DOMESTIC WATER USE AND ITS IMPLICATIONS FOR CHILDHOOD DIARRHOEA IN THE ATWIMA NWABIAGYA DISTRICT, GHANA: A DI-SEASONAL DICHOTOMY

by

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DECLARATION

I hereby declare that this submission is my own work towards the PhD and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

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DEDICATION

I dedicate this thesis to my parents Mr. Nicholas Danquah and Madam Mary Amoah. Thank you very much for your good advice, unceasing encouragement, fervent prayers and overwhelming financial support. God richly bless you.

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ABSTRACT

It is estimated that diarrhoea is responsible for the deaths of 1.5 million children per year making it the second leading cause of death in children under-five years globally. The relationship between water quality and diarrhoea has received much attention in the literature however much needs to be learnt about long-term variations in domestic water use behaviour, per-capita water consumption and its relationship with childhood diarrhoea in Sub-Saharan Africa in general and Ghana in particular. This panel study therefore explored seasonal variations in domestic water use and its relationship with childhood diarrhoea in households having children under-five years. A total of 378 households were drawn from 4 communities in the Atwima Nwabiagya District, Ghana using simple random sampling. The communities were surveyed in the wet season (June – August, 2012) and dry season (January – February, 2013) respectively. Quantitative data was collected from mothers of under-five year old children using interviewer-administered questionnaire and observation schedules whereas qualitative data was collected using Focus Group Discussions (FGDs) and in-depth interviews. Multiple regression and correlational analysis were used to examine the determinants of domestic water use for households in the wet and dry seasons as well as for urban, peri-urban, piped and un-piped households. Bi-variate and multivariate logistic regression were used to identify risk factors associated with childhood diarrhoea and expressed in odds ratios (OR). A paired sample *t*-test; $t(255) = 10.92$, $p \leq 0.001$, showed a statistically significant variation in mean per capita water use in the wet and dry seasons. Mean daily per capita water use was estimated to be 54 liters in the wet (n = 263) and 22 liters in the dry season (n = 366). Household size and size of the primary water storage vessel accounted for 9% of total variation in per-capita water use in the wet season whereas household size, length of water storage (days), duration of water service and size of the primary water storage vessel accounted for 35% of the total variation in per-capita water use in the dry season. Residential location (AOR= 3.01, 95% CI 1.61 – 5.63) showed a statistically significant relationship with childhood diarrhoea in the wet season. In the dry season, the mother's age (AOR= 3.52, 95% CI 1.00 – 10.32), the mother's educational level (AOR= 4.67, 95% CI 1.80 – 12.13), storage of water outside the dwelling (AOR= 0.38, 95% CI 0.17 – 0.84) and children often playing on the bare ground (AOR= 3.05, 95% CI 1.35 – 6.89) showed a statistically significant relationship with childhood diarrhoea. This study concludes that mean per-capita water use in households varied across the wet and dry seasons. The number of under-five year olds was not a statistically significant determinant of per-capita water use and no statistically significant association was found between per-capita water use and childhood diarrhoea in the wet and dry season. The intensification of maternal education on the mechanisms of transmission of environmentally related diseases such as diarrhoea in the household was recommended. Other recommendations included the provision and maintenance of adequate sanitation infrastructure, regular monitoring of per capita water use and institutional capacity building. It was recommended that future research focuses on an assessment of the microbiological quality of water sources and stored water in the domestic domain.

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LIST OF ABBREVIATIONS

ANDA ....Atwima Nwabiagya District Assembly

AOR ....Adjusted Odds Ratio

CSIR.......................................Council for Scientific and Industrial Research

DFID ....Department for International Development

DOW ....Drawers of water

EPA ....Environmental Protection Agency

FGD..Focus Group Discussion

GHS..Ghana Health Service

GSS ....Ghana Statistical Service

ISD ....Information Services Department

JMP ....Joint Monitoring Programme

LDCs ....Less Developed Countries

MOFA ....Ministry of Food and Agriculture

MWRWH ....Ministry of Water Resources, Works and Housing

MLGRD ....Ministry of Local Government and Rural Development

OR ....Odds Ratio

ORS ....Oral Rehydration Salt

ORT..Oral Rehydration Therapy

PATH ....Programme for Appropriate Technology in Health

UNDP.....................................United Nations Development Programme

UNEP ....United Nations Environment Programme

UNESCO................................United Nations Educational Scientific and Cultural Organization

UNICEF ....United Nations International Children's Fund

UNWWAP ....United Nations World Water Assessment Programme

WASH....................................Water Sanitation and Hygiene

WEDC....................................Water Engineering and Development Center

WELL ....Water and Environmental health at London and Loughborough

WHO ....World Health Organization

OPERATIONAL DEFINITIONS

Childhood diarrhoea: A child under-five years of age experiencing three or more loose stools during a 24 hour period.

Diarrhoea: Having three or more loose stools during a 24 hour period.

Diarrhoea episode: Having diarrhoea after two or more days without a diarrhoea experience.

Domestic water use: The use of water for domestic purposes such as cooking, laundry, bathing and drinking.

Dry season: The study period ranging from January 01 – February 31, 2013 characterized by the presence of the northeasterly winds called 'Harmattan'.

Faecal coliform: Bacteria found in the intestinal tracts of mammals and therefore in faecal matter. Their presence in water is an indicator of pollution and possible contamination by pathogens.

Faecal-oral diseases: Diseases transmitted by the consumption or contact with faecally contaminated water. Examples are cholera, typhoid, amoebic dysentery and diarrhea.

Household: A person or group of persons who live together in the same house or compound, sharing the same house-keeping arrangements and are catered for as one unit.

Household head: The person responsible for the upkeep of the household and recognized by other household members as the head.

Index child: A child that is selected by lottery method for study in a household where there are more than one under-five year old child.

Immediate access to sanitation: Households' use of sanitation facilities that are located within their dwellings or on their home compounds.

Odds Ratio: The measure of association which compares the odds of disease of those exposed to the odds of disease for those not exposed.

Per-capita domestic water use: The volume of water (liters) collected per person per day which is estimated by dividing the total amount of water collected per day in a household by the household size.

Peri-urban: The transition zone in which non-agricultural activities predominate with the surrounding rural areas engaged predominantly in agricultural activities.

Refuse: Solid waste that is thrown away and considered as being of no value or use.

Remote access to sanitation: Households' use of sanitation facilities which are located off their home premises. Eg. Public latrines.

Risk factor: An attribute or exposure that is associated with an increased probability of having diarrhoea and may not necessarily be a causal factor.

Sewage: Human and domestic waste matter from houses that is carried away through sewers.

Urban: An area characterized by higher population density, relatively large number of improved socio-economic infrastructure, and a large number of inhabitants with non-agricultural jobs.

Waste: Unwanted or unusable liquid or solid matter.

Water-borne diseases: Diseases that are transmitted through the ingestion, direct skin contact with polluted water or lack of water. They include diarrhoea, cholera, typhoid, skin infection, eye infection.

Water quality: The physical, chemical and bacteriological condition of water with respect to the amount of impurities in it.

Water quantity: The volume of water which is measured in liters.

Wet season: The study period ranging from June 01 – August 31, 2012.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Water is an essential component of life and having access to it is a fundamental human right. Worldwide, water is used for purposes such as drinking, cooking, washing, cleaning, manufacturing and electricity generation. The most important use however is for drinking. This is because the human physical structure is built up of approximately 70% water and water serves as a primary medium through which bio-chemical processes takes place in the body (Miller, 2005). Humans can live for days without food but cannot do so without water. Regrettably, many people in the world do not have access to this cherished resource.

In 2008, approximately 900 million of the global population lacked access to improved water sources whilst 2.6 billion people did not have access to improved sanitation (WHO, 2010:2). In 2014, estimates showed that there had been improvements in access to water but slow progress had been made with sanitation compared to 2008. According to WHO and UNICEF, in 2014, 700 million people lacked access to improved water sources, whereas 2.5 billion did not have access to improved sanitation (WHO/UNICEF, 2014:6). That notwithstanding, this picture of water and sanitation coverage has numerous implications for the health and socio-economic well-being of affected people all over the world. The reality is that many people without access to water and sanitation, most of whom are children, lose their lives.

Globally, diarrhoea is the second leading cause of death among children under-five years of age with about 4 billion cases occurring each year (UNICEF/WHO, 2009:1; Fischer Walker et al., 2012). Diarrhoea together with pneumonia and malaria cause the deaths of 3 out of every 10 children under the age of 5 years (UNICEF, 2014: 21). More than 1.5 million children under 5 years die as a result of diarrhoea alone representing 17 percent of all deaths in children under 5 years (UNICEF, 2010: 89). In terms of regional distribution, Africa accounts for 46% of all deaths due to diarrhoeal diseases in children under five followed by South Asia, East Asia and the rest of the world which accounts for 38%, 9% and 7% respectively (UNICEF/WHO, 2009:7).

The most vulnerable group of people who suffer from insanitary environmental conditions are children between the age of 0-5 years. The immune systems of children below the age of 5 years are lower and are more likely to suffer from diseases such as diarrhoea when they are exposed to pathogens in the environment (Mintz et al., 2001; Clasen and Bastable, 2003). Therefore, attention has been placed on securing a healthy environment for children and it is most needed in the context of the household where children first begin to grow.

