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An Empirical Perspective of Water Quality in Appeadu: A Suburb of Kumasi in the Ashanti Region, Ghana

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ABSTRACT

The provision of quality water supply to communities is critical in enhancing their health status and promoting human development. In this study, 100 respondents were selected randomly and interviewed based on demography, water usage patterns as well as their general perception of their water quality. Analysis of the results after the interview showed that, with respect to water treatment, fewer proportions of peri-urban dwellings (5%) rendered their water for drinking and for domestic purposes to some form of treatment (filtration) before use compared to their urban control (18%). This was statistically significant ($p = 0.004$). Greater proportions of the peri-urban areas (93) and (97%) did not object negatively with respect to the taste and smell respectively of their drinking water compared to the urban ($p < 0.0001$). With regards to the regularity of water supply, the results showed that majority of the peri-urban population (67%) were satisfied with their water supply as compared to the urban populace (43%) ($p = 0.0006$). A higher proportion of the peri-urban respondent (66%) answered negatively to preference for an alternative source of water supply as compared to their urban counter part (27%) and this was significant. Results of the study has shown that, there was a common sight of water distribution systems laid among drainage channels, thereby exposing drinking water supplied to homes to possible pollution. Inhabitants of Appeadu (Study area) within the Kumasi Metropoli of Ghana were however not bothered by the quality of their drinking water.

Key words: Perception, peri-urban, urban, water quality, Appeadu

INTRODUCTION

Water has always been an important and life-sustaining drink to humans and is essential to the existence and survival of all known organisms (Greenhalgh, 2001). About 75% of the earth's surface is covered by water but only 1% of that is drinkable, Soechtig (2009). The human body is made up of 60% of water (USGS, 2009) and therefore, our basic existence as humans is largely dependent on safe drinking water. Apart from drinking, water also serve useful purposes such as agriculture, washing, transportation, recreation, industrial application and other uses (Doe, 2007). Access to safe drinking is a major challenge affecting many countries in the world especially developing countries (WHO/UNICEF, 2012) and the provision of quality water supply to communities is critical in enhancing the health status to promoting human development DFID (1998).

Africa has the lowest water supply and sanitation coverage of any region in the world. More than 30% of Africans residing in urban areas currently lack access to adequate water services and facilities. In the year 2000, World Health Organisation (WHO) estimated that Africa contains 28% of the world's population without water access to improved water supplies and 13% of the world's population without access to improved sanitation. With this, only 62% of the people in African countries have access to improved water supplies and only 60% have access to improved sanitation (WHO, 2000). The situation is clearly appreciated worldwide and therefore the Millennium Development Goal 7 of ensuring environmental sustainability, has a target of significantly reducing by half, by 2015, the proportion of population in developing countries without access to safe drinking water and basic sanitation. Although, water remains a renewable resource that is replenished by precipitation, the quality of water that is available for human use has significantly been affected by human activities Herman and Zaslow (1996).

In Ghana, rural communities and small towns constitute about 12.6 million (60%) of the total population (CWSA, 2005). Although safe drinking water supplies in small towns and rural communities have improved considerably within the last six years from about 41 in 2001-52% in 2005, a significant 48%, mainly rural communities, still continue to face major shortage in the supply of good quality water (CWSA, 2005). It is in the light of this that it is being implied that the integrity of the reservoirs and mains in the distribution network is critical for the safety of the drinking water (Van Lieverloo *et al.*, 2006). Lack of maintenance of pipelines and other distribution infrastructure causes leaks and breaks which may serve as entry point for the intrusion of microorganisms. Hunter (1997) reported that 15 out of 57 outbreaks in public water supplies in the UK between 1911 and 1995 were associated with contamination within the distribution.

