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Piped water flows but sachet consumption grows: The paradoxical drinking water landscape of an urban slum in Ashaiman, Ghana

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ABSTRACT

Packaged "sachet" water has become the primary drinking water source for millions of West Africans despite ongoing controversy over inadequate management of the new waste streams created by all the plastic wrappers. While recent literature from Ghana has shown that municipal water rationing and lower socioeconomic status tend to drive sachet consumption at the metropolitan scale, some low-income communities with a reliable piped water supply still exhibit diverse drinking water-seeking behaviours. This paper explores the drinking water landscape of one poor, informal community in Ashaiman, Ghana, as a case study of the individual- and community-level factors that shape household drinking water decisions. Using the results of a water questionnaire completed by 95 households and the transcripts of four focus groups, our findings suggest that, after controlling for demographics, sachet water consumption is associated with proxies for higher disposable income and lack of knowledge about household water treatment methods, while social processes and attitudes toward water quality do not seem to drive drinking water decisions. This community presents a paradoxical drinking water landscape, as poverty abounds despite excellent piped water access, and low-income households with slightly greater means tend to opt for packaged water as opposed to being driven to it by piped water shortages. These nuances in drinking water purchasing behaviour can inform policy and planning for drinking water provision in urban slums across the region.

Introduction

The proportion of global disability-adjusted life years (DALYs) attributable to unimproved water and sanitation has fallen steadily over the last two decades, though with substantial regional heterogeneity as diarrhea remains a leading killer in sub-Saharan Africa (Lim et al., 2012; Pullan, Freeman, Gething, & Brooker, 2014). Despite the UN announcement in March 2012 that Target 7C of the Millennium Development Goals (MDG) was met ahead of schedule globally (WHO/UNICEF, 2012), sub-Saharan Africa continues to have the lowest percentage of population with access to an improved water source among all world regions, particularly in urban areas (WHO/UNICEF, 2013), and a number of critiques have noted the inadequacy of the metric "access to an improved water source." Drinking water access in sub-Saharan Africa may be qualified by water quality (Bain et al., 2012; Onda, LoBuglio, & Bartram, 2012), fragmented distribution (Bakker, 2010), unsustainability (Stoler, 2012), usage patterns (Kayaga, Fisher, & Franceys, 2009) and government corruption (Nganyanyuka, Martinez, Wesselink, Lungo, & Georgiadou, 2014). Along similar lines, Obeng-Odoom (2012) frames "deep" access as the interaction between four dimensions: quality, reliability, cost, and equity. Other recent studies continue to refine the methods for estimating the burden of inadequate water, sanitation, and hygiene (Clasen et al., 2014), as well as underscore the persistent role in the global diarrheal disease burden among low- and middle-income nations (Prüss-Ustün et al., 2014; Wolf et al., 2014).

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It has been estimated that just a quarter of Accra's population has 24-h access to a piped water supply (WaterAid, 2005), and this estimate has not changed despite much growth and development of Greater Accra over the last decade. Like many developing nations, Ghana has struggled to keep pace with infrastructure improvements amid rapid population growth and urbanization (Ainuson, 2010). In the 1990s, nearly half of urban residents in Accra were living below the World Bank's absolute poverty threshold, and the poor tended to concentrate in fringe settlements or in defined areas within the urban core with limited access to basic services (McGranahan, Jacobi, Songsore, Surjadi, & Kjellen, 2001: 71). Over a quarter of Accra's residents are still estimated to live below the poverty line (Ainuson, 2010).

The political economy of water service in Ghana is rife with poor governance and missed opportunities that have historically plagued Ghana's water resource management and induced subsequent drinking water shortages (Nsiah-Gyabaah, 2001). While the post-colonial political elite lacked the vision of universal public water provision strategies (Yeboah, 2006), the ruling class used it as a tool to recompense the electorates that favour government and penalize opposition-leaning constituencies resulting in a phenomenon McCaskie (2009) referred to as "water wars." McCaskie (2009) offers a historical portrait of drinking water access in Kumasi, Ghana's second-largest city, which mirrors that of Accra: a colonial legacy of patchy water systems, low investment in asset maintenance, breakneck–speed urbanization, and subsequent chronic acute water shortages politicized by each successive decade's ruling elite and ethnic majorities. McCaskie's analysis illuminates the institutional and structural antecedents to the present disequilibrium in supply and demand of water, which is further exacerbated by inefficiencies in public water provision, governmental budgetary difficulties in the context of rising population, and the search for financial capital investments. This confluence of factors opened the door for the private sector to fill gaps in demand (Yeboah, 2006), a process also described by McCaskie (2009: 148): "soaring demand, acute shortages, new technologies and increasing desire to inhabit the world of globalised capitalist modernity produced a revolution in the business of selling water." Similar reasons were advanced in support of water privatization during the adoption of the structural adjustment programme implemented as Ghana's Economic Recovery Programme (Obeng-Odoom, 2014). The neoliberalist approach to water policy which resulted in Aqua Vitens Rand Limited's management contract from 2006 to 2011, although heavily contested by civil society, is well-documented (Dreschel & Van-Rooijen, 2008; Yeboah, 2006), and has invoked rights-based discourses (Eguavoen & Spalthoff, 2008; Obeng-Odoom, 2012). Since Ghana's cancellation of that contract in 2011, areas connected to the municipal water grid through the current operator, Ghana Water Company Limited (GWCL), continue to experience water rationing and generally unreliable water service (Stoler, Fink, et al., 2012; Stoler, Weeks, et al., 2012) due to Accra's daily water shortfall of over 130,000 m^3, or 25% of daily water demand (UN-Habitat, 2011), despite substantial surface water resources. According to the 2008 Ghana Demographic and Health Survey, only an estimated 57% of urban residents had access to piped water in their dwelling or