The supply of water to households holds much significance in reducing the likelihood of contracting water-related diseases. However, having water source improvements alone may not be enough to ensure better health outcomes for all household members of which children are part (Gundry et al., 2004). Research evidence indicates that there is the possibility of water contamination at source, during transportation, or during storage within the household and that the provision of 'improved sources' does not guarantee that water is 'safe' for drinking or cooking (Clasen and Bastable, 2003; Gundry et al., 2006). WHO/UNICEF (2005) maintains that deteriorating drinking water quality is likely to erode the gains made in improving access to drinking water. Knowing where faecal or bacteriological contamination is taking place is crucial in order to properly place interventions that will secure good health for all in the household environment.

In order to secure and increase gains made in improving access to drinking water, an understanding of domestic water use behaviour and its related factors is also crucial. Thus, Rosen and Vincent (1999) advance the argument that an understanding of how households decide how much water to use and the relationship between distance and quantity consumed is crucial to achieving many of the health benefits expected from investments in water supply. An understanding of long-term trends and changes in domestic water use behaviour holds significance in helping to achieve two Sustainable Development Goals (SDGs) in particular. The first is SDG 3 which is to ensure healthy lives and promote well-being for all at all ages and SDG 7 which is to ensure availability and sustainable management of water and sanitation for all (UNDP, 2015). This research therefore examined domestic water use behaviour at the household level, factors that affected domestic water use across the wet and dry seasons and their interrelationship with under-five diarrhoea morbidity.

1.2 Statement of the Problem

Diarrhoea kills about 1.8 million people each year and accounts for 17% of deaths of children under 5 years of age in developing countries (WHO, 2008: ii). It is estimated that 9 million episodes of diarrhoea are recorded in Ghana each year with diarrhoea also causing about 84,000 deaths of children under five annually (Scott et al., 2007). In 2004, the first four leading causes of death of children under 5 years (0-4) of age in Ghana were malaria (33%), Acute lower respiratory infection (17%), peri-natal conditions (17%) and diarrheal diseases (14%) (MOH, 2006:5). In 2009, diarrhoeal diseases ranked 3rd with a proportional morbidity rate of 5.1% for the top ten causes of admissions for children under 5 years in Ghana. In the same year, diarrhoeal diseases ranked 6th on the top ten causes of deaths for children under 5 years with a proportional mortality rate of 2.6% (GHS, 2009:49).

Health data from the Health Information Unit of the Ghana Health Service in 2011 indicated that from 2008 to 2010, the Atwima Nwabiagya District recorded a total of 8,956 childhood diarrhoea cases with a mean ($\bar{X}$) of 2,985 cases over the three year period. However, within the same period, 7,453 ($\bar{X}$ = 2,484) cases were recorded in the Obuasi Municipality, 7,049 ($\bar{X}$ = 2349) in the Ahafo Ano South District, with 6636 ($\bar{X}$ = 2,212) and 6,202 ($\bar{X}$ = 2,067) cases recorded in the Ejisu Juaben and Sekyere East Districts respectively (GHS, 2011b). The relatively high number of childhood diarrhoea cases reported in the Atwima Nwabiagya District compared to its sister administrative districts drew attention for investigation. This was particularly so given the backdrop that the district had a potable water supply coverage of about 80% in 2006 and 95% in 2009 (ANDA, 2011:31).

Hygiene practices such as the washing of hands with soap and water after defecation are enhanced when adequate volumes of water are easily accessible and well managed in the household (Curtis et al., 2000). Accessibility is in part dependent on the provision of adequate and reliable water infrastructure. However, Howard and Bartram, (2003) were of the view that the provision of water infrastructure alone may not secure health benefits for the household. That notwithstanding the literature also suggested that less attention had been given to the relationship between domestic water consumption and diarrhoea compared to that of water quality and diarrhoea (Aiga 1999).

The United Nations World Water Assessment Programme (UN WWAP, 2009:97), indicated that ‘our knowledge of water use is poor and the limited knowledge of water use patterns inhibit our ability to manage water resources appropriately’. Also, research evidence pointed to a paucity of literature on determinants of domestic water use as well as long-term trends and changes in developing countries (Sandiford, 1998; Thompson et al., 2000). Rosen and Vincent (1999) stressed that understanding decision making processes in how much water to use and the relationship between distance and quantity was crucial to achieving many health benefits. Thus Makoni et al., (2004), indicated that there was the need to fill in the gap regarding domestic water use and understanding domestic water use patterns. They believed it would help improve the ability to meet domestic water demand’.

Aiga (2003) pointed out that more water consumption studies was need in order to facilitate meta-analysis which would enable the relevant authorities to improve the minimum requirements for consumption. Globally, water planning and management is shifting focus from provision of water supply infrastructure to understanding the factors that affect water use and how best to meet water demand (House-Peters and Chang, 2011; Gleick, 2003). Therefore the information gathered on changing water use patterns over time is central to making analysis of trends (Gleick, 2003).

Given the level of water accessibility in the Atwima Nwabiagya District as well as the need to better understand the relationship between domestic water use behaviour and childhood diarrhoea, the following questions were drawn. Most importantly, what similarities and differences exist in terms of domestic water use behaviour in the wet and dry seasons?, What factors influence domestic water use in the wet and dry seasons?, What seasonal risk factors are associated with childhood diarrhoea?, Is there a relationship between domestic water use and childhood diarrhoea in the wet and dry seasons? Answers to these questions are important in any attempt to address domestic water use and childhood diarrhoea challenges in the Atwima Nwabiagya District.

1.3 Research Objectives

The general objective of the study was to explore seasonal variations in domestic water use behaviour at the household level and its relationship with childhood diarrhoea morbidity in the Atwima Nwabiagya District.

The specific objectives of the study were:

1. To characterize domestic water use behaviour for the wet and dry seasons in the Atwima Nwabiagya District.
2. To examine determinants of domestic water use in the Atwima Nwabiagya District in the wet and dry seasons.
3. To assess the risk factors associated with childhood diarrhoea.
4. To examine the relationship between childhood diarrhoea and domestic water use in households during the wet and dry seasons.

1.4 Research Hypotheses

The following null hypotheses were formulated to guide the research:

a. H_0: There is no difference between mean daily per capita water use in the wet season and mean daily per capita water use in the dry season.

b. H_0: The number of under-five year old children in the household is not a statistically significant determinant of per-capita water use.

c. H_0: There is no statistically significant association between per-capita water use and childhood diarrhoea in the wet and dry seasons.

1.5 Research Methodology

1.5.1 Research design

This study was conducted using a longitudinal study design and a panel study approach. Longitudinal studies involve the collection of data on each variable for two or more distinct periods, the subjects analyzed are comparable from one period to the next and involves comparison of data among periods (Menard 1991:4). A panel study is a type of longitudinal study in which a sample from a population is studied at one point in time and re-studied at another distinct period with the aim of studying change at the individual or household level (Bechhofer and Paterson, 2000:115). It affords the gathering of data about disease states, helps to identify trends and is useful for determining the associations between risk factors and disease outcomes as well as health planning for a defined population (Silman and Macfarlane, 2004). The first wave of the panel survey involved a household survey in the wet season (June – August) of 2012. The second took place in the dry season (January – February) of 2013 and consisted of a repeat survey of all households that had been visited earlier in the wet season. The unit of inquiry was households with under-five year old children. Quantitative and Qualitative methods were used in order to draw from the strengths of each. The quantitative methods included the use of an interviewer administered questionnaire and structured observation schedules. Qualitative methods which were employed included Focus Group Discussions (FGDs) and in-depth interviews.

1.5.2 Preliminary reconnaissance survey

Prior to conducting the first household survey, a series of reconnaissance surveys were conducted in December, 2011 with the aims of getting acquainted with the socio-cultural terrain, reviewing health data from the district and requesting for approval to conduct the study. The Assembly men of the study communities, the District Director of Medical Services and the District Chief Executive were met and formally briefed on the essence of the research and its purposes after which formal approval was given by the District Assembly.

1.5.3 Sample size estimation

This study was carried out in communities which had consistently recorded increases in under-five diarrhoea morbidity cases in the 3 years (2008-2010) preceding this study (See Appendix IV). Research logistics and time constraints allowed for the study of four communities, namely, Abuakwa, Nkawie, Asuofua and Barekese. The study communities were manually mapped and divided into 10 sectors each using key transportation routes in each community in order to facilitate the enumeration of eligible households (See Appendix II). The number of households per sector was arrived at by dividing the community's sample size by the 10 sectors. Table 1.1 shows the selected study communities and their corresponding sample size allocations.

Table 1.1 Selected study communities and their corresponding sample sizes.

Community	**Total number of Households (2010)***	**Percentage of total number of households**	**Sample size**	**Average number of households per sector**	**Spatial setting**
Abuakwa	4, 400	46.3	175	18	Urban
Nkawie	1, 597	17.7	67	7	Urban
Asuofua	1, 645	17.2	65	7	Peri-urban
Barekese	1, 812	18.8	71	7	Peri-urban
Total	9, 454	100	378	-	-

Source: GSS (2007); * Estimated

From Table 1.1, the total number of households from the 4 selected communities was 9,454. The minimum number of households for study was 378 representing 1.07% of the total number of households in the Atwima Nwabiagya District (GSS, 2014:19). It was arrived at by using the following formulae:

$$n = N / (1+N(a)^2) \quad (1)$$

where ‘n’ = minimum number of households for study

‘N’ = Total household population (N = 9, 454)

‘a’ = margin of error estimated at 5% (Miller and Brewer, 2003; Saunders et al., 2007: 212).