Many waterborne outbreaks are as a result of contamination of drinking water in the distribution system. A study conducted by Egwari and Aboaba (2002) to assess the impact of town planning, infrastructure, sanitation and rainfall on the bacteriological quality of domestic water supplies in Lagos, Nigeria, revealed that water samples collected from points of leak were more frequently contaminated with *E. coli* or other coliforms. The Appiadu community water system draws groundwater from borehole which is pumped to a series of overhead tanks. The water is later distributed through a network of pipelines to individual homes. Most of these pipelines run through drainage system and since the distributed water undergoes no treatment process, there is an increasing chance of contamination from the waste drainage water. The main objective of this study is to assess the perception of the quality of water supplied from the Appiadu Borehole water distribution system.

MATERIALS AND METHODS

Study area: This study was conducted in Appiadu a peri-urban community while its control counterpart was limited to Asafo, (Urban community). Both communities are located within Kumasi, the capital of Ashanti Region of Ghana. Kumasi covers an area of about 245 km² and is located in the transitional forest zone and is about 270 km north of the national capital, Accra. It is between latitude 6.35-6.40° and longitude 1.30-1.35° and lies within the wet semi-equatorial zone marked by double maximum rainfall ranging between 1150 and 11750 mm per annum. The major rainfall season is from April to July and the minor season is between September and Mid-November. Ghana Urban Water Limited (GUWL) is responsible for supplying pipe borne water to the numerous urban and peri-urban areas within Kumasi but the rapid expansion of the city coupled with other infrastructure deficiencies of GUWL have led to intermittent and irregular

supplies and in many cases a total lack of water in the communities. This phenomenon has resulted in many communities resorting to streams, rivers and groundwater as a source of potable/ domestic water.

Historical background of Appiadu community water system: Before the year 2009, Appiadu was prone to guinea worm infection, a water-borne disease which had tremendous adverse effect on the health of the inhabitants. In 2009, through the community's own efforts and in partnership with the erstwhile Ghana Water Company Limited (GWCL), piped water was extended to the community. However, this supply of water to the area was irregular coupled with lack of maintenance of the pipelines and this resulted in the community reverting to the guinea worm-infested streams, hence the return of the disease (Akrofi and Whittal, 2011). Later the community sought technical assistant from GWCL to sink a borehole to supply water. Electricity was extended to the borehole site and a reservoir was later installed to store the pumped water. Distribution pipelines were also laid and connected to the already existing GWCL pipelines to supply water from the reservoir to individual homes in the community.

Household survey: Structured questionnaires designed for households included both open-ended and closed questionnaires. A total of 200 questionnaires were administered to people in both peri-urban (100 questionnaires) and urban (100 questionnaires) communities to assess information on response to water quality and the perception of water management. These numbers was thought to offer a good representation of the population of households and a tolerable level of accuracy (Lagardere, 2007). Households were selected at random and interviewed. The questions included basic socio demographic questions (including sex, age, marital status, educational level and reported monthly household income). The questions also aimed at seeking information regarding household water usage patterns and households hygiene behaviour as perceived by respondents in the study areas.

Field observation: This study methodology involved a transect walk and visual inspection of water reservoir and the various distribution systems. The field observation as a study methodology was done to have a fair idea about the general water usage patterns and mode of domestic storage. The transect walk and the visual inspection were carried out early in the mornings and late in the evenings when household members were at home and use of water facilities was at its peak. Some distribution systems laid in drains and gutter that supplied water to homes of the study participants were also observed.

Data analysis: The study was based on qualitative and quantitative methods of data analysis. Chi-square test was used to test for significance between categorical variables. Questionnaires were entered manually into Microsoft Excel 2007. Chi-square test was used to examine associations between dichotomous variables from respondents in peri-urban compared to the control Gyasi *et al.* (2011). Two-tailed tests were used with $p < 0.05$ considered significant (Odeyinka *et al.*, 2007).