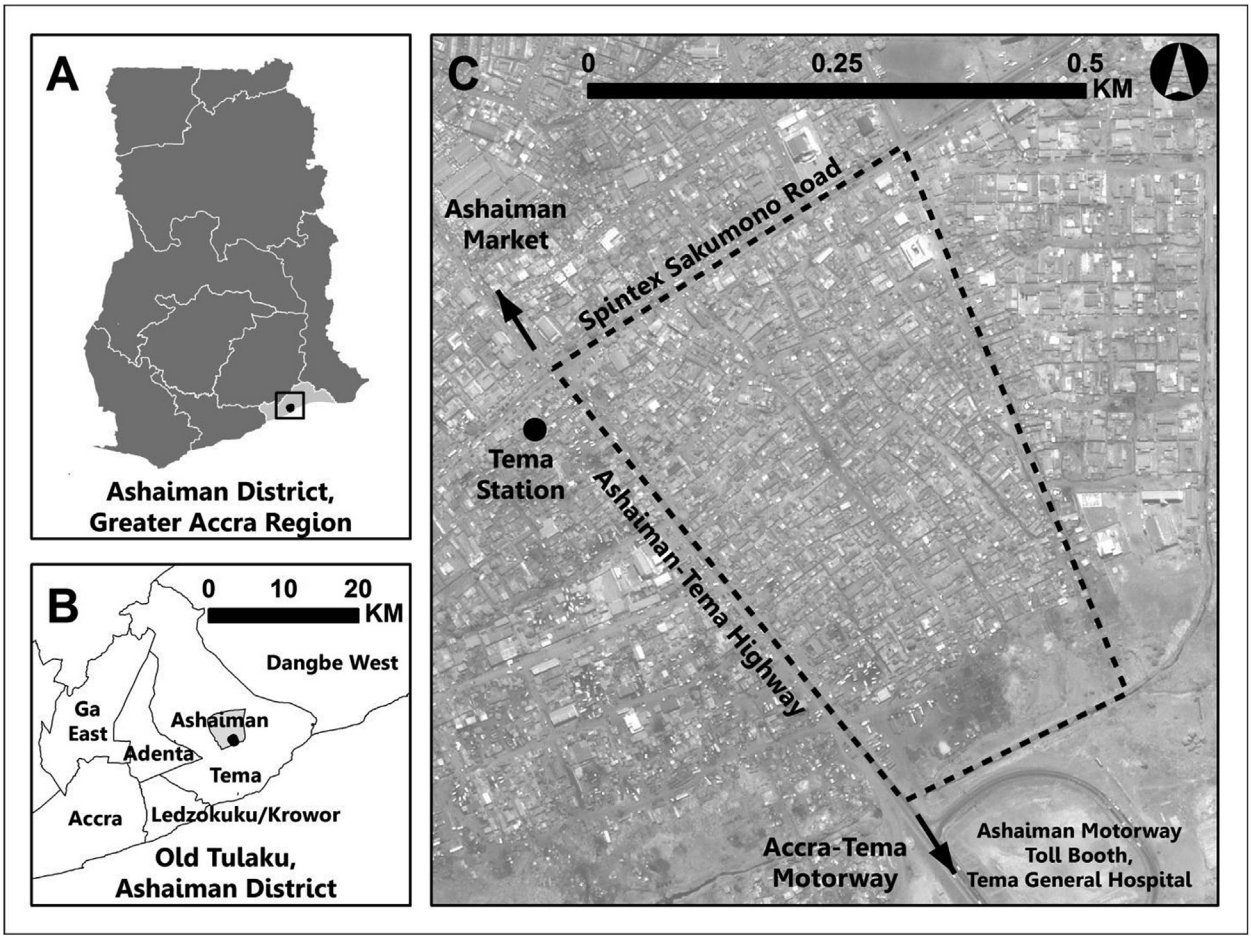

Fig. 1. The study site, showing (a) Greater Accra Region within Ghana, with Ashaiman District highlighted, (b) Ashaiman District with Old Tulaku highlighted, and (c) Old Tulaku draped over a May 2010 IKONOS panchromatic image.

compound, or a public tap (Macro International Inc, 2013). This is clear evidence that the marketization of water as an inheritance of the neoliberal state—the creation of the requisite policy terrain with incentives that produce business settings that perpetuate neoliberalism (Obeng-Odoom, 2014)—has not achieved the claimed intended outcomes since its inception.

While Ghana has made some progress toward the MDG Target for drinking water, the WHO characterization of "access to an improved source" often masks true drinking water coverage given the intermittency of the municipal water supply. For example, a localized definition of drinking water access in low-income Accra communities produces estimates of access that fall egregiously short of WHO estimates (Mahama, Anaman, & Osei-Akoto, 2014). The burden of water inadequacies continues to fall disproportionately upon disadvantaged or low-income communities as seen elsewhere in sub-Saharan Africa (Hopewell & Graham, 2014), and higher costs of maintenance and billing present obstacles for GWCL to expand municipal services to the urban poor. Decentralization of service provision is one means to address the infrastructural challenges of the rapid urban growth seen in Ghana, but recent efforts by Metropolitan Assemblies in Accra and Sekondi-Takoradi to address the needs of slum communities through public–private partnerships and community-based participation have fallen short of stated goals and alienated the Assemblies from many poor communities (Owusu & Afutu-Kotey, 2010).

A notable, recent response to the gap in Ghana's urban water provision has been the proliferation of sachet water, known on the street by the more suggestive product name *pure water*, which are single-serve 500 ml polyethylene bags of drinking water sold at markets, kiosks, and by street vendors, and are now a ubiquitous feature of the drinking water landscape (Dada, 2011). Recent population studies in Accra have shown that sachet water consumption is driven by younger age, lower socioeconomic status, and poorer self-reported health (Stoler, Weeks, & Appiah Otoo, 2013), and exacerbated by municipal water rationing (Stoler, Fink, et al., 2012; Stoler, Weeks, et al., 2012). Yet the multilevel models implemented in those two studies reflect substantial unexplained variability in sachet consumption, as well as "spatial outliers," i.e. areas of stable piped water access that still exhibit high rates of sachet consumption. As Yeboah (2006) notes, ordinary Ghanaians who are excluded from the political discourse on Ghana's water problems have spoken with actions rather than words. The power of human agency in daily drinking water acquisition, given the available market options, has shaped the growth and ubiquity of the sachet water industry. But community-level factors specific to sachet water use, such as gender or attitudinal differences, have not been investigated, and social scientists have only recently started exploring the evolution of drinking water-seeking behaviour in peri-urban Accra.

A recent study in one such community, the newly-created district of Ashaiman, notes how residents "chase for water" and use a patchwork of coping mechanisms to fill gaps in water security, as many residents often cannot pay monthly water bills and have little trust in GWCL to manage their water needs (Peloso & Morinville, 2014). Ashaiman is a significant urban area on the periphery of the Accra Metropolitan Area where poverty persists in some neighborhoods amid some of the best, albeit variable, water access in Greater Accra. Ashaiman may epitomize the challenges of fast growing peri-urban communities that are poised to absorb most of West Africa's projected population growth over the next few decades.

This study presents a case study from an informal urban slum community, Old Tulaku in Ashaiman, Ghana, to improve our understanding of local drinking water knowledge, attitudes, and practices, as well as the social, economic, and educational drivers of sachet use. We present the results of a household survey of 95 residents and summarize themes from four focus groups in an effort to dissect the complexity of drinking water decision-making in a low-income, urban context. We build on prior knowledge of sachet water consumption among younger and lower-income consumers (Stoler et al., 2013); household employment gender patterns, with women more likely to work at home and bear a greater burden of water fetching responsibilities (Sorenson, Morssink, & Campos, 2011); and attitudes toward drinking water expressed in previous in-depth interviews, and shaped by social and economic pressures that culminate in hybrid approaches to water security (Peloso & Morinville, 2014; Yeboah, 2006). From these prior studies, we identify four sets of factors that we hypothesize would make residents more likely to rely on sachet water in Old Tulaku:

1. The *demographic hypothesis*, i.e. residents who are younger, male, and poorer;
2. The *knowledge hypothesis*, i.e. residents who are less educated or unfamiliar with water treatment options;
3. The *social attitudes* hypothesis, i.e. residents who neither know anyone else who treats their water, nor have anyone encouraging them to do so;
4. The *individual attitudes* hypothesis, i.e. residents who perceive a need to treat their water or have low confidence in their ability to effectively treat their own drinking water.

