.2%, 2.1% and 6.0% of supply. Sachet and bottled water were not accounted for as sources of water for domestic use.

[1] Differences in estimation can be explained by referring to the different geographical units used as a reference by the studies, the changing administrative configuration of GAMA and its implication on the collection of census data. The mismatch between administrative boundaries and the GWCL district boundaries also contributes to blur the picture.

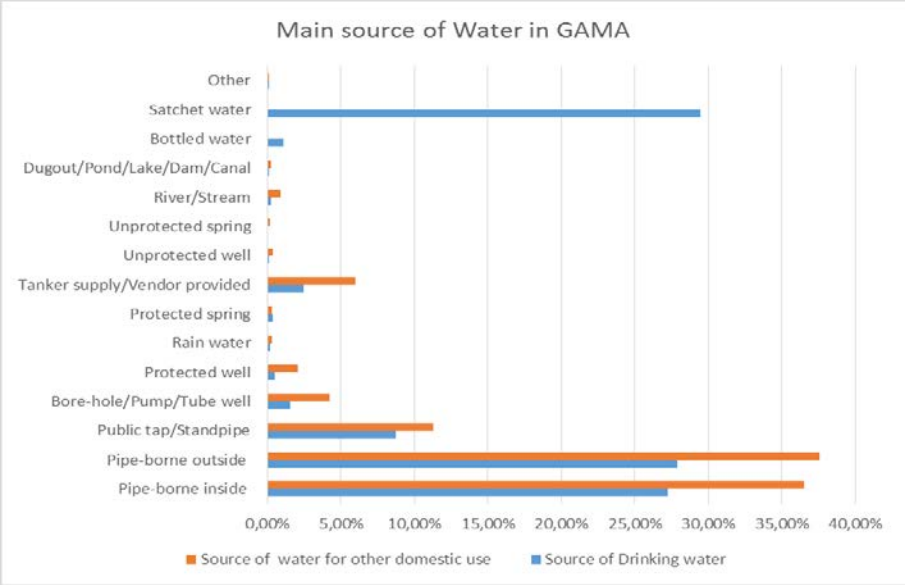

Figure 6 - Main source of water in GAMA in 2010.

Source: Population and Housing Census 2010, own calculations based on the data for Metropolitan, Municipal and Districts (MMDs) of GAMA provided by the Ghana Statistical Service in September 2015. Note sachet and bottled water was not part of the survey for "other domestic use".

The categories employed by the census include a variety of water sources (i.e. river, rainwater, ponds) and water provision modalities (i.e. tanker supply, sachet water, pipe-born). However, they do not account for domestic water vendors including neighbours who retail water from water tankers or sell groundwater from their private well or borehole. Indeed, sellers and retailers are not mentioned as a separate source of water-provision despite their increased presence in GAMA (Adank et al. 2012; Peloso and Morinville, 2014; Bartels, 2015).

Furthermore, it should be noted that aggregated data for GAMA hides variation within the different MMDAs of the metropolis, particularly in the case of domestic water.[2] For instance, the aggregated data shows that ca. 6.0% of the households of GAMA resort to water supplied by tankers. Yet the data per district (appendix B) reveals a great diversity in water supply by tankers among different MMDAs. For instance, 52.0% of the households of Adenta Municipal Assembly access water from tankers while only 0.8% of the households of Tema Metropolitan Assembly (TMA) do so. This can be partly explained by looking at the spatial coverage of piped water infrastructure in the two areas: While TMA has relatively good coverage with

[2] There are methodological problems with the census of 2010 in regard to household residents. Yet this does not primarily affect the data on water access.

piped water (54% pipe-borne water inside dwelling), this is not the case for Adenta where only 14% of households access water through piped connections inside dwellings. In Adenta, the extension of the piped water network was on-going at the time of the fieldwork. The same variation in tanker supply applies for groundwater abstraction for domestic uses. Aggregated data for GAMA depicts that in total, 6.3% of the households of the metropolis access water through a borehole (4.2%) and protected wells (2.1%). Yet this percentage is higher in most of the Ga Metropolitan Assemblies (Ga West 37.5%, Ga East 34.1%, Ga Central 21.7%), and lower in most of the other MMDs (Adenta 3.9%, Ledzokuku-Krowor 2.1%, Tema 0.3%, Ashaiman 0.5%). The variations in groundwater access could be explained by a combination of multiple factors such as the availability of groundwater in the respective administrative units and the availability of other water sources such as pipe-born water.