After estimating the minimum number of households (n = 378), simple percentage proportion was used to estimate the minimum sample size for each community. Total number of urban and peri-urban households studied were 242 (64%) and 136 (36%) respectively.

1.5.4 Sampling strategy

Having established the sample size required for each community and sector, simple random sampling was used to select households for study. There were two criteria for a household to have been deemed eligible for inclusion into the study. First, the household must have had at least one child below the age of five years at the time of recruitment. Secondly the mother, who was 18 years or older, should have agreed to participate in the study and signed a consent form to that effect. In houses where multiple families resided, simple random sampling was used to select one household for study. Also, an 'index child' was selected by the lottery method where the household had two or more under-five year old children. The GPS location of each household was taken with GARMIN Dakota™ 10 GPS handsets and recorded in a log book. In addition, unique household codes were generated for each household and written on the respective household dwelling wall to facilitate identification at the data collection stage. This process was repeated for each sector until the required number of households was achieved.

1.6 Types of Data

1.6.1 Primary data

Primary data were collected under major themes such as socio-economic background, housing characteristics, water sources, water collection, distance to primary water source, levels of service, cost of domestic water and domestic water storage. Others included, sanitation and hygiene, period prevalence (2 weeks) and point (24 hours) prevalence of childhood diarrhoea as well as the treatment and management of diarrhoea.

1.6.2 Secondary data

Secondary data were sourced from the Atwima Nwabiagya District Assembly, Ghana Statistical service, Ghana Health Service, Health facilities located in the district, the Community Water and Sanitation Agency, EPA, Ghanaian University libraries, WHO, UNICEF and relevant internet web pages. The types of data which were reviewed included reports, government publications, conference proceedings, manuscripts, statistical summary reports, theses, articles and relevant books. Journal articles and abstracts were accessed through indices and internet databases such as Social Science citation index, ISI web of science, PubMed, EBSCOhost, and the Health Internetwork Access to Research Initiative (HINARI).

1.7 Recruitment and Training of Research Assistants

There was a need to collect data considering factors such as reliability and accuracy given the time, human and monetary resources available for the research. Considering the length of time for the panel study and geographic distribution of the study areas, the services of two different sets of six Senior High School (SHS) graduates were engaged as Research Assistants. The first set of six helped to collect data in the wet season whilst a different set of six assistants helped to collect data in the dry season. Prior to data collection for each season, the assistants were taken through training for one week on how to conduct the household survey. Specifically, they were trained on how to measure distance and time, conduct the household interviews, record data on the observation schedules, data management, study of water use in the household and ethical issues in research. Also, the research assistants were trained on how to identify water sources and sanitation facilities using pictorial guidelines from the Joint Monitoring Programme (JMP) at http://www.childinfo.org/files/JMP_Pictorials_for_Water_and_Sanitation.pdf.

1.8 Pilot Study

Pilot studies are essential in ensuring that research instruments are not only well understood but well administered too. In order to ensure that questions were complete and comprehensible, a one week pretest was conducted in Kobeng using 10 households after which a one week pilot study was also conducted in Abuakwa using 30 households which were not included in the enumeration stage. The feedback from the pretest and pilot study were used to make corrections to the research instruments before they were administered in the wet and dry seasons. The pretest and pilot study afforded an opportunity to observe the research assistants, assess their uptake of the research training and correct errors that they made whilst conducting the surveys. Omissions and errors in the research instruments were addressed after a thorough review of the pilot study had been completed in May 2012.

1.9 Data Collection Procedures

1.9.1 Estimation of domestic water use

Mothers estimated the total volume of water collected a day in the household by using a pictorial guide of locally appropriate water container sizes (See Appendix III; UNHCR, 2013:14). Per capita domestic water use was calculated by dividing the volume of water collected per day by the household size.

1.9.2 Focus group discussion (FGD)

Three focus group sessions were conducted in January 2013. The first and second were held in Nkawie and Abuakwa respectively whereas the third was held in Asuofua. Twelve (12) mothers of under-five year old children in each of the study communities were selected using the lottery method from a list of eligible respondents who give their consent to take part in the FGDs. In order to shed more light on the quantitative data, a focus group discussion guide was used to access qualitative information. The major themes included knowledge, attitudes and practices relating to personal and domestic hygiene, sanitation, water treatment and storage practices, childhood diarrhoea awareness, treatment, management and health care seeking behaviour. Others included water uses in the household, productive uses to which water is put, challenges faced when accessing water, gender issues, as well as participants' perceptions on how to solve water quantity and quality problems. Each session was recorded by means of an audio recorder and hand written notes from an assistant.

1.9.3 Interviews

Interviews afford researchers the ability to follow up on ideas, motifs and probe responses in ways that questionnaires cannot do (Bell, 1999). In-depth interviews were conducted using an unstructured interview guide in order to elicit institutional perspectives on themes such as domestic water use, service level, water quality, hygiene, sanitation aspects, diarrhoea treatment and management. The unstructured interview guide was a qualitative instrument which facilitated the collection of qualitative data on the themes. This method afforded the respondent to freely discuss each theme, events, and also discuss the behavioural patterns relating to domestic water use and childhood diarrhoea from their institutional perspective. The following officers were interviewed once using the unstructured interview guide on a one-to-one basis: The Eastern Sector Manager of the Ghana Water Company Ltd. Ashanti Region, District Assembly Planning Officer, District Environmental Health Officer and the District Director of Health Services.

1.9.4 Structured observation

In this research, a structured observation schedule was used to collect additional quantitative data in the wet season and repeated in the dry season to afford comparisons of behavioural patterns over time. It was deemed useful to use structured observation in this study because compared to participant observation, structured observation afforded an understanding of how often households engaged in behavioural patterns of interest. It was considered relatively easy to replicate, less time consuming, afforded collection of data in the natural setting and afforded easier statistical analysis (Saunders et al., 2007). Research assistants were required to observe the surroundings of the household in which they carried out the interview and indicate on the schedule the presence or absence of environmental sanitation indicators, examples of which were the presence of human and animal excreta on the compound of the dwelling, flies, sanitation facilities, hygienic state of latrines, drinking water storage containers, presence of lid for water storage containers and how water was taken from the water storage container and given to the index child for drinking. It was also deemed important to use this method because results from the pilot indicated that households were likely to under-report on matters relating to their household environmental sanitation practices. Examples of related studies that were found in the literature to have employed observation schedules include Thompson et al., (2001), Strina et al., (2005), Scott et al., (2007) and Evans et al., (2013).

1.10 Data Analysis

Data which were collected using the interviewer administered questionnaires and observation schedules were imputed into PASW v.16 (Predictive Analytics SoftWare). Chi-square was used to examine the relationships among socio-demographic factors such as household size, number of under five year old children, marital status, highest level of education of the mother, estimated household wealth and number of rooms occupied. Also, Chi-square was used to examine the relationships between socio-demographic factors and domestic water use factors. The chi-squared test was used to test the difference between groups and statistical significance was set at $p \leq 0.05$ (El-Gilany and Hammad, 2005).

Based on the review of literature and the conceptual framework a total of 11 factors (variables) were hypothesized to be determinants of domestic water use in households with children under-five years for both wet and dry seasons. They were household socio-economic status (Gazzinelli et al., 1998, Thompson et al., 2001), mother's educational level (House-Peters et al., 2010; Shandras and Parandvash, 2010), amount paid for water per vessel (Arbues and Villanua, 2006; Arbues et al. 2010), household size (Domene and Sauri, 2006; Keshavarzi et al., 2006; Sandiford et al. 1990; Thompson et al., 2000), time taken to make a return water collection trip (Thompson et al., 2001), number of functional taps in the household (Thompson et al., 2001), number of under-five year olds (Corbella and Pujol, 2009), number of water storage vessels (Thompson et al., 2001), duration of water service (Thompson et al., 2001), duration of water storage (Thompson et al., 2001) and the volume of the primary water storage vessel (Thompson et al., 2001).

In order to facilitate a comparison of the factors that predicted per capita water use, the cases were sorted into household categories. These were urban and peri-urban, piped and un-piped households (Thompson et al., 2001). In order to arrive at the determinants, the most important factors affecting water use, multiple regression models were derived. The models were derived through stepwise inclusion of the hypothesized variables which gave rise to the greatest statistically significant ($p < 0.05$) improvement in the goodness of fit at each stage (Sandiford et al., 1990).

The risk factors associated with childhood diarrhoea were identified using bi-variate and multivariate logistic regression analysis. It has been noted that in order to understand children's morbidity, an examination of the linkages and interactions amongst socio-economic, physical, behavioural and environmental factors was necessary (Dessalegn et al., 2011; Mosley and Chen, 1984). Hence in order to assess the risk factors of childhood diarrhoea for both wet and dry seasons, hypothesized variables were placed under three main categories; socio-demographic, environmental and behavioural variables (factors). Bi-variate logistic regression (Odds ratio analysis) was used to assess the relationship between childhood diarrhoea (2 weeks prior to the survey) and each hypothesized variable (Appendix V). An association was deemed to exist between the two variables if the p-value was $p \leq 0.05$.