The study contextualizes these results using themes derived from focus groups about drinking water conducted in Old Tulaku one week prior to the household survey. We conclude by discussing the quality and appeal of sachet water, and the implications for its inclusion in a decentralized urban water provision strategy.

Research methodology

Study site

The Ashaiman Municipal District is a predominantly urban district within the Greater Accra Region, roughly 30 km northeast of central Accra. Its capital, Ashaiman, is now the fifth-largest urban area in Ghana (after Accra, Kumasi, Tamale, and Sekondi-Takoradi) with a population of nearly 300,000 (Ghana Statistical Service, 2012). Ashaiman grew rapidly as a community to house low-income laborers from the nearby seaport terminal in Tema (Owusu, 1991), and was originally administratively part of the Tema Municipal Area. Ashaiman's population ultimately exceeded Tema's in the 2000 Ghana census, was demarcated as its own municipal district in 2008 in advance of the 2010 census, and has grown to nearly twice Tema's size.

Our focus was Old Tulaku, an informal community of approximately 2500–3000 residents on the southern border of the Ashaiman Municipal District bordered by the Accra–Tema Motorway to the south, Spintex Sakumono Road to the north, the Ashaiman–Tema Highway to the West, and an unnamed dirt lane to the east (Fig. 1). Additional dirt lanes bisect the community both east-west and north-south, effectively creating four quadrants which were used to delineate four enumeration areas for the 2010 Ghana Census. Old Tulaku is not an officially-sanctioned settlement and thus lacks any notion of formal urban planning comparable to communities in other Ghanaian municipalities (or in Ashaiman itself). The design of the physical environment has been left to local residents, particularly local community and opinion leaders.

We were drawn to Old Tulaku because the community epitomizes many of the rapidly-growing informal communities in peri-

urban Greater Accra (or at least outside of the Accra Metropolitan Area, as Ashaiman is certainly urban) which have intermittent access to one or more basic services such as water, electricity, and waste disposal. As Accra increasingly becomes too expensive for migrants from Northern Ghana and its neighbors, communities like Old Tulaku are increasingly absorbing population growth in the shadow of new market areas and transportation hubs with a patchwork of services. Due to Ashaiman's relative proximity to Tema and the water pipeline from Kpong Waterworks, the water treatment plant near the Akosombo Dam which provides piped water to the eastern half of the Greater Accra Region and Accra Metropolitan Area, water service is generally more reliable than in Accra, and yet there is still persistent poverty and patterns of water use otherwise seen in water-stressed communities.

Instruments: household survey and focus groups

We conducted a household knowledge, attitudes, and practices (KAP) survey in June 2013 of the heads-of-household (or those making household water decisions) in Old Tulaku. Because we had no pre-existing sampling frame, a geographic information system was used to select 120 geographically-random households in the study area, and five local, trained interviewers were each assigned an east-to-west transect across the community, finishing at Ashaiman–Tema Highway. Ninety-five households completed the survey in a single day; many houses were empty or the household head was unavailable, and just two households refused to answer the survey. All participants were read an informed consent script and gave verbal consent to participate in the survey.

The survey consisted of 25 questions beginning with basic demographic information (sex, age, years of schooling, literacy, and ownership of various livestock and consumer goods as a proxy for household income), and proceeded with questions about knowledge, attitudes and practices related to drinking water treatment and sachet water. Attitude questions utilized a standard 5-point Likert scale. Questions were generally adapted to the local context from the World Health Organization's *Core Questions on Drinking-Water and Sanitation for Household Surveys* (WHO/UNICEF, 2006). The entire survey was designed to take about 15 min for completion, thus minimizing the time commitment for participants, and results were summarized and reported back to local community leaders.

We also conducted four focus groups in June 2013 at the school in the center of Old Tulaku. Participants were recruited by local community leaders for age- and sex-stratified groups: male aged 18–24 (8 participants), male 25 + (8), female 18–24 (8), and female 25 + (9). The focus group scripts were previously developed and implemented in urban slums in the Accra Metropolitan Area, and consisted of a series of questions about drinking water sources, social perceptions of water, prices and fetching burdens, vulnerability, and health. We read an informed consent script to all participants, and everyone gave verbal consent for both their participation and for us to make a digital audio recording before any discussion commenced. All focus groups lasted about 1 h and were conducted in a combination of English and Twi; two local Ghanaian project assistants served as note-takers and later transcribed the audio recordings.

Statistical analyses

The study used Pearson's chi-square and analysis of variance *F* tests to compare nominal and continuous measures, respectively, between those households who used sachet water as the *primary* water source vs. all other households, and then for households who use sachet water as the *only* water source vs. all other households. We subsequently used multivariable logistic regression to assess predictors of sachet consumption, and we fit separate regression models for the use of sachets as the primary, and only, water source. All quantitative analyses were conducted using SPSS version 21 software (IBM, Armonk, NY) with statistical significance assessed at the conventional level ($\alpha = 0.05$). This study was approved by the respective Institutional Review Boards at the University of Miami and Delaware State University.

Results and discussion

KAP survey

We were qualitatively familiar with the drinking water patterns in Ashaiman when we chose Old Tulaku as a study community, and Table 1 underscores the variability in household drinking water choices. We observe that 96% of respondents have purchased sachet water, with 59% reporting using it as their *primary* water source, and 26% using sachets as their *only* water source. The median number of sachets consumed per day was 5, and the top reasons given for buying sachet water were convenience (43%), better quality (23%), and because they were chilled (15%), although some people also bought sachets when there was no other option (10%), when they were away from home (4%), and because friends told them to (3%). Reasons cited for foregoing sachet water included the rainy seasons or cooler weather (17%), financial cost (16%), spending time inside their home (11%), lack of availability (10%), availability of piped water (3%), and bad taste or smell (3%). Although the area around Old Tulaku has regular access to piped drinking water, only 8% reported piped access in their home, 46% used a public tap, and none reported using a private well, rain harvesting, bottled water, or delivery by water tanker. Physical

Table 1
Drinking-water-related practices among 95 survey participants in Old Tulaku.