3.2 A qualitative view on water access

While the data from the Population and Housing Census indicates only the *main* drinking or domestic water source for households in GAMA, interviews carried out during fieldwork in GAMA revealed that households secure their access to water by resorting to multiple sources and providers at the same time. The different access modalities for urban and peri-urban dwellers are illustrated below (Figure 7). The figure focuses on the ability of residents to materially access water through self-supply, with an in-house connection, a bucket or a storage facility supplied by mobile providers. The in-house connection and the storage facility supplied by mobile providers refer to an access modality in which water is delivered to the households, the bucket refers to a system where residents fetch the water. Self-supply includes private boreholes with a pump that is connected to the household (delivery), but also wells or rainwater harvesting.

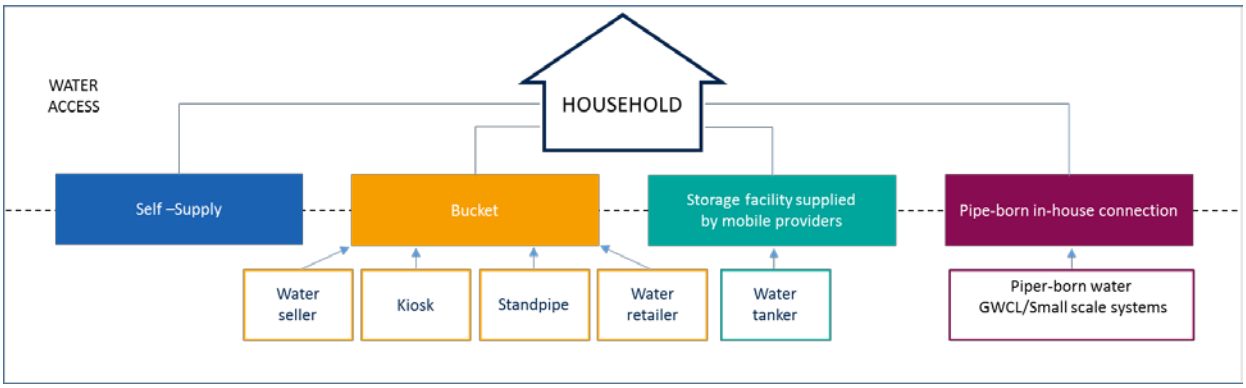

Figure 7 - Household water access modalities.

It is important to note that even though there are multiple providers and sources of water, these might not be directly visible to a household. For instance, residents do not know (or rather, cannot know) with certainty from which source (surface water, treated surface water and checked

groundwater or individual groundwater) tankers have fetched their water. Thus, households fully rely on trust in the tanker driver to deliver the water. This also applies to residents who fetch water with a bucket from a neighbour who retails water from a tanker.

Figure 2 (see p.3) shows the supply chain related to water provision via mobile water vendors (tankers). This is however not directly visible for a household. Indeed, for households, access to water through tankers might be visible as only one single access modality even though there are several water flows associated with tankers (in regard to the sources but also the inclusion of intermediates such as bulk water vendors). Decisions relative to access modalities depend on several factors, including the socio-economic status of the users (i.e. low, middle or high-income households), the location and the situation in relation to piped water supply (i.e. rationing scheme, presence of piped water supply), the geomorphology of the area (i.e. presence of shallow groundwater) and the general availability of different provision modalities in the neighbourhood. Socio-economic status often defines the material means through which households access water. Since water tankers deliver water in bulk only, more high-income households can afford to buy water from tankers. Low-income households rather access water by fetching it with a bucket from a water retailer or seller.

When multiple providers are present, providers and water sources are chosen depending on the use of water. For instance, residents buy sachet water for drinking purposes, they resort to water from tankers for cooking and they fetch water directly from the source for washing and for construction (i.e. groundwater, water from rivers or rainwater). Households´ strategies to access water also depend on the number and reliability of water providers operating in the area in which they live. It is common for households to have a ´favourite´ provider i.e. a provider where the household commonly fetch water. A provider can turn into a ´favourite´ due to kin- or friendship, the proximity to the household or due to the low water price. Furthermore, sometimes users themselves turn into providers. For instance, during the fieldwork it was observed that the same household that accessed piped water from the utility network had a borehole for individual use and would sell water to neighbours.