Multivariate logistic regression was also performed in SPSS separately for each of the categories of variables in steps and variables were kept in a model only when they had a p-value of ≤ 0.30 (Dessalegn et al., 2011; Mulugeta, 2003; Victora et al., 1997). In the first step, all hypothesized socio-demographic variables (factors) were assessed together and those that had a p-value of ≤ 0.30 were kept in model 1. In the second step, all environmental variables were assessed together and those that had a p-value of ≤ 0.30 were kept in model 2 and in the third step, all behavioural variables were assessed together and those that had a p-value of ≤ 0.30 were kept in model 3. In the fourth model, all the variables in models 1, 2 and 3 were assessed together. The 'final model', model 4 is an estimation of the overall effect of all the three models (Mengistie et al., 2013). In each of the multivariate models, the potential confounding effect of geographic location was controlled for.

The wealth status of households was investigated using a household wealth index.WEDC (2002) asserts that obtaining reliable figures for household income may prove difficult in contexts where household income is largely from the informal sector. Following from the pre-testing of field instruments which unearthed difficulties with under-estimation, over estimation, multiple sources of household income, multiple contributors and problems with recall, a wealth index was developed by adapting wealth indices developed by Thompson et al., 2001 and Gazzinelli et al., 1998. Table 1.2 shows the selected household assets and the score per asset.

Table 1.2 Household asset score.

Household asset	Score per asset
Working radio, thatch/mud roof.	1
Electricity, cassette player, bicycle, ply wood roof.	2
Working television, motor cycle, household utensils, metal roof.	3
Car, refrigerator, tile/concrete roof.	4

Source: Adapted after Thompson et al., 2001 and Gazzinelli et al., 1998

In Table 1.2, two columns are presented; the first indicating household assets and the second, score per asset. Each houshold was asked about the presence of all the 13 assets, the score per asset was recorded and totaled. Where a housheold did not have a particular asset, 0 was written against it. The wealth index was categorized as follows: 1-4 'Low income', 5-8 'lower middle income', 9-12 'Median middle income', 13–16 'Upper middle income', 17-20 'High income' and 21 or more 'Very high income'

Qualitative data was analyzed manually by first reviewing the audio recordings and transcribing the proceedings and secondly reviewing the hand written notes. Responses from the discussants were grouped under the major themes of each research objective and the most important comments which gave significant insights into behavioural patterns under each major theme were selected.

1.11 Control of Potential Biases

It was anticipated that observer bias, recall bias and selection biases may be present in the course of the study. However, the reduction of biases to the barest minimum was relevant for ensuring reliability and validity (Silman and Macfarlane, 2004). In order to control observer bias, the research assistants and the respondents were blinded to the objectives and hypotheses of the study. The adoption of 2 weeks and 24 hours recall of household health information helped to reduce recall bias (Gundry et al., 2006). WHO (2006) indicated that in child studies, where parental co-operation was required, selection bias was likely to occur. Therefore to address selection bias, parents were asked to give their informed consent before their children were enrolled onto the study. In addition, daily debriefing and review sessions were conducted in order to identify and ameliorate data collection practices and problems that were likely to introduce biases into the study. In order to control for interviewer bias, a different set of 6 enumerators assisted to collect the dry season data.

1.12 Scope of the Study

This study was limited in geographic scope to two urban and two peri-urban communities of the Atwima Nwabiagya District. With respect to time, this study was longitudinal. It consisted of two surveys of selected households of which the second was conducted five months after the first. This research was also limited in scope to the domestic environment and indoor domestic water use. Selected themes on domestic water use characteristics and per capita water consumption in relation to childhood diarrhoea were also discussed. Themes relating to water quality and its relationship with childhood diarrhoea were outside the scope of this study.

1.13 Ethical Approval

Research data is to be collected and processed in a methodologically sound manner and should be morally defensible to all those who are involved (Saunders et al., 2007). It was explained to the participants that the data collection was not intended to bring embarrassment, stress, discomfort, pain or harm to them and that they were free to exit the study at any point in time. Residents who were willing to participate in the study were asked to give their consent by signing a consent form. The confidentiality of the information provided by the respondents was ensured by using unique household codes and omitting personal names and phone numbers from the research instruments. After assessing the research proposal and research instruments, ethical approval for the research was given by The Committee on Human Research, Publications and Ethics (CHRPE) of the Kwame Nkrumah University of Science and Technology, School of Medical Sciences (CHRPE/AP/187/12). Additional formal approval was given by the Atwima Nwabiagya District Assembly and the Atwima Nwabiagya District Health Directorate.

1.14 Organization of the Thesis

The thesis is organized into seven (7) chapters. The ‘Introduction’ is contained in ‘Chapter One’ and it provides an introduction to the research and discusses the statement of the problem, methodology, research objectives, research hypotheses and limitations of the study.

The literature review in chapter two (2) discusses a descriptive review of relevant literature. The review presents existing knowledge and research gaps which gave impetus to the development of research methodology for meeting the research objectives. ‘Chapter Three’ presents the ‘Background of the study area’. Specifically, the chapter discusses the location, size as well as the socio-demographic characteristics of the study area.

Chapter four discusses ‘Characterization of domestic water use’. This chapter is an analysis of the domestic environment and highlights similarities and differences between domestic water use in the wet season and that of the dry season. Specifically, it discusses water sources, levels of service, domestic water collection, distance to water sources, cost of obtaining water and domestic water storage. The determinants of domestic water use for piped and un-piped households, urban and peri-urban households, wet and dry seasons are analyzed in 'Chapter Five'.

Chapter six discusses maternal knowledge, health seeking behaviour and practices relating to childhood diarrhoea, childhood diarrhoea prevalence, risk factors associated with childhood diarrhoea and the relationship between domestic water use and childhood diarrhoea. Lastly, 'Chapter Seven' presents a summary of the research findings, conclusions and policy recommendations.

1.15 Chapter Summary

The main objective of this study was to explore seasonal variations in domestic water use behaviour and its relationship with childhood diarrhoea morbidity at the household level. A total of 378 households representing 1.07% of the total number of households in the Atwima Nwabiagya district were studied in the Wet and Dry seasons. The study communities were Abuakwa, Nkawie, Asuofua and Barekese. The research problem arose out of a disconnect between childhood diarrhoea cases recorded from 2008 – 2011 and water supply coverage in the district which was reported as 95% urban and 70% rural (ANDA 2011:13). The research question that arose was that, Did the wide water coverage have any implications for childhood diarrhoea in the study communities?

This study was longitudinal and it employed a panel study approach. It also employed a mix of quantitative and qualitative data collection methods to elicit data for analysis. The units of analysis were households with at least one child under-five years of age and 'index' children who were five years old or younger. The literature pointed to the need to understand domestic water use behaviour and the role it played with respect to diarrhoeal morbidity amongst children under 5 years at the household level. This was especially important given the fact that global attention in general and national attention in particular was being drawn to the need to provide safe environments for children to develop (WHO/UNEP, 2010).

Chapter two presents a descriptive review of literature related to domestic water use and childhood diarrhoea at the household level.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview of the Review Process

The objective of the literature review was to gain an understanding of the extent of research work on domestic water use behaviour, and its relationship with childhood diarrhoea. In doing so, various texts were examined. These included refereed journal publications, conference proceedings, books, and internet sourced publications. Key words such as 'childhood diarrhoea', 'diarrhoeal diseases', 'water quality', 'household water use', 'domestic water use' 'child health', 'e-coli', 'GIS and water quality', 'water related diseases', 'water quantity modeling', 'water use and human health' were keyed into the Google® scholar search engine and on-line bibliographic databases such as Medline, PubMed, Cochrane library and Ebsco Host. From each search engine, a list of seminal authors was developed, abstracts were read, and the related articles written by the authors were downloaded and reviewed. In terms of language, the search was limited to papers and research work published in English. For each of the references, the following was assessed: The work that was done by the researcher(s), the relevance of the published work, the methods employed, other research work that correlated with the published work and other works or publications that contradicted the findings.

2.2 Domestic Water Use at the Household Level

Water is a resource that has profound implications not only for human health but human amenity. Water is put to varied uses within the domestic environment and the larger socio-economic landscape. One of the seminal studies carried out on water use is that of *Drawers of water I* (DOW I) study which was carried out in East Africa from 1966 – 1968 and published in 1972. It was the first large scale assessment of domestic water use in Africa (Thompson et al., 2001). In that study, researchers examined the use of water for basic consumption, hygiene and amenities in domestic life. Following therefrom, a number of studies on water supply were based on the findings of the Drawers of Water I research (Rosen and Vincent, 1999). Findings from the DOW I study showed that increasing the quantities of water use per capita was more important for a household's health and well-being than improving its quality. In addition, the study yielded the 'Bradley Classification System' for faecal-oral diseases which represented the first attempt to simplify the relationship between water supply and public health (White et al., 1972). The Joint Monitoring Programme (JMP) of WHO and UNICEF, distinguished between two kinds of drinking water sources: Improved and Unimproved. Improved drinking sources include piped water into dwelling, yard or plot, public tap or stand pipe, tubewell or borehole, protected dug well, protected spring and rainwater collection. Unimproved sources on the other hand include unprotected dug well, unprotected spring, cart with a small tank or drum, tanker truck, surface water (river, dam, lake, pond, stream, canal, irrigation channel and bottled water (WHO/UNICEF, 2010:34). Rain water collection is a source of water for households within sub-Saharan Africa whose water quantity demands fall short of their expectations for domestic purposes. However, research shows that collecting rain water for drinking purposes may be potentially dangerous to human health due to the possibility of collecting feaecally contaminated water that runs off dirty rooftops that have been littered with bird droppings and other faecal matter (Levesque et al., 2008).