Practice	Total	%
Ever use sachet water	91	95.8
Sachets are primary drinking water source	56	58.9
Sachets are only drinking water source	25	26.3
Number of sachets consumed per day		
1–3	19	20.0
4–6	33	34.8
7–9	9	9.5
10+	21	22.1
Don't know	13	13.7
Why use sachet water		
Convenience	41	43.2
Better quality	22	23.2
Because the water is cold	14	14.7
No other option	9	9.5
Only when outside the home	4	4.2
Someone told me to	3	3.2
Why *not* use sachet water		
During rainy season or cool weather	16	16.9
Too expensive or have no money	15	15.8
When inside the home	10	10.5
Not available or cannot find it	9	9.5
When taps are flowing	3	3.2
Bad taste or smell	3	3.2
Other drinking water sources used		
Pipe inside home	8	8.4
Public tap	44	46.3
Well, rainwater, bottles, tanker	0	0.0
Drinking water is treated at home	16	16.8
Treatment methods used		
Boiling	3	3.2
Cloth	3	3.2
Settling	10	10.5
Camphor	3	3.2

access to water was generally not an issue, as only four respondents said they walked more than 5 min to acquire their water. Just 17% of respondents said they ever treat their piped drinking water, with most simply letting the water settle (11%), and a few others using some combination of boiling (3%), using a straining cloth (3%), or adding camphor (3%).

The demographics of the 95 respondents are presented in Table 2 along with bivariate relationships with our two dependent measures (sachets as the primary, and only, water source). Because males are more likely to work outside of the home and have fewer housekeeping and childcare responsibilities, our respondents were mostly female (78%), though only 42% of these households were headed by a female, and only 54% of head-of-households were literate. Mean age was 37, with an average of about 5.5 years of schooling. A minority of respondents owned transportation-related assets like a bicycle (19%) or a motorized vehicle (motorcycle, car, or truck) (22%), and 23% owned one or more livestock (chicken, goat, or cattle). The majority did own one or more electronic devices, as 92% owned a mobile phone, 84% had a television, 62% had a radio, and 48% owned a refrigerator. Respondents who used sachet water as their *primary* water source, compared with all other respondents, were statistically significantly younger (33 vs. 41 years, $P = 0.012$), and more likely to own a motorized vehicle (32% vs. 8%, $P = 0.005$), refrigerator (61% vs. 31%, $P = 0.004$), and phone (98% vs. 82%, $P = 0.005$). Respondents who used sachet water as their *only* water source did not exhibit any statistically significantly differences from other respondents, but tended to be slightly younger (33 vs. 38 years, $P = 0.116$), more likely to be male (36% vs. 17%, $P = 0.051$), and more likely to own a refrigerator (64% vs. 43%, $P = 0.069$), and phone (100% vs. 89%, $P = 0.077$). We therefore observe mixed evidence for our demographic hypothesis in bivariate analysis, as youth and being male seem to be associated with sachet consumption, but so does the ownership of durable goods like a refrigerator, hardly a proxy for poverty.

Knowledge and attitudes toward sachets and water treatment were rather mixed. Although nearly every respondent had used sachet water at some point, sachet brand awareness in the context of a survey, divorced from the act of purchasing, was lower than expected. When asked to name as many sachet water brands as possible, 50% of respondents named zero or one brand, while the other 50% named between two and five brands (overall mean 1.67, *SE* 0.11). As would be expected, respondents who used sachets as their primary water source named more brands than their counterparts (mean 1.95, *SE* 0.14 vs. 1.28, 0.16, $P = 0.003$), but surprisingly those who only used sachets for drinking water did not exhibit greater brand recall (1.64, 0.18 vs. 1.69, 0.14, $P = 0.858$). Knowledge of household drinking water treatment methods was also low; the top responses were boiling (34%), settling (22%), any kind of filter (cloth, membrane, or biosand) (17%), and use of a coagulant or flocculent such as alum (16%), and 44% of respondents could not name any treatment method. When stratifying respondents' knowledge of various treatment methods by use of sachets as the *primary* or *only* drinking water source, we consistently observe lower percentages in the sachet groups, sometimes with statistically significant differences (Table 3), and consistent with our knowledge hypothesis. Respondents were more likely to recall no treatment methods if they used sachets as the *primary* water source (57% vs. 26%, $P = 0.002$) or *only* water source (64% vs. 37%, $P = 0.020$), which initially seems to support the notion that the availability of sachet water effectively alleviates the need for attention to safe water practices.

Attitudes toward water treatment were captured by four questions that employed a five-point Likert scale response ranging from *strongly agree* to *strongly disagree* (Table 3). Two questions addressed social attitudes by inquiring about knowledge of neighbors treating their drinking water at home, and whether friends encourage household water treatment. Two other questions addressed individual attitudes specifically about one's confidence in treating their own water at home, and whether there was a perceived need to treat drinking water at all. The overall findings suggest that very few people know neighbors who are treating their water (7.4% strongly agree or agree), or are encouraged by neighbors to treat their water (20% strongly agree or agree); although most people are confident that they can treat their own water (55.8% strongly agree or agree). Only the statement, *I see no need to treat water*, yielded mixed attitudes, as 43.2% strongly agree or agree, while 44.2% strongly disagree or disagree. In bivariate (chi-square) analysis, none of these questions reveal statistically significantly differences between those using sachets as the primary or only drinking water source vs. all other households, with one exception. Those using sachets as the primary water source were more likely to agree or strongly agree with "I see no need to treat water," while those not relying on sachets were more likely to disagree or strongly disagree ($P = 0.033$). This makes intuitive

Table 2
Demographic characteristics of 95 survey participants in Old Tulaku, and bivariate relationships with dependent measures *sachets as the primary drinking water source*, and *sachets as the only drinking water source*.

Characteristic	Total		Sachets as primary drinking water source					Sachets as only drinking water source				
			Yes		No		P[a]	Yes		No		P[a]
	Freq.	%	Freq.	%	Freq.	%		Freq.	%	Freq.	%	
Sex is male	21	22.1	12	21.4	9	23.1	0.849	9	36.0	12	17.1	0.051
Household head is female	40	42.1	23	41.1	17	43.6	0.807	9	36.0	31	44.3	0.471
Household head is literate	51	53.7	29	51.8	22	56.4	0.657	12	48.0	39	55.7	0.507
Ownership:												
Bicycle	18	18.9	11	19.6	7	17.9	0.836	4	16.0	14	20.0	0.661
Motorcycle, car, or truck	21	22.1	18	32.1	3	7.7	0.005	7	28.0	14	20.0	0.408
Livestock (chicken, goat, cattle)	22	23.2	15	26.8	7	17.9	0.315	8	32.0	14	20.0	0.222
Television	80	84.2	49	87.5	31	79.5	0.292	21	84.0	59	84.3	0.973
Radio	59	62.1	37	66.1	22	56.4	0.340	18	72.0	41	58.6	0.235
Phone	87	91.6	55	98.2	32	82.1	0.005	25	100.0	62	88.6	0.077
Refrigerator	46	48.4	34	60.7	12	30.8	0.004	16	64.0	30	42.9	0.069
	Mean	SE	Mean	SE	Mean	SE		Mean	SE	Mean	SE	
Age (years)	36.62	1.51	33.48	1.97	41.13	2.19	0.012	32.64	2.72	38.04	1.79	0.116
Schooling (years)	5.56	0.47	5.98	0.61	4.95	0.76	0.285	5.44	0.93	5.60	0.56	0.883

[a] P-values are calculated from X^2 test for categorical measures, and from F test of difference in means for continuous measures.