Storing water obtained from multiple sources has become an important aspect of water accessibility strategies of many residents of GAMA and elsewhere. Indeed, water storage facilities such as polytanks are not only important for accessing water through tankers, but also for residents who have an in-house pipe connection from either GWCL or a small town water supply system. They often install water storage facilities due to the erratic water supply through the pipes. This ensures the maintenance of water accessibility even though tap water may not be flowing through the pipes. Meanwhile, residents who fetch water with a bucket fill barrels with water using several buckets or gallons and containers. Thus, residents do not have to fetch water with a bucket several times per day, but can at least store water for several days.

4 Conclusions

This paper focuses on infrastructure that links multiple water provision modalities with water access strategies as they currently play out in the Greater Accra Metropolitan Area. The urban water utility plays a major role in supplying water in Accra, particularly in the inner city. Alternative water providers such as private water vendors and mobile providers have emerged in addition to the utility, serving a considerable part of the (peri-) urban population of GAMA. They are a central feature of contemporary urbanization processes (Ahlers et al., 2014; Alba & Bruns, 2016; Bartels & Bruns, 2016). Water kiosks and community managed small town water supply systems further contribute to meet the water needs in peri-urban areas. Eventually, residents resort to self-supply systems to meet their water needs: this includes mainly the construction of deep wells and boreholes for the abstraction of groundwater or the harvesting and storage of rainwater.

Although acknowledged by many, the existence of multiple water providers and the multiple strategies used by peri-urban dwellers to access water seems to find only limited recognition in policies and planning. Indeed, as Peloso and Morinville (2014) note for the case of Ashaiman a peri-urban area in GAMA: “There is an important disjuncture between realities of heterogeneous water access and urban planning designs that hinge on tap water infrastructures and standardized systems of provision” (p. 135). This report is a first step towards the elaboration of an integrated view on urban water supply. Bringing together both provision and access perspectives helps to shed light on and providing an understanding of the complexities of urban water supply in the rapidly urbanizing areas in the Global South.

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Appendix A

Figure 8 – Weija Treatment Plant © WaterPower, 2015.

Figure 9 – Kpong Treament Plant © WaterPower, 2015.

Figure 10 – Water kiosk in Zeenu © WaterPower, 2015.

Figure 11- Standpipe and polytank in Abokobi © WaterPower, 2015.

Figure 12 – Water tricycles in Ashaiman © WaterPower, 2015.

Figure 13- Water tanker in Ga West © WaterPower, 2015.

Appendix B

Main sources of water for drinking and other domestic uses per households in GAMA in 2010.

Main source of drinking water for household per MMDAs	Ga West Municipal	Ga East Municipal	Ga South Municipal	Ga Central Municipal	Adenta Municipal	La Nkwantan-ang-Madina Municipal	Ledzokuku-Krowor Municipal	Tema Metropoli-tan Area	Ashaiman Municipal	Accra Metropo-litan Area	GAMA
Pipe-borne inside (%)	8,56	11,94	19,69	17,47	8,04	7,78	25,85	49,43	23,29	31,82	27,18
Pipe-borne outside (%)	10,46	12,96	38,27	18,89	15,40	11,90	31,95	25,42	51,13	28,35	27,86
Public tap/Standpipe (%)	2,16	5,24	7,48	4,17	3,49	2,80	6,43	16,04	17,51	9,13	8,72
Bore-hole/Pump/Tube well (%)	7,08	6,49	3,64	6,00	1,94	2,13	0,84	0,11	0,11	0,29	1,60
Protected well (%)	1,91	1,39	0,94	1,16	0,29	1,05	0,84	0,12	0,10	0,17	0,50
Rain water (%)	0,69	0,54	0,45	0,62	0,24	0,21	0,02	0,01	0,03	0,03	0,17
Protected spring (%)	0,39	0,41	0,30	0,29	0,28	0,36	0,32	0,26	0,27	0,38	0,35
Bottled water (%)	1,04	1,61	0,57	0,75	2,99	1,35	0,73	1,11	0,33	1,24	1,11
Sachet water (%)	63,16	54,72	22,11	43,33	53,64	61,88	23,58	6,49	6,41	27,90	29,44
Tanker supply/Vendor provided (%)	3,54	4,14	3,57	6,52	13,41	10,30	9,25	0,61	0,77	0,51	2,49
Unprotected well (%)	0,29	0,15	0,64	0,20	0,02	0,07	0,00	0,01	0,01	0,03	0,12
Unprotected spring (%)	0,02	0,05	0,16	0,09	0,00	0,01	0,00	0,00	0,01	0,00	0,03
River/Stream (%)	0,54	0,16	1,37	0,12	0,14	0,07	0,12	0,02	0,01	0,05	0,24
Dugout/Pond/Lake/Dam/Canal (%)	0,13	0,05	0,74	0,31	0,02	0,03	0,00	0,00	0,00	0,00	0,11
Other (%)	0,02	0,15	0,06	0,08	0,09	0,06	0,04	0,36	0,02	0,09	0,10
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