In 2006, 54% of the world's population had a piped connection to their dwelling, plot or yard and 33% used other improved drinking water sources. The remaining 13%, which amounted to 884 million people, relied on unimproved sources (UN WWAP, 2009). However in 2012, over 780 million people were still without access to improved sources of drinking water (UNICEF/WHO, 2012:2). In Sub-Saharan Africa, only 60% of the population used improved sources (WHO/UNICEF, 2010:7). Also, 35% of urban dwellers had water piped into the household whereas in rural areas of Sub-Saharan Africa, it was only 5% (WHO/UNICEF, 2010:25).

2.2.1 Estimation of domestic water use at the household level

With respect to the estimation of domestic water use, the reviewed literature indicated that unlike measuring water quality, there was little consensus on how to collect and analyze water use data in un-metered households (Arbués et al., 2003; Wutich, 2009). It was noted that various authors measured domestic water use in a variety of ways. In terms of approach, Wutich (2009) was of the view that the survey approach was less expensive compared to observation. Enger and Smith (1992) also noted that water uses could be measured by the amount withdrawn or the amount consumed and could be classified into four different types: domestic use, agricultural use, in-stream use and industrial use. In their study, Thompson et al., (2001) measured the actual amount of water used by weighing on a scale during observations from 6am to 8pm whilst water use between 8pm to 6am was estimated by interviewing the household members. Sandiford et al., (1990) also estimated total water consumption by multiplying the volume of each water container by the number of times it was filled in a day. In Mueda, Mozambique, researchers measured amounts of water used by observation of water collection. Each observer estimated by eye the volume of water in a container and watched water collection activity in adjacent households (Cairncross and Cliff, 1987). In Benin, Arouna and Dabbert, (2009) estimated water consumption by use of an interview based survey. In studying residential water demand at the household level in Ilorin, Nigeria, Ayanshola et al., (2010) used structured questionnaires to collect water consumption data and used regression to determine the variables affecting water consumption. Likewise, Keshavarzi et al., (2006) in their Rural Iran study used questionnaires to estimate water use. Also in Muthara, Kenya, Kennedy (2006) assessed water use by asking about the number of trips per day and the volume of the water container by use of a questionnaire.

In the face of limited time and logistical constraints, a researcher has to make a choice on the most appropriate method given the resources available. Wutich (2009) advocated for the use of the observation method but also admited that it is very expensive. Also Wutich (2009) conceded that observations may not be appropriate in some settings because researchers may not be allowed into private spaces such as homes and courtyards. The diary method is considered more appropriate than observation however the use of the diary may be problematic where some participants may not be able to read or write and in situations where respondents are not given adequate training on how to record in the diary. Prompted recall methods could be used as a substitute to the diary method and when well developed, prompted recall methods have the advantage of being rapid, inexpensive and easily administered to respondents in a survey (Wutich, 2009). The United Nations High Commissioner for Refugees (UNHCR) recommended the use of a pictorial guide when assessing water use in its 2013 Standardized Expanded Nutrition Survey (SENS) guidelines for refugee populations (UNHCR, 2013: 47). Therefore considering the advantages of prompted recall over the diary method, recommendations by the UNHCR's Standardized Expanded Nutrition Survey and the need to objectively collect information on domestic water use, prompted recall was used for this study.

2.2.2 Determinants of domestic water consumption

The domestic use of water within the household environment is very crucial and it has significant implications for health and well-being. The domestic uses include drinking, bathing, cooking, washing clothes, washing dishes, watering lawns and gardens. The DOW I study grouped domestic water use into three categories: consumption (drinking and cooking); hygiene (bathing, washing and cleaning); amenity (watering lawns or gardens and washing cars) (Thompson et al., 2001). An update of the Drawers of Water II study by Thompson et al., (2001) added a fourth category which was 'productive use'. Productive uses of water included brewing, animal watering, construction and small scale horticulture (WHO 2003a:2). According to the WHO, consumption and hygiene had direct implications for human health physiologically and in controlling water related diseases (WHO, 2003a:2).

In the DOW 1 study, the mean per-capita water used for consumption was a little over 4 liters a day. Piped households used an average of 33.7 liters for hygiene purposes compared to 13.9 for un-piped households (Thompson et al., 2001: 29). Piped households used an average of 4.4 liters compared to 0.33 liters used by un-piped households for amenity (Thompson et al., 2001: 31). The DOW I showed that urban dwellers used more water than their rural counterparts. Per-capita water use had an inverse relationship with the proportion of children in the household, number of household members and cost per liter. Household wealth was the most important determinant of water use. However, the WHO notes that the quantity of water that households collect and use is primarily dependent on accessibility which is in turn determined by both distance and time (WHO, 2003a). Few reports have been published on the association between water consumption and diarrhoea (Aiga, 1999) however it is known that the quantity of water used for domestic purposes and personal hygiene has implications for controlling environmentally related diseases such as diarrhoea (Esrey and Habicht, 1986; Esrey et al., 1985; Victora et al., 1988; Sandiford et al, 1989). Sandiford et al., (1990) carried out a large scale study in Nicaragua from 1986 -1988 with the aim of finding out factors related to domestic water use. Household size, site of clothes washing, types of water source and distance to water source were negatively correlated with per capita daily domestic water consumption. However, mother's level of schooling (years), father's level of schooling (years) and ownership of cattle as proxy for wealth were positively correlated with per capita daily domestic water consumption. Sandiford et al., (1989) were of the view that distance from house to water source was significantly associated with diarrhoea, however Sandiford et al., (1990) also concluded that water consumption may not be an important factor influencing diarrhoea and that distance from the home to the water source could be a better proxy for the quantity of water used in hygiene - related activity than per capita domestic water consumption. Nyong and Kanaroglou (2001) in a study of household domestic water use patterns in rural Nigeria, showed that even though women were the main users of domestic water, women were not the principal collectors in contradiction to popular beliefs. In a similar study by Makoni et al., (2004) in rural areas of Zimbabwe, women were the users, managers and custodians of household water and hygiene. However, men had a greater role than women in decision making.

Although there was little global consensus on the minimum requirement of water quantity for domestic use, the World Bank, (2006: 31), defined reasonable access as the availability of at least 20 liters per capita per day from a source within 1 km of the users dwelling. For disaster relief, the Sphere Project indicated a minimum of 15 liters of water use per capita per day (The Sphere Project, 2011: 97). WELL (1998) and Carter et al., (1997) also indicated a minimum of 20 liters per capita per day. Gleick (1996) indicated 50 litres per capita per day for a healthy and productive lifestyle. The Joint Monitoring Programme (JMP) defined access to drinking water as the availability of least 20 litres of drinking water per person per day within 1 km of the dwelling (a 30 minute round trip journey) (UN WWAP, 2009:103). Also, Aiga (2003) suggested that 140 liter per capita per day should serve as a minimum requirement for water consumption to ensure less diarrhoeal incidence among children under 5 years of age.

Examples of studies which found an association between water consumption and socio-economic determinants included White et al., (1972), Darr et al., (1975) and Wong (1987). Other studies such as Agthe and Billings, (1987), Arbués and Villanua (2006), Arbués et al., (2003), Hoffman et al., (2006) and Cole (2004) demonstrated a positive relation between domestic water consumption and income. These studies suggested that the wealthy tend to have more water consumption appliances and would therefore need more water to use appliances such as showers, baths, and swimming pools. Water price influences water demand. Studies such as Arbués et al., (2004), Garcia and Reynaud (2004) have shown that increasing water prices reduces demand.

2.3 Drinking Water Quality Parameters at the Household Level

Water is a precious element that sustains human life. Water can be used for varied purposes within a variety of contexts. However the most profound context which also has significant implications for human health is within the domestic environment. Water runs through a complex cyclical system of evaporation, condensation and precipitation within nature called the hydrological cycle (Pepper et al., 2006). At any point within the cycle, water may be exposed to contaminants from human (anthropogenic) or natural sources. Such contaminants may render the water unusable or not fit for human consumption. The quality of water available for man's use has been a matter of concern due to the profound relationship it has with sustenance of human health. The WHO has therefore recognized water quality as an important transmission route for infectious diseases such as diarrhoea (WHO, 1993).

According to Hronchic (1999), factors that influence water quality can be categorized as natural and human or as point and non-point factors. Point sources refers to a single source or other definable point of discharge or release whilst non-point sources are generally diffused or widely spread and difficult to control or manage (Cunningham and Saigo, 1999: 436). Examples of natural factors that influence water quality are climate, watershed topography, geology, nutrients, fire, saltwater intrusion and reservoir density stratification (Hronchic, 1999). With reference to point sources, natural factors include waste water discharges, hazardous waste facilities, spills and releases. On the other hand, non-point human factors include agricultural and urban runoff, land development, atmospheric deposition and recreational activities.