Table 3
Select knowledge and attitude characteristics related to household drinking water treatment among 95 survey participants in Old Tulaku, and bivariate relationships with dependent measures *sachets as the primary drinking water source*, and *sachets as the only drinking water source.*

Characteristic	Total		Sachets as primary drinking water source					Sachets as only drinking water source				
			Yes		No		P[a]	Yes		No		P[a]
	Freq.	%	Freq.	%	Freq.	%		Freq.	%	Freq.	%	
Knowledge												
Household water treatment method(s) named												
Boiling	32	33.7	15	26.8	17	43.6	0.088	7	28.0	25	35.7	0.484
Settling	21	22.1	6	10.7	15	38.5	0.001	2	8.0	19	27.1	0.048
Filter (cloth, membrane, biosand)	21	16.8	8	14.3	13	33.3	0.028	4	16.0	17	24.3	0.391
Coagulant or flocculent	15	15.8	6	10.7	9	23.1	0.104	2	8.0	13	18.6	0.213
Camphor	5	5.3	3	5.4	3	7.7	0.645	1	4.0	5	7.1	0.579
Liquid chlorine	1	1.1	1	1.8	0	0.0	–	0	0.0	1	1.4	–
None	42	44.2	32	57.1	10	25.6	0.002	16	64.0	26	37.1	0.020
Attitudes												
Others I know also treat their water at home							0.538					0.743
Strongly agree	3	3.2	1	1.8	2	5.3		1	4.0	2	2.9	
Agree	4	4.2	1	1.8	3	7.9		0	0.0	4	5.9	
Don't know	28	29.5	18	32.7	10	26.3		9	36.0	19	27.9	
Disagree	31	32.6	19	34.5	12	31.6		8	32.0	23	33.8	
Strongly disagree	27	28.4	16	29.1	11	28.9		7	28.0	20	29.4	
My friends encourage me to treat water							0.130					0.955
Strongly agree	4	4.2	2	3.6	2	5.3		1	4.0	3	4.4	
Agree	15	15.8	11	20.0	4	10.5		5	20.0	10	14.7	
Don't know	10	10.5	8	14.5	2	5.3		3	12.0	7	10.3	
Disagree	37	38.9	23	41.8	14	36.8		10	40.0	27	39.7	
Strongly disagree	27	28.4	11	20.0	16	42.1		6	24.0	21	30.9	
I am confident I can treat my water at home							0.507					0.287
Strongly agree	24	25.3	14	25.9	10	26.3		8	32.0	16	23.9	
Agree	29	30.5	14	25.9	15	39.5		5	20.0	24	35.8	
Don't know	20	21.1	14	25.9	6	15.8		4	16.0	16	23.9	
Disagree	11	11.6	6	11.1	5	13.2		4	16.0	7	10.4	
Strongly disagree	8	8.4	6	11.1	2	5.3		4	16.0	4	6.0	
I see no need to treat water							0.033					0.833
Strongly agree	7	7.4	2	3.6	5	13.2		1	4.0	6	8.8	
Agree	34	35.8	25	45.5	9	23.7		9	36.0	25	36.8	
Don't know	10	10.5	8	14.5	2	5.3		4	16.0	6	8.8	
Disagree	11	11.6	4	7.3	7	18.4		3	12.0	8	11.8	
Strongly disagree	31	32.6	16	29.1	15	39.5		8	32.0	23	33.8	

[a] P-values are calculated from X^2 test.

sense; again we see that the use of sachet water may alleviate the perceived need for water treatment. We do not observe any strong support for either the social attitudes or individual attitudes hypotheses.

To test for the adjusted effects of demographic, knowledge, and attitudinal factors, we fit two multivariate logistic regression models to test the relationship between select characteristics and the binary responses of sachet water as the primary, and only, drinking water source. We initially computed bivariate correlations for all of the characteristics in Tables 2 and 3 to assess potential for multicollinearity, and then entered all characteristics into a series of forward– and backward–selection stepwise regression models using varying significance criteria for entry and removal. This approach, combined with the bivariate results already reported, provided a short-list for introducing variables into the logistic regression model. We proceeded with an iterative model-building approach in which we introduced independent variables and first-order interaction terms one at a time until we achieved a model that parsimoniously minimized the initial log likelihood function (−2 log likelihood, or −2LL). Mobile phone ownership, while statistically significant in bivariate analysis, was nearly universal in Old Tulaku (only one respondent who used sachets as the primary drinking source did not also have a mobile phone), and was thus dropped from the analysis because it led to unstable multivariate models. The final models of sachet water as the primary drinking water source, and sachet water as the only drinking water source, are reported in Table 4. The final models are similar, which is not surprising because the *sachets-as-only* group is a subset of the *sachets-as-primary* group.

Four factors were statistically significantly predictive of using sachet water as the primary drinking water source: age, inability to name a water treatment method, refrigerator ownership, and motor vehicle ownership, while years of schooling and sex were important non-significant controls which contributed positively to overall model fit. After adjusting for other variables, respondents were about 4% less likely to use sachets as the primary water source for each additional year of age (OR 0.96, 95% confidence interval [CI] 0.93–0.99, $P = 0.035$), over 5 times more likely if unable to name a water treatment method (OR 5.10, 95% CI 1.70–15.31, $P = 0.004$), nearly 3 times more likely if owning a refrigerator (OR 2.82, 95% CI 1.02–7.80, $P = 0.045$), and over 5 times more likely if owning a motor vehicle (OR 5.05, 95% CI 1.10–23.25, $P = 0.038$). The final −2LL for this model was 97.94, and Nagelkerke $R^2 = 0.37$. A slightly different four factors were statistically significantly predictive of using sachet water as the only drinking water source: age, sex, inability to name a water treatment method, and refrigerator ownership, while years of schooling and television ownership were non-significant but included to improve overall model fit. After adjusting for other variables, respondents were about 5% less likely to use sachets as the only water source for each additional year of age (OR 0.96, 95% CI 0.91–0.99, $P = 0.032$), over 8 times as likely if male (OR 8.35, 95% CI 1.91–36.51, $P = 0.005$), 3 times more likely if unable to name a water treatment method (OR 3.32, 95% CI 1.12–9.90, $P = 0.031$), and over 3 times more likely if owning a

Table 4
Multivariate logistic regression model of the relationship between select respondent demographic and household characteristics ($n = 95$) and (a) sachets as the primary drinking water source, and (b) sachets as the only drinking water source.