RESULTS

In this study, participants who responded to structured questions consisted of males and females who ranged between ages 6-50 years and above as shown in Table 1. Fewer proportions of peri-urban dwellings were single and educated to levels as high as tertiary. Majority

Table 1: Stratification of respondents demographic data among peri-urban inhabitants

Variables	Peri-urban (100) (%)	Urban (100) (%)	p-value	OR
Age				
6-15	0 (0)	1 (1)	0.3161	0.33
16-20	14 (14)	7 (7)	0.1064	2.163
21-50	64 (64)	83 (83)	0.0023	0.3641
50 upwards	22 (22)	9 (9)	0.0248	1.444
Sex				
Male	43 (43)	48 (48)	0.4777	0.8173
Female	57 (57)	52 (52)	0.4777	1.224
Marital status				
Married	42 (42)	31 (31)	0.1062	1.612
Single	31 (31)	59 (59)	<0.0001	0.3122
Divorced	18 (18)	6 (6)	0.009	3.439
Widowed	9 (9)	3 (3)	0.074	3.198
Separated	0 (0)	1 (1)	0.3161	0.33
Educational level				
Primary	24 (24)	6 (6)	0.0004	4.947
JSS/MSLC	47 (47)	28 (28)	0.0055	2.28
Tertiary	4 (4)	32 (32)	<0.0001	0.08854
SSS	13 (13)	31 (31)	0.0021	0.3326
Never been to school	9 (9)	2 (2)	0.0299	4.846
Tech/Comm/Voc	3 (3)	1 (1)	0.3124	3.062
Occupation				
Farmer	19 (19)	0 (0)	<0.0001	48.09
Trader	11 (11)	11 (11)	1	1
Unemployed	28 (28)	26 (26)	0.7501	1.107
Govt. worker	2 (2)	14 (14)	0.0018	0.1254
Self-employed	40 (40)	41 (41)	0.8855	0.9593
None of the above	0 (0)	8 (8)	0.0039	0.05414

OR: Odds Ratio, p: p-value, while all other parenthesis within the table represent the various percentages

of peri-urban respondents (24%) had at least primary education compared to the control (6%) and this was statistically significant as shown in Table 1. Majority of these peri-urban respondents were farmers with fewer proportion employed as civil servants. Analysis of respondents questionnaire of demographic data based on age with respect to the type of settlement showed, there were about 2 times more study subjects in the peri-urban localities (14%) with ages ranging between 16-20 years of age compared to their urban counter-part (7%) (OR = 2.163). This was however not significant (p = 1.064) as shown in Table. This was also seen with the adult population (i.e. age >50 years) (Table 1).

The study also showed that, fewer proportions of the peri-urban settlements were single (31%) compared to their urban counter part and this was significant (p<0.0001). The marital population within the peri-urban settings were however greater (42%) compared to their urban counter part (31%) but this was not significant as shown in Table 1 (p = 1.612). Educational level stratification based on settlement types during the study showed that, greater proportion of peri-urban dwellers (9%) had never been to school compared to their control (2%). This was however not statistically significant (p = 0.0299) (Table 1). When the occupational status of the respondents were analysed, the study showed that, majority of peri-urban subjects who responded to the questionnaires were farmers (19%) compared to their urban control (0%) and this was significant (p<0.0001) as shown in Table 1.

Table 2: Respondent perception of general water stratified by location

Variables	Peri-urban (100) (%)	Urban (100) (%)	p-value	OR
Is your water treated before drinking?				
Yes	5 (5)	18 (18)	0.0040	0.2398
No	95 (95)	80 (80)	0.0013	4.75
Don't know	0 (0)	2 (2)	0.1552	0.196
Do you store water in a container before use?				
Yes	97 (97)	86 (86)	0.0093	5.264
No	3 (3)	14 (14)	0.0447	0.2784
If yes, do you see sediments at the bottom of the container?				
Yes	50 (50)	77 (77)	<0.0001	0.2987
No	47 (47)	6 (6)	<0.0001	13.89
Don't know	0 (0)	3 (3)	0.0810	0.1386
Do you have any concern about the taste of the water?				
Yes	7 (7)	35 (35)	<0.0001	0.1398
No	93 (93)	60 (60)	<0.0001	8.857
Don't know	0 (0)	5 (5)	0.0235	0.08639
Do you have any concern about the smell of the water?				
Yes	3 (3)	37 (37)	<0.0001	0.05266
No	97 (97)	63 (63)	<0.0001	18.99
Do you have any concern about the colour of the water?				
Yes	0 (0)	65 (65)	<0.0001	0.002696
No	100 (100)	35 (35)	<0.0001	0.002696
Do you drink any other water source?				
Yes	37 (37)	73 (73)	<0.0001	0.2172
No	63 (63)	27 (27)	0.0002	2.899
If yes, specify				
Sachet	34 (34)	50 (50)	0.0219	0.5152
Bottled	2 (2)	23 (23)	<0.0001	0.06832
Do you have regular water supply?				
Yes	67 (67)	43 (43)	0.0006	2.691
No	33 (33)	57 (57)	0.0006	0.3716
Suspected leakage of environmental water into the main distribution lines?				
Yes	55 (55)	54 (54)	0.8871	1.041
No	45 (45)	43 (43)	0.7757	1.085
Don't know	0 (0)	3 (3)	0.0810	0.1386
Preferred an alternative source of water supply?				
Yes	33 (33)	73 (73)	<0.0001	0.1822
No	66 (66)	27 (27)	<0.0001	5.248
Don't know	1 (1)	0 (0)	0.3161	3.03