Principal features of water quality that scientists are most concerned with are categorized into three main groups- Physical, Chemical and Biological (Tebbutt, 1977 cited in Shaw, 1994). A significant change in any of the parameters or principal features have implications not only for aesthetic purposes but health concerns as well (Hronchic, 1999). Water serves as a medium of waste water disposal in many communities around the world due to its unique property of being a universal solvent. In some communities, sources of drinking water such as streams, rivers, ponds, lakes are scarcely separated from sources of sewage disposal (Shaw, 1994). In developing countries, many residents collect water directly from streams, rivers, ponds, lakes. Water quality problems are more acute in this region due to poor and inadequate infrastructure for waste water treatment. Also, factors such as low water pressure, frequent water rationing and inadequate plumbing contribute to the practice of water storage within the home, even among households with a water connection (Checkley et al., 2004). Hence much attention is being given to the monitoring of water quality in order to ensure the health of consumers.

2.3.1 Physical quality

Physical water quality parameters in water quality studies include Colour, Taste and Odour, Total Suspended Solids (TSS), Turbidity, Electrical Conductivity (EC) and Temperature.

2.3.1.1 Colour, taste and odour

Colour, taste and odour are aesthetic values of water which are subjectively judged or assessed. They are often caused by dissolved impurities from natural sources (Shaw, 1994: 161).

2.3.1.2. Total Suspended Solids (TSS)

All solids suspended in water that will not be able to pass through a 2.0µm glass fiber filter. The filter is dried in an oven with temperatures between 103°C and 105°C. When weighed, the increase in the weight of the filter represents the amount of total suspended solids (Pepper et al., 2006:283).

2.3.1.3 Turbidity

Turbidity refers to the cloudiness of water due to fine suspended colloidal particles of clay or silt, waste effluents and micro-organisms. It is measured in nephelometric turbidity units (NTU) (Shaw, 1994: 161; Pepper et al., 2006).

2.3.1.4 Electrical conductivity

Electrical conductivity (EC) is the physical property of water that is dependent on dissolved salts. It is measured in microsiemens per centimetre (µS cm^{-1}) (Shaw, 1994: 161).

2.3.1.5 Temperature

Temperature is the physical characteristic that is prime importance is the consideration of chemical properties of water. It is measured in °C (Shaw, 1994: 161).

2.3.2 Chemical quality

Chemical water quality parameters include pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Nitrogen (N), Metals; Phosphorus (P), Sulphur (S), Fluoride (F), Iron (Fe), Mercury (Hg), Arsenic (As), Manganese (Mn), Aluminium (Al), and Residual Chlorine.

2.3.2.1 pH

pH refers to the measure of concentration of hydrogen ions (H^+) and it indicates the degree of alkalinity of water. pH is rated on a scale from 0 to 14 and a pH of 7 shows a neutral solution. Whereas a pH less than 7 indicates that water is acidic, a pH greater than 7 indicates that the water is alkaline (Shaw, 1994: 161).

2.3.2.2 Dissolved oxygen (DO)

Dissolved oxygen is an essential property used by aquatic organisms like fish for respiration. It affects the taste of water and is measured in mg 1^{-1} (O_2).

2.3.2.3 Biochemical oxygen demand (BOD)

Biochemical Oxygen Demand refers to the measure of the consumption of oxygen, usually 5 to 20 days, by micro-organisms such as bacteria in the oxidation of organic matter. It is measured in mg 1^{-1} (O_2) (Shaw, 1994; Pepper et al., 2006: 304)

2.3.2.4 Nitrogen

Nitrogen (N) may be present in water in several forms such as ammonia, ammonium salts, nitrites or nitrates. It is measured in mg 1^{-1} (N) and it gives an indication of pollution by organic waste (Pepper et al., 2006).

2.3.2.5 Metals

Examples of metals that are of importance in water quality studies include Phosphorus (P), Sulphur (S), Zinc (Zn), Iron (Fe), Lead (Pb), Mercury (Hg), Arsenic (As), Fluoride (F), Manganese (Mn), Aluminium (Al). Industrial, municipal and urban runoff constitutes the primary sources of metals (Pepper et al., 2006).

2.3.3 Biological quality

A variety of biological and organisms exist in water sources such bore holes, streams or rivers. Micro-organisms such viruses, protozoa, fungi and bacteria use water sources as their habitat. The examination of water for bacteria and other micro-organisms at source and within domestic stored water is essential for the assessment of water quality for domestic purposes the most profound of which is drinking (Shaw, 1994; Rangwala et al., 2007).

2.4 The Relationship Between Water Quality and Human Health

The presence of pathogenic organisms in polluted water and their ability to cause disease was poorly understood till the middle of the nineteenth century (Weiner and Matthews, 2003). Dr. John Snow (1813 – 1858) was one of the first scientists to make a connection between infectious disease and drinking water contaminated with sewage (Pepper et al., 2006). His *Broad street pump* study in 1854 linked an outbreak of cholera to contaminated water which residents of London consumed. Research has shown that water related diseases affect human health through 'mechanisms' (White et al., 1972; Cairncross and Feachem, 1983). The UNEP/WHO (1996) categorizes infectious water related diseases as waterborne, water-hygiene, water-contact and water-habitat vector diseases. These diseases categories are not mutually exclusive as one disease may fall in two or more categories.

Water borne diseases are contracted when one ingests contaminated water. Examples of water borne diseases include diarrhoea, cholera, typhoid, shigellosis, amoebic dysentery, hepatitis A and guinea worm (Pepper et al., 2006; UNEP/WHO, 1996). Water-hygiene diseases can be contracted when there is inadequate water for washing and personal hygiene. Examples include skin infections like tinea, scabies, pediculosis and eye infections such as trachoma. Others include infectious conjunctivitis and diarrhoea. Diarrhoeal diseases in this category may be spread through direct contact with feaecally contaminated hands or cooking utensils (Pepper et al., 2006; UNEP/WHO, 1996). When water for washing hands is inadequate and adequate steps are not taken to ensure good hand hygiene and food hygiene practices, households' become prone to infection. Water-contact diseases are ones that are caused by pathogens or disease causing organisms that spend part of their life cycle in water and depend on other aquatic organisms for the completion of their life cycles. The water-contact disease is transmitted when an individual's skin comes into contact with the pathogen infested water (Pepper et al., 2006; UNEP/WHO, 1996). Examples include Schistosomiasis (Bilharzia) and Legionnaires' diseases. The last category of water related diseases are water-habitat vector diseases. These diseases are transmitted by insect vectors that spend all or part of their lives in water. The pathogen spends a portion of the life cycle in a vector. Examples include malaria, filariasis, onchocerciasis, yellow fever and dengue (Pepper et al., 2006; UNEP/WHO, 1996). The major causes of the water-related diseases worldwide are microorganisms; bacteria, viruses and Protozoa (Pepper et al., 2006). Table 2.1 shows examples of common water borne pathogens and their effects on humans.

Heavy metals are known to be very toxic to humans when they are assimilated in excessive doses. They include Arsenic, Cadmium, Chromium, Copper, Lead, Mercury and Zinc. For example, it is estimated that about 50% of the 125 million people who live in Bangladesh are at risk of exposure to extremely high (from 50 to <

1000µgl^{-1}) arsenic concentrations in drinking water (Pepper et al., 2006: 143). Hardoy et al., (2001) indicated that at any one time, about half of urban populations living in Africa, Asia and Latin America suffer from one or more diseases that are associated with inadequate provision of water and sanitation.

Table 2.1 Examples of common water related pathogens and their effects on humans.

Microorganism/Pathogen	**Disease**
Bacteria	
Camphylobacter	Gastroenteritis
Clostridium botulinum	Gastroenteritis
Clostridium perfringens	Gastroenteritis
Escherichia coli O157:H7	Gastroenteritis
Legionella	Pneumonia-like pulmonary disease
Sammonella paratyphi	Paratyphoid
Salmonella typhi	Typhoid fever
Shigella	Shigellosis (dysentery)
Staphylococcus aureus	Gastroenteritis
Vibro comma (V. Cholerae)	Cholera
Yersinia enterocolitica	Gastroenteritis
Protozoa	
Cryptosporidium	Cryptosporidiasis
Entamoeba histolytica	Amoebic dysentery
Giardia lamblia	Giardiasis
Viruses	
Hepatitia A virus	Hepatitis
Poliovirus	Poliomyelitis