Characteristic	Sachets as primary drinking water source					Sachets as only drinking water source				
	B	SE	OR	95% CI	*P*	*B*	SE	OR	95% CI	*P*
Constant	0.003	0.894	1.00	–	0.998	0.121	1.213	1.13	–	0.921
Age (years)	−0.040	0.019	0.96	0.93–0.99	0.035	−0.052	0.024	0.95	0.91–0.99	0.032
Schooling (years)	0.091	0.062	1.10	0.97–1.24	0.144	−0.034	0.065	0.97	0.85–1.10	0.601
Sex is male	−0.214	0.653	0.81	0.22–2.91	0.744	2.123	0.753	8.35	1.91–36.51	0.005
Could not name a water treatment method	1.629	0.561	5.10	1.70–15.31	0.004	1.201	0.557	3.32	1.12–9.90	0.031
Refrigerator ownership	1.038	0.519	2.82	1.02–7.80	0.045	1.289	0.618	3.63	1.08–12.19	0.037
Motor vehicle ownership	1.619	0.779	5.05	1.10–23.25	0.038					
Television ownership						−1.223	0.818	0.29	0.06–1.46	0.135
Model diagnostics	−2LL = 97.94; Nagelkerke $R^2 = 0.37$					−2LL = 89.28; Nagelkerke $R^2 = 0.28$				

refrigerator (OR 3.63, 95% CI 1.08–12.19, $P = 0.037$). The final −2LL for this model was 89.28, and Nagelkerke $R^2 = 0.28$.

These results lend mixed support for our demographic hypothesis, as youth was a significant predictor of sachet water use in both models and being male was significant in the *sachets-as-only* model, yet so were the ownership of durable goods such as refrigerators and motor vehicles, clearly not marks of relative poverty. Sachet consumption in Old Tulaku thus seems to be associated with younger adults, perhaps males, and those with relatively higher household wealth. Although years of schooling served as a control variable in these models, the inability to name a household water treatment method was persistently statistically significant, thus lending support to our knowledge hypothesis. We observe no evidence for our social and individual attitudes hypotheses, as none of the social or individual attitude measures were associated with sachet purchasing behaviour. Livestock ownership also never approached statistical significance in any model, and while we speculated that having animals around the home might spur greater attention to household hygiene, perhaps livestock ownership was not of sufficient quantity (i.e. of livestock heads) to warrant such behaviour change.

Focus groups

Respondents from all four focus groups confirmed variability in Old Tulaku's water service, but the perceived effect on residents' lives and their relationship with drinking water differed slightly by sex. All respondents expressed frustration and a sense of powerlessness during periods when water mains are shut off due to maintenance work by GWCL, although communities are usually notified in advance. Many women also admitted that residents sometimes complain about the shutoffs to each other, but not to attending Assemblymen or Chiefs. While coping mechanisms varied, sachet water consumption did not seem as strongly linked to intermittent water shutoffs as it was to popular street perceptions of sachets, or the related effects of marketing and television advertising. Participants also revealed several knowledge gaps related to water quality, but attitudes and resulting behaviours also differed by sex.

Male respondents frequently purchase sachet water when they are in town, i.e. away from the home, and some may bring sachets home to store in the refrigerator. A male 25 + respondent who did not own a refrigerator at home stated that he purchased sachet water because it was chilled, while another male 25 + respondent said that people will "buy chilled water irrespective of the quality." Male respondents seemed drawn to sachet water over concerns for convenience, rather than quality of the water, which is consistent with *convenience* being the top reason for purchasing sachet water as reported in Table 1. Men typically work outside of the home and are rarely responsible for fetching household water, which was why we expected men to be more likely to rely on sachets as operationalized by our demographic hypothesis and affirmed in Table 4.

Female respondents reported the greatest frustration during periods of no piped water service due to the resulting increased travel distances for water. The shutoffs seem to be happening less frequently, but the inconveniences are seared into the memories of those most affected. The burden of housekeeping responsibilities—and particularly for fetching the household's water supply—overwhelmingly falls on women and children in Old Tulaku, which is consistent with the plight of women and children in much of the developing world (Buor, 2004; Sorenson et al., 2011). Older respondents noted that water fetching can cause them to be late to work or delay household tasks such as cooking and childcare, while younger females reported being late to school when the taps are shut off. Female respondents in both age groups also described tap water as dirty, particularly when water mains are being shut off or when they are first turned back on and built-up sediment needs to be flushed out. Although women described the water as dirty, white, or "containing moving things in it" right after a shutoff, they may continue to collect it if they are not able to afford better sources.

Respondents admitted minimal awareness of water treatment and water quality across all focus groups, consistent with our knowledge hypothesis. Males in the 18–24 focus group explained that virtually everyone drinks water without knowing if it is of good quality: "We can't tell if it is clean or not because we use it without any knowledge about it." Another 25 + male claimed that seeing the Food and Drug Authority's seal on the sachet water package was a sign that the water has been treated well and approved for sale. The street name of *pure water* is certainly intended to imply a product of superior quality, but while people generally believe sachet water is treated more than tap water, one 25 + male said he believed more education is needed:

> Some people think it is more treated than the tap water so I think the education should go on more… if the tap water is already treated and you go and add other chemicals to it before selling, I think you are damaging it rather. Once it is treated, it is treated and those here, if they hear that the sachet water is treated, they rush for it.

Another male respondent asked, "How do the small sachet water companies start their business; are they trained, approved? But you don't get answers to such questions." These quotes highlight the skepticism about how small sachet water companies start and purify their water, although there was consensus that some

brands of sachet water are chosen because the television commercials show expensive machinery and part of the purification process, as one 25 + male noted:

> One fact why I choose some brands from the television is they show the various stages of how they purify the water from the source but the small who can't advertise their product, I think are doing something shoddy.

Females also reported having little or no knowledge of the source, production process, or quality of sachet water. One 18–24 female explained, "I can't tell the kind of water they use for production of sachet water. Whether pipe, river or underground. I don't know the process they go through." While residents are sometimes able to identify dirt or other impurities in the tap water and therefore identify it as dirty, the lack of knowledge regarding water treatment during sachet production echoes the similar lack of knowledge about methods household water treatment presented in Table 3.

Notably, there was no evidence from any of the focus group discussions that social attitudes or peer pressure had much to do with the choice of drinking water. Decisions regarding drinking water seemed to be more linked to tradeoffs between source availability, financial considerations, and the perception of quality. This was an unexpected departure from the themes of "deep" access espoused by Obeng-Odoom (2012). Except during an occasional maintenance-related shutoff (which seemed to be happening less frequently), residents have reliable, equitable access to affordable piped water, yet still use sachets to varying degrees. The biggest threat to the quality of the municipal water may not be physio-chemical in nature, but rather the doubt cast by the slick marketing efforts of packaged water manufacturers.