OR: Odds Ratio, p: p-value, while all other parenthesis within the table represent the various percentages

Respondent's perception of water quality: The study also sought to compare the water usage behaviour of the respondent population based on whether a subject lived in a peri-urban or an urban area. Analysis of the results after the interview showed that, with respect to water treatment, fewer proportions of peri-urban dwellings (5%) rendered their water for drinking and for domestic purposes to some form of treatment (filtration) before use compared to their urban control (18%).

This was statistically significant ($p = 0.004$) as shown in Table 2. The storage of domestic water in plastic containers before usage was however, evenly distributed among both peri-urban and their urban control ($p = 0.0093$) (Table 2).

Fewer proportions of peri-urban settlers (50%) perceived debris settled at the bottom of their storage container when kept for some time before use compared to their peri-urban counterpart

(77%) and this was significant ($p < 0.0001$). These fewer proportions of peri-urban dwellers (7%) however, did not have any concerns with the taste of the water during drinking or usage for cooking and other domestic purpose compared to the urban dwellers (35%) ($p < 0.0001$). Greater proportions of the peri-urban areas (93) and (97%) did not object negatively with respect to the taste and smell respectively of their drinking water compared to the urban ($p < 0.0001$) as shown in Table 2.

Fewer proportions of this population i.e., peri-urban (0%) answered in the affirmative when questions relating to concerns of the colour of their drinking water compared to the urban settlement as shown ($p < 0.0001$) (Table 2).

With regards to the regularity of water supply, the results revealed that majority of the peri-urban population (67%) were satisfied with their water supply as compared to the urban populace (43%) ($p = 0.0006$). A higher proportion of the peri-urban respondent (66%) answered negatively to preference for an alternative source of water supply as compared to their urban counter part (27%) and this was significant as shown above (Table 2). Fewer proportions of peri-urban inhabitants (37%) drink other water source at home as compared to the urban inhabitants (73%) and this was statistically significant ($p < 0.0001$) as shown in Table 2.

DISCUSSION

The objective of this survey study was to investigate the perception of inhabitants of Appiadu; a peri-urban community, on the quality and satisfaction of their water supply using Asafo as a control urban community (Both in the Ashanti Region, Ghana). This study has become relevant because some of the water distribution system (Fig. 1) linking the main overhead water tank at Appiadu in Kumasi, Ghana is laid among underground drainage systems. The obvious suspension is that, these distribution system could be polluted with materials from the solid waste should there be an openings along the distribution pipes. The fact still remains that, perceptive survey has been employed in past studies to investigate water quality issues Kite-Powell (2003). The data from analysis of this study showed that age, sex, marital status, education level and occupation of the respondents had no effect on their perception with respect to concerns of water quality.