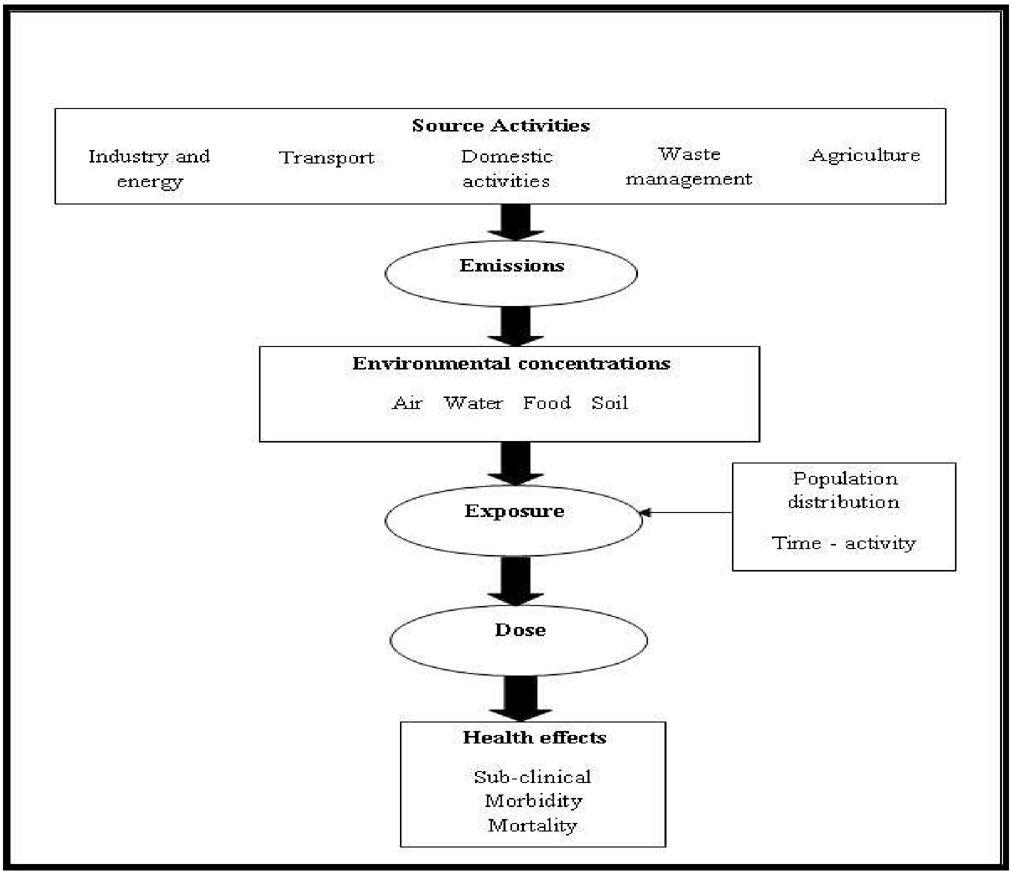
Source: Adapted from Weiner and Matthews, (2003: 100).

According to Hardoy et al., (2001) and Weiner and Matthews, (2003), many health problems are linked to water and water borne diseases remain health threats especially in developing countries. In many countries, the serious effects of poor water quality on human health remain unreported or under reported due to the lack of adequate monitoring of water quality (UN WWAP, 2009). It is therefore necessary to assess the quality of water to certify their suitability for consumption and the results from the water quality analysis serves as a scientific basis for remediation (Adelekan, 2010). According to McGarvey et al., (2008), a research gap needs to be filled with respect to how household socio-demographic and sanitation factors influence water quality and such research will answer questions about differences in water acquisition, use and quality at the community and household levels.

2.5 Environmental Health at the Household Level

Environmental health is concerned with the environmental factors that influence human health positively or negatively (WHO, 2003b).The home environment is a very crucial setting that has implications for health and wellbeing (Songsore et al., 2005; Hardoy et al., 2001). The household is defined as a 'person or group of persons who live together in the same house or compound, share the same house-keeping arrangements and are catered for as one unit' (GSS, 2002: viii). According to Songsore et al., (2005:1) improving the household environment could avert the annual loss of about 80 million years of disability free years of human life. Research evidence indicates that within the household environment, diseases could be contracted by adults and children alike (WHO, 2003b). Some of the environmental problems that households suffer include inadequate potable water supply, unsanitary conditions, insect infestation, uncontrolled garbage, poor waste disposal, smoky kitchens, overcrowding and inadequate infrastructure (Songsore et al., 2005). Songsore et al., (2005) were of the view that the greatest immediate health impacts were felt through environmental problems that were in close proximity to the home. The household health impacts manifest themselves in diseases such as malaria, upper respiratory tract infection, diarrhoea and skin diseases. Research has shown that there is a 'path way' through which human health is associated with the environment and can be applied at the community and the household levels (Fig. 2.1). In other words, in the home environment, the pathogens or disease causing organisms affect human health through a pathway (Songsore et al., 2005).

Fig. 2.1 Environmental health hazard pathway.



Source: (WHO, 2003b)

Within the pathway, the starting point is the pollution of the environment through human or natural source activities such as industry, transport, domestic, waste management, and agriculture leading to the release of pollutants into air, water, food or soil. The amount of time that an individual comes in contact with the pollutant in the environment is significant as it determines the dose that the individual is likely to receive leading to morbidity or mortality. Knowledge from the Environmental Health Hazard Pathway has necessitated attention being given to contamination of water at home and not only limited to source or within the distribution channel (Gundry et al., 2004). The doses of contaminants that household members are exposed to, significantly influences their health.

Research evidence indicates that the environment plays a significant role in determining the health of households and this is primarily due to the fact that most diseases and injuries are contracted in the house and the immediate surroundings (Hardoy et al., 2001). In Nigeria, Schistosomiasis infection was deemed to have been contracted whilst doing household chores such as fetching water and cleaning clothes.

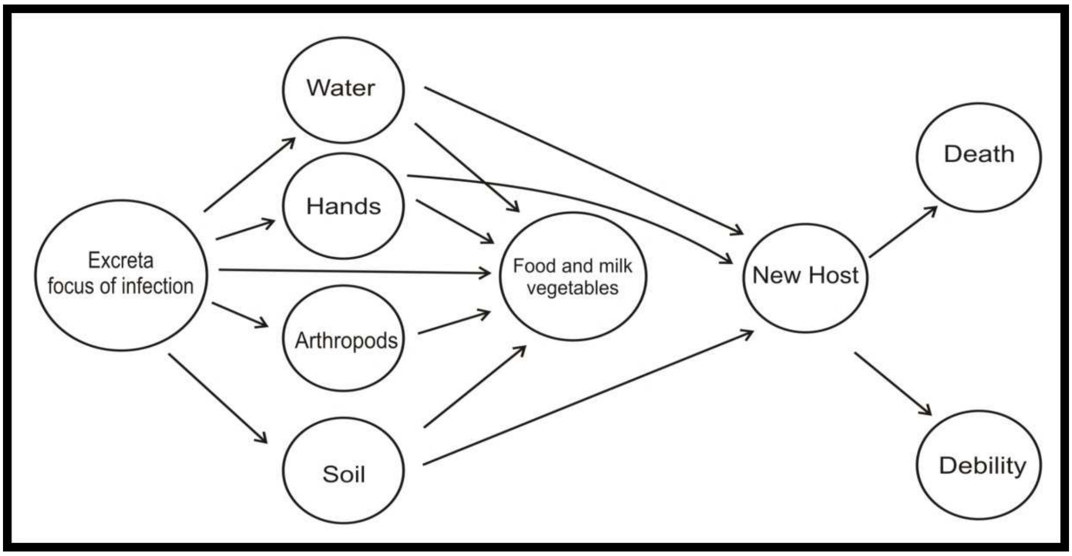
Within the household, interrelationships exist amongst water, sanitation, flies, animals personal hygiene and food (Esrey and Feachem, 1989). However, Hardoy et al., (2001) suggested that the interaction between environmental factors and human well-being was poorly understood because individuals and social groups have different needs and priorities. For instance, a child's development can be hindered by poor physical environments. The environmental conditions shape the developing brain of a child (Irwin et al., 2007). Evans and Katrowitz (2002) mentioned that an inverse association existed between socio-economic status of a community and the extent to which its residents were exposed to environmental hazards like air pollutants, excessive noise and poor water quality. Exposure to environmental hazards can occur in the three main spatial scales of the ambient environment, community and the home (WHO, 2002). However children spend most of their time in the home and it is where most exposures occur (WHO, 2003b).

2.6 Diarrhoeal Disease Transmission in the Household

2.6.1 Faecal - oral transmission route of diarrhoeal diseases

Transmission of infectious agents of diarrhoeal disease primarily takes place through the faecal-oral route (Black, 2001). The concept of the faecal-oral transmission route was first developed by Wagner and Lanoix (1958).

Fig. 2.2 Channels of transmission of disease from excreta.