Conclusion

We present a community-level case study of drinking water knowledge, attitudes, and practices in Old Tulaku, an informal, slum-like community in Ashaiman, Ghana, with persistent material deprivation despite having substantially better water access than most of Accra's in famous slums. The drinking water decisions of many slum residents in Accra are shaped by chronic water shortages and municipal water rationing, which leads to the poor generally adopting sachet water in lieu of stable piped water access. Yet in Old Tulaku we see high sachet consumption alongside regular piped water access, a paradox seemingly driven by demographic and economic factors, and with substantial nuance in individual behaviour.

The water-seeking behaviour of Old Tulaku residents exemplifies a hybrid of modernization and post-traditional approaches to water security described by Yeboah (2006). The practice of purchasing household and on-the-go drinking water in sachets represents the most recent incarnation of traditional water vending. Yet both the street name "pure water," and gravitation toward advertised brand names reputed to possess better water quality, mirrors the transformed purchasing habits of the upper classes due to globalization. The propensity for residents with slightly higher financial means to be more likely to consume sachet water resembles the adoption patterns first observed amid the initial growth of the sachet water sector in the mid-2000s (Stoler, Weeks, & Fink, 2012), and the overall pattern is consistent with previous findings where low-income residents typically turn to neighbors or private vendors as water supply coping strategies (Nyarko, Odai, Owusu, & Quartey, 2008). The trending privatization of public water supplies by vendors reflects GWCL's most current incarnation of neoliberalist water policy, which has been described as a "new public management style of governance that encourages private provision of plastic packaged water" (Obeng-Odoom, 2014).

The household KAP survey and focus groups confirm that sachet water consumers in Old Tulaku tend to be younger, less knowledgeable about their options for safe water, and with slightly better financial means. Neither the survey nor the focus groups reveal any evidence of social processes at work in shaping household water purchasing behaviour, though it is possible that unknown interviewer- or instrument-related biases may have led to ambiguous participant responses. Our findings show that residents' attitudes about themselves and each other appear to be substantially less important than their perceptions of, and frustration with, the local utility, which itself seems to be a minor factor in determining household drinking water patterns. Vexation against GWCL over inadequate communication about maintenance-induced shutoffs is certainly reminiscent of the historical accounts of residents' insurrections in Kumasi's water wars over mistreatment by the utility (McCaskie, 2009). Women in particular seem more likely to struggle with the trade-off between convenience-of-access and perceived quality. Risk perception was recently shown to be correlated with propensity for treating non-piped drinking water in Kenya (Onjala, Ndiritu, & Stage, 2014), and our results suggest the potential for a drinking water intervention that educates communities about water quality and teaches residents how to treat their water. But alternative household water treatment technologies—such as ultraviolet light or ceramic filtration, neither of which treat water instantaneously—may be hard-pressed to compete in an urban setting with the convenience and ubiquity of chilled, vended sachet water.

In a companion study of sachet water quality, 30 sachet water samples were collected from vendors in Old Tulaku and tested for basic microbial indicators. These sachets were of surprisingly good quality with no fecal contamination detected, and heterotrophic bacteria levels within international standards, though with some variation by brand (Stoler, Tutu, Ahmed, Asantewa Frimpong, & Bello, 2014). The association of sachet water with quality, i.e. *pure water*, by residents is now much more realistic than when sachet water first hit the market over a decade ago. But the promotion—or even subsidization—of sachet water is not currently an attractive policy option due to two circumstances: (1) inflation and recent price increases which threaten the affordability of sachet water for the urban poor, and (2) a lagging supply chain among private-sector plastic recyclers, an industry which may help curb the sanitation menace of discarded plastic sleeves, though with its own attendant problems (Obeng-Odoom, 2013). This context helps explain why Yeboah's (2006) observation—that water privatization is seldom driven by altruistic and public-spirited objectives like promoting good health and well-being, improving water access for the poor, and extending life expectancy—remains as true today as ever.

Respondents in all four focus groups revealed a conscious intimacy in their relationship with drinking water as seen in another recent study in Ashaiman (Peloso & Morinville, 2014), though without the persistent struggle for water depicted in neighboring communities. Residents are acutely aware of the price differentials between different drinking water sources, as well as the tradeoffs in travel time and health risk that can affect attendance at work or school, or daily completion of household activities. These choices reflect the daily conundrums faced by slum dwellers all over the world, and very clearly pose an impediment to maximizing household incomes and the potential for community-based slum upgrade projects, and thus underscore the need for sustainable water and sanitation solutions. Sachet water is an unlikely solution for water quantity issues related to household hygiene and sanitation, but if coupled with stringent quality control and efficient

plastics recycling (as implemented for aluminium and glass in much of the world), sachets may be one piece of a decentralized drinking water provision strategy for low-income urban communities expected to house an increasing proportion of the world's population by mid-century.

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References

Ainuson, K. G. (2010). Urban water politics and water security in disadvantaged urban communities in Ghana [Article] *African Studies Quarterly, 11*(4), 59–82.

Bain, R. E. S., Gundry, S. W., Wright, J. A., Yang, H., Pedley, S., & Bartram, J. K. (2012). Accounting for water quality in monitoring the millennium development goal on access to safe drinking-water: lessons from five countries. *Bulletin of the World Health Organization, 90*, 228–235A.

Bakker, K. (2010). *Privatizing water: Governance failure and the world's urban water crisis*. Cornell, NY: Cornell University Press.

Buor, D. (2004). Water needs and women's health in the Kumasi metropolitan area, Ghana. *Health and Place, 10*(1), 85–103. http://dx.doi.org/10.1016/S1353-8292(03)00050-9.

Clasen, T., Pruss-Ustun, A., Mathers, C. D., Cumming, O., Cairncross, S., & Colford, J. M. (2014). Estimating the impact of unsafe water, sanitation and hygiene on the global burden of disease: evolving and alternative methods. *Tropical Medicine and International Health, 19*(8), 884–893. http://dx.doi.org/10.1111/tmi.12330.

Dada, A. C. (2011). Packaged water: optimizing local processes for sustainable water delivery in developing nations. *Globalization and Health, 7*, 24. http://dx.doi.org/10.1186/1744-8603-7-24.

Dreschel, P., & Van-Rooijen, D. J. (2008). Water privatization in Ghana. *Corporate Africa, 4*, 108–111.

Eguavoen, I., & Spalthoff, D. (2008). *Getting access right: Human rights and household water rights in Ghana*. Paper presented at the 13th IWRA World Water Congress, Montpellier, France.

Ghana Statistical Service. (2012). *2010 Population and Housing Census, population by Region, District, age groups and sex*.

Hopewell, M., & Graham, J. (2014). Trends in access to water supply and sanitation in 31 major sub-Saharan African cities: an analysis of DHS data from 2000 to 2012. *BMC Public Health, 14*(1), 208.