average household size	3,9	3,9	4,01	3,97	3,7	3,7	3,64	4,03	3,72	3,7	
population	219788	147742	411377	117220	78215	111926	227932	292773	190972	1665086	

Source: Population and Housing Census 2010, own calculations based on the data for Metropolitan, Municipal and Districts (MMDs) of GAMA provided by the Ghana Statistical Service in September 2015. Note sachet and bottled water was not part of the survey for "other domestic use".

Main source of water for household for other domestic use per MMDAs in GAMA	Ga West Municipal	Ga East Municipal	Ga South Municipal	Ga Central Municipal	Adenta Municipal	La Nkwantanang-Madina Municipal	Ledzokuku-Krowor Municipal	Tema Metropolitan Area	Ashaiman Municipal	Accra Metropolitan Area	GAMA
Pipe-borne inside dwelling (%)	16,23	17,75	26,07	24,88	13,82	13,66	32,66	53,80	24,14	44,45	36,52
Pipe-borne outside dwelling (%)	21,13	20,91	46,54	28,38	22,27	23,99	42,59	27,60	53,66	39,91	37,54
Public tap/Standpipe (%)	3,92	8,39	8,98	6,12	5,61	5,22	7,69	16,61	18,19	12,63	11,27
Bore-hole/Pump/Tube well (%)	25,79	26,16	4,58	15,56	2,57	8,71	0,88	0,19	0,28	0,60	4,20
Protected well (%)	11,70	7,97	1,43	6,14	1,36	12,27	1,22	0,13	0,24	0,48	2,08
Rain water (%)	1,59	1,38	0,73	1,56	0,88	0,53	0,05	0,02	0,08	0,02	0,33
Protected spring (%)	0,32	0,28	0,28	0,43	0,16	0,23	0,20	0,18	0,30	0,27	0,27
Tanker supply/Vendor provided (%)	12,24	14,49	5,48	12,30	51,99	33,65	14,00	0,75	2,70	1,06	6,01
Unprotected well (%)	1,53	1,00	0,75	1,35	0,51	0,96	0,13	0,09	0,13	0,16	0,39
Unprotected spring (%)	0,28	0,25	0,50	0,76	0,18	0,21	0,16	0,10	0,17	0,02	0,15
River/Stream (%)	4,35	1,03	3,44	1,20	0,33	0,28	0,32	0,07	0,04	0,29	0,89
Dugout/Pond/Lake/Dam/Canal (%)	0,65	0,12	1,17	1,27	0,17	0,17	0,01	0,02	0,03	0,01	0,22
Other (%)	0,27	0,25	0,07	0,06	0,15	0,10	0,09	0,44	0,03	0,09	0,13
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00
average household size	3,9	3,9	4,01	3,97	3,7	3,7	3,64	4,03	3,72	3,7	
Population	219788	147742	411377	117220	78215	111926	227932	292773	190972	1665086	

Source: Population and Housing Census 2010, own calculations based on the data for Metropolitan, Municipal and Districts (MMDs) of GAMA provided by the Ghana Statistical Service in September 2015. Note sachet and bottled water was not part of the survey for "other domestic use".

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