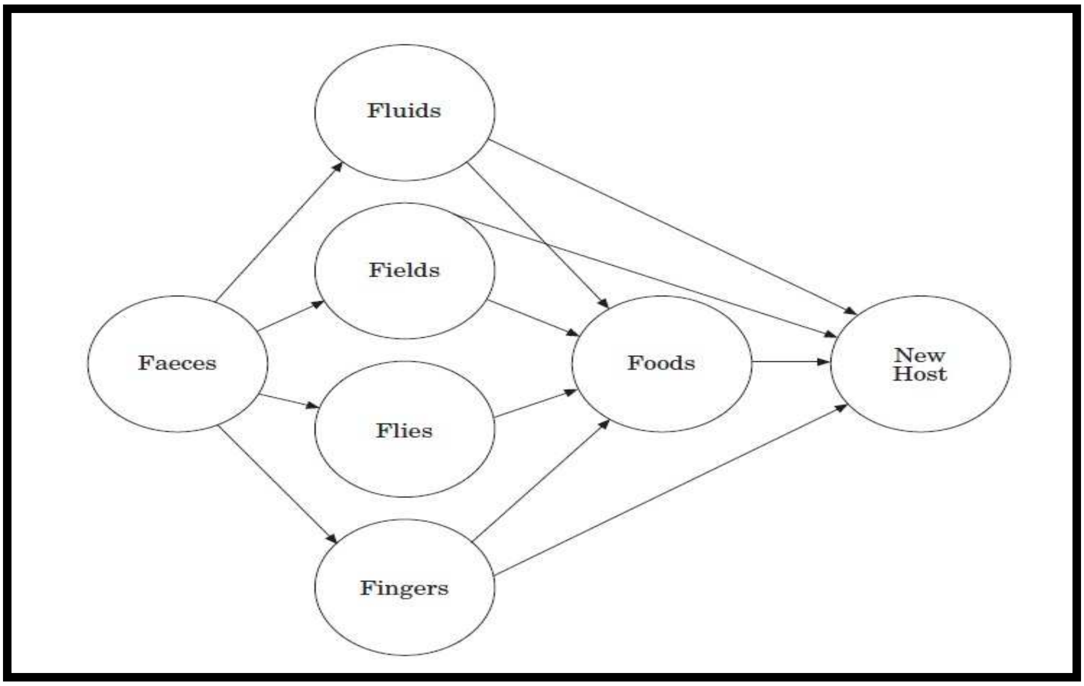


Source: Adapted from Vagner and Lanox (1958:12).

In the WHO monograph series number 39 Wagner and Lanoix (1958) explained that, not only did inadequate and insanitary disposal of human faeces lead to contamination of ground and water resources, improper disposal of faeces also attracted domestic animals and rodents who spread the faeces. The causative agent of enteric diseases could reach a new host through a variety of ways (paths) such as hands, water, soil, food and milk. The host suffers death or debility as depicted in Fig. 2.2.

The faecal-oral transmission route represents the routes that pathogens of faecal origin take to reach a new host (Curtis et al., 2000). Revisions have been made to the original diagram depicted in Fig. 2.2. The result of the revisions yielded the F-diagram in which fluids, fingers, flies and fields took the place of water, hands, anthropods and soil (Fig. 2.3).

Fig. 2.3 The F-Diagram.



Source: Adapted from Curtis et al., 2000.

Pathogens get into fingers, food or fluids when excreta are not properly disposed. Flies which settle on excreta also transmit pathogens to food and other surfaces that may be used for eating. Faecal material could be brought into the household environment through human or animal feet which have been in contact with faecal matter. Children who often play on bare floor of feaecally contaminated compounds may be infected by pathogens which are available on the contaminated floor (Curtis et al., 2000).

2.6.2 Causes of diarrhoeal disease

Human faeces are noted to be the primary source of diarrhoeal pathogens (Graeff et al., 1993) and examples of diarrhoeal diseases include dysentery, cholera, typhoid, diarrhoea. Geographically, diarrhoeal diseases are more prevalent in developing countries than in developed countries and the major pathways for infection are human or animal faeces, food, water and human contact. Risk factors for diarrhoeal diseases include poor domestic sanitation and hygiene, lack of safe water and exposure to solid waste (WHO, 2003a). Diarrhoea is defined as having loose or watery stools at least three times per day or more frequently than normal for an individual (UNICEF/WHO, 2009). It is caused by a number of pathogens such as bacteria, viruses and protozoa. Contaminated water and poor sanitation contribute to 5.4 million cases of diarrhoea and 1.6 million deaths, most of whom are children under 5 years of age (Hutton and Haller, 2004). Rotavirus is noted as the leading cause of acute diarrhoea which is responsible for about 40 percent of all global hospital admissions of childhood diarrhoea (UNICEF/WHO, 2009:9). Bacterial pathogens that cause diarrhoea include *Escherichia coli, Shigella, Campylobacter* and *Salmonella.* According to UNICEF (2011), Diarrheoa is the most important public health problem directly related to water and sanitation with the disease causing about 4 billion cases per year with 1.8 million deaths with over 90 percent of deaths (1.6 million) among children under 5 years.

Enteric pathogens that have the ability to reside in human beings include *Enterotoxigenic Escherichia coli, Shigella spp, Vibro cholera, Giardia lamblia, Entamoeba histolytica*. *Camphylobacter jejuni*, *Salmonella spp* and *Yersinia enterocolitica* are mostly found in animals and human beings. Transmission of the pathogens originates from both human faeces and animal faeces through the faecal-oral transmission route (Feachem, 1984; Jamison et al., 2006; UNICEF/WHO, 2009).

Globally, diarrhoeal illness due to *Escherichia coli*, is a major cause of morbidity and mortality especially in children (Hunter, 2003). *Escherichia coli,* has been used as an indicator organism in studies assessing the relationship between water quality and diarrhoea (Lloyd-Evans et al., 1984; Echeverria et al., 1987). The WHO (2002) indicated that *Escherichia coli,* was a more reliable indicator of faecal contamination than that of total coliforms. Attention is now being given to the role of *Escherichia coli,* as a pathogen responsible for causing diarrhoea disease rather than an indicator of faecal pollution alone. An individual affected by diarrhoea looses water and electrolytes in his or her stools. Fluid loss may range between 5ml/kg to 200ml/kg or more in 24 hours (WHO, 2005:4).

2.6.3 Risk factors for diarrhoeal diseases

A study of contamination of drinking water between source and point of use in rural households of South Africa and Zimbabwe showed that, over forty percent (40%) of household water samples collected from household storage vessels were unsafe due to bacteriological contamination. In other words, more than 40% of households using improved sources of water had water samples that contained more than 10cfu/100ml of e.coli (Gundry et al., 2006). This signifies that improvements in water sources alone do not necessarily translate into safe water at the point of consumption. Similar studies such as Clasen and Bastable, (2003); Wright et al., (2004) and Trevett et al., (2005) showed that water from improved sources deteriorated significantly after collection and storage in the household. Post source contamination was noted as a problem for households and the risk of contracting diarrhoea from contaminated drinking water was noted (Gundry et al., 2004). VanDerslice and Briscoe, (1993) were of the view that other faecal-oral routes may be responsible for diarrhoeal disease. Pathogens which are consumed in food or dirty hands may be more important than drinking water in causing diarrhoeal disease. To VanDerslice and Briscoe, (1993), members of the household developed immunity to pathogens that were found within the household environment. However, Gundry et al., (2004) noted that if post-source contamination had no negative health impact then continued emphasis on new water sources was justified. However, if post-source contamination resulted in negative health impacts, then attention had to be given to improving water at the point of consumption (Gundry et al., 2004). Mintz et al., (2001); Sobsey (2002); and Gundry et al., (2004) showed that water quality interventions reduced the incidence of endemic diarrhoea and argued that poor water quality in the household environment was primarily responsible for diarrhoea within the household, the most vulnerable of whom were children under 5 years of age.

On the other hand, Esrey et al., (1991), VanDerslice and Briscoe (1995); Huttly et al., (1997) supported the argument that the quantity of water that people had available for hygiene was of equal or more importance for the prevention of diarrhoea. The premise underlying their argument was that diarrhoea was a water washed disease. This meant that it was acquired when one did not have enough water to carry out hygiene practice. This paradigm was underpinned by findings of the 1972 landmark study of water and environmental health in East Africa known as the Drawers of Water Study. The drawers of water study concluded that increasing the volume or quantity of water per capita was more important for a household's health that its quality. If a household had a small quantity of water to use it affected their hygiene, bathing, laundry and washing of hands, food and dishes (WHO, 2002). Furthermore reviews by Esrey et al., (1985) and Esrey et al., (1991) strengthened arguments in favour of adequate water quantity. The results helped to shape a paradigm whereby greater attention was paid to safe excreta disposal and proper use of water for personal hygiene (Clasen and Cairncross, 2004). According to Clasen and Cairncross, (2004), “none of the studies that Esrey et al. examined for their conclusions regarding the impact of water quality reflected interventions at the point of use”.

Cairncross et al., (1996) suggested that to be able to make a good judgement as to either water quantity or water quality and their implications for diarrhoea in the household, two domains were to be identified and studied. These were the public (outside the household) and the domestic domain (inside the household). Thus, to maximize the benefits of interventions, an analysis of faecal contamination was to be made in both domains (Jensen et al., 2004). Contamination in the domestic domain was often overlooked therefore Jensen et al., (2002) advocated that interruption of pathogenic transmission needed to be directed at both domains. Earlier studies that pointed to the possibility of contamination of drinking water included Van Zilj (1966) and Van Derslice and Briscoe (1995). Lindskog and Lundquist (1989) in a study in Malawi discovered that faecal coliform and faecal streptococci from wells, forvers, springs and taps increased significantly during water storage. In a cohort study of 180 households in a rural village in Cambodia, Brown et al., (2008) found a weak but positive association between e-coli counts in household drinking water and diarrhoea after a bi-weekly monitoring of water sources and diarrhoeal episodes over a 22 week period. It therefore suggested that attention needed to be given to factors within the environment that facilitated the acquisition of diarrhoeal diseases.

Results of studies by Jagals et al., (1997), indicated that members of a low socioeconomic urban community were exposed to micro-biologically related health risks when consuming water supplied by the public stand pipe system. When water was