Kayaga, S., Fisher, J., & Franceys, R. (2009). Improved access to urban water services in Uganda. In *Proceedings of the Institution of Civil Engineers-Municipal Engineer* (Vol. 162, p. 165e170).

Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., et al. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the global Burden of disease study 2010. *The Lancet, 380*(9859), 2224–2260.

Macro International Inc. (2013). *MEASURE DHS STAT compiler*. Retrieved June 21 2013 http://www.measuredhs.com.

Mahama, A. M., Anaman, K. A., & Osei-Akoto, I. (2014). Factors influencing householders' access to improved water in low-income urban areas of Accra, Ghana. *Journal of Water and Health, 12*(2), 318–331.

McCaskie, T. C. (2009). 'Water wars' in Kumasi, Ghana. In F. Locatelli, & P. Lugent (Eds.), *African cities: Competing claims on urban spaces* (pp. 135–155). Leiden, Netherlands: Brill.

McGranahan, G., Jacobi, P., Songsore, J., Surjadi, C., & Kjellen, M. (2001). *The citizens at risk: From urban sanitation to sustainable cities*. London, UK: Earthscan.

Nganyanyuka, K., Martinez, J., Wesselink, A., Lungo, J. H., & Georgiadou, Y. (2014). Accessing water services in Dar es Salaam: are we counting what counts? *Habitat International, 44*, 358–366. http://dx.doi.org/10.1016/j.habitatint.2014.07.003.

Nsiah-Gyabaah, K. (2001). *The looming national dilemma of water crisis in peri-urban areas in Ghana*. Kumasi, Ghana: DFID (DFID Project Funded Project R 7330).

Nyarko, K. B., Odai, S. N., Owusu, P. A., & Quartey, E. K. (2008). *Water supply coping strategies in Accra*. Paper presented at the 33rd WEDC International Conference: Access to Sanitation and Safe Water. Accra, Ghana: Global Partnerships and Local Actions.

Obeng-Odoom, F. (2012). Beyond access to water. *Development in Practice, 22*(8), 1135–1146. http://dx.doi.org/10.1080/09614524.2012.714744.

Obeng-Odoom, F. (2013). Do African cities have markets for plastics or plastics for markets? *Review of African Political Economy, 40*(137), 466–474. http://dx.doi.org/10.1080/03056244.2013.817087.

Obeng-Odoom, F. (2014). Green neoliberalism: recycling and sustainable urban development in Sekondi-Takoradi. *Habitat International, 41*, 129–134. http://dx.doi.org/10.1016/j.habitatint.2013.07.009.

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.

Onjala, J., Ndiritu, S. W., & Stage, J. (2014). Risk perception, choice of drinking water and water treatment: evidence from Kenyan towns. *Journal of Water, Sanitation and Hygiene for Development, 4*(2), 268–280. http://dx.doi.org/10.2166/washdev.2014.131.

Owusu, T. Y. (1991). *Rural-urban migration and squatter settlement formation in African cities: A case study of a ghanaian squatter settlement*. MM68679 M.A. Canada: Wilfrid Laurier University (Canada).

Owusu, G., & Afutu-Kotey, R. L. (2010). Poor urban communities and municipal interface in Ghana: a case study of Accra and Sekondi-Takoradi Metropolis. *African Studies Quarterly, 12*(1), 1–16.

Peloso, M., & Morinville, C. (2014). 'Chasing for water': everyday practices of water access in peri-urban Ashaiman, Ghana. *Water Alternatives, 7*(1), 121–139.

Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V., et al. (2014). Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: a retrospective analysis of data from 145 countries. *Tropical Medicine and International Health, 19*(8), 894–905. http://dx.doi.org/10.1111/tmi.12329.

Pullan, R. L., Freeman, M. C., Gething, P. W., & Brooker, S. J. (2014). Geographical inequalities in use of improved drinking water supply and sanitation across sub-Saharan Africa: mapping and spatial analysis of cross-sectional survey data. *PLoS Medicine, 11*(4), e1001626. http://dx.doi.org/10.1371/journal.pmed.1001626.

Sorenson, S. B., Morssink, C., & Campos, P. A. (2011). Safe access to safe water in low income countries: water fetching in current times. *Social Science and Medicine, 72*(9), 1522–1526. http://dx.doi.org/10.1016/j.socscimed.2011.03.010.

Stoler, J. (2012). Improved but unsustainable: accounting for sachet water in post-2015 goals for global safe water. *Tropical Medicine & International Health, 17*(12), 1506–1508. http://dx.doi.org/10.1111/j.1365-3156.2012.03099.x.

Stoler, J., Fink, G., Weeks, J. R., Appiah Otoo, R., Ampofo, J. A., & Hill, A. G. (2012). When urban taps run dry: sachet water consumption and health effects in low income neighborhoods of Accra, Ghana. *Health & Place, 18*(2), 250–262. http://dx.doi.org/10.1016/j.healthplace.2011.09.020.

Stoler, J., Tutu, R. A., Ahmed, H., Asantewa Frimpong, L., & Bello, M. (2014). Sachet water quality and brand reputation in two low-income urban communities in greater Accra, Ghana. *American Journal of Tropical Medicine and Hygiene, 90*(2), 272–278.

Stoler, J., Weeks, J. R., & Appiah Otoo, R. (2013). Drinking water in transition: a multilevel cross-sectional analysis of sachet water consumption in Accra. *PLoS One, 8*(6), e67257. http://dx.doi.org/10.1371/journal.pone.0067257.

Stoler, J., Weeks, J. R., & Fink, G. (2012). Sachet drinking water in Ghana's Accra-Tema metropolitan area: past, present, and future. *Journal of Water, Sanitation and Hygiene for Development, 2*(4), 223–240. http://dx.doi.org/10.2166/washdev.2012.104.

UN-Habitat. (2011). *Participatory slum upgrading and prevention: Millennium city of Accra, Ghana*. Accra, Ghana: UN-Habitat.

WaterAid. (2005). *National water sector assessment: Ghana* (London, UK).

WHO/UNICEF. (2006). *Core questions on drinking-water and sanitation for household surveys*. Geneva: World Health Organization.

WHO/UNICEF. (2012). *Progress on drinking water and sanitation, 2012 update*. Geneva: World Health Organization.

WHO/UNICEF. (2013). *Progress on sanitation and drinking-water: 2013 update*. Geneva: World Health Organization.

Wolf, J., Prüss-Ustün, A., Cumming, O., Bartram, J., Bonjour, S., Cairncross, S., et al. (2014). Assessing the impact of drinking water and sanitation on diarrhoeal disease in low- and middle-income settings: systematic review and meta-regression. *Tropical Medicine and International Health, 19*(8), 928–942. http://dx.doi.org/10.1111/tmi.12331.

Yeboah, I. A. N. (2006). Subaltern strategies and development practice: urban water privatization in Ghana. *Geographical Journal, 172*(1), 50–65. http://dx.doi.org/10.1111/j.1475-4959.2006.00184.x.