Peri-urban perception on water quality: Results of the study showed that a significantly high number of inhabitants in the peri-urban area did not treat their water before drinking and this phenomenon was probably due to the fact inhabitants in the peri-urban area had advance perception of the source of their water supply to be of doubtless quality. In addition to this, would be the proximity of the water supply site to the community members. Gyau-Boakye and Dapaah-Siakwan (2000) in assessing groundwater as a source of rural water supply in Ghana stated that, ground water has excellent microbiological and chemical quality due to adequate aquifer protection and therefore requires minimum or no treatment. This perception among the peri-urban community may also be due to the fact that no previous history of health complaint or complication associated with usage of their water has been reported or observed.

This awareness may have been the reason why greater proportion of these respondents did not drink water from any other sources at home, neither sachet water nor bottled water. This was consistent with a study carried out in the Upper Region of Ghana Apambire *et al.* (1997).

The observation that 2 times more respondents in the peri-urban area did not drink water from any other source at home apart from the main community water source was expected. In addition, it was also established that, majority of respondents from the peri-urban area were satisfied with



Fig. 1(a-b): Water distribution systems among drianage system, (a) Solid waste and (b) Connecting drinking water from the main overhead distribution tank to domestics outlets at Appeadu in Kumasi, Ghana

the physical properties (That is, taste, smell and colour) of their drinking water was also anticipated. In a study conducted by a group of researchers in Tarkwah, Ghana on the contamination status of drinking water in the region, results of the showed that, people would always accept drinking water whose quality was not doubtful (Asante *et al.*, 2007).

Majority of respondent from the peri-urban area had no concern at all about the taste and smell respectively. In the case of colour, none of the inhabitants from the peri-urban area expressed concern about the colour of their water. This was consistent with earlier study conducted in India Brindha and Elango (2011).

Response to the quality of water supply: The greater proportion of both peri-urban and urban inhabitants storing drinking water and water for domestic purposes in containers in times of draught was expected. However, fewer proportions of peri-urban settlers complained sediments were seen at the bottom of the containers after few days of storage. This assertion could be understood because data collected during the study showed that, a significantly higher number of peri-urban settlers were satisfied with the regular flow of their water supply. This was consistent with earlier study (Subramani *et al.*, 2010). Once it has been perceived water may not flow regularly, there was the propensity water would be kept in reservoirs for longer periods. However, the longer water stays in a container the higher probability of sediment build up. The presence of sediments in water is generally undesirable and may be an indication of poor or compromised quality (Yidana and Koffie, 2013).

The perception that water flows regularly among peri-urban settlers did not come as a surprise and this could be attributed the presence of adequate infrastructure and management support at the community level. Research has shown that, settlements where infrastructure is well established often do not have water shortage challenges Bakker (2003). Within this peri-urban settlement, a community stand pipe has been installed to provide inhabitants whose homes are not connected to the distribution pipelines assess. Subjects' satisfaction with the physical properties of their water for drinking and domestic purposes (taste, smell and colour) in the peri-urban community was consistent with answers to question posed relative to an alternative source of water supply.

The data also shows that significantly higher No. of peri-urban settlers were satisfied with their water source. Consistent with other studies, Mohammed (2012) in investigating customer

perception on the quality of water at Adum a suburb in Kumasi, Ghana, established that, respondents' perception of the water taste, smell and colour affected their choice of the water for drinking.

Respondent's satisfaction with taste, smell and colour among the peri-urban settlers alone could not account for reasons why majority of these groups did not prefer an alternative to their water supply. The community's previous bad experience with supply from Ghana Water Company (The Government owned water Distribution Company) may have influenced their perceived reaction to their water. It must be emphasized that, with the benefit of hindsight; they would have preferred their current water source for drinking and for domestic purposes to no other. This was consistent with an earlier research (Yidana and Koffie, 2013).

CONCLUSION

Results of the study has shown that, there was a common sight of water distribution systems laid among drainage channels, thereby exposing drinking water supplied to homes to possible pollution. Inhabitants of Appeadu (Study area) within the Kumasi Metropoli of Ghana were however not bothered by the quality of their drinking water. The question that warrant an urgent answer is that, are inhabitants of the study area exposed to harmful effects of the perceived polluted water as well as some pathogenic assaults? It is therefore recommended an extensive water quality analysis urgently be carried out to elucidate the health implications of this water distribution system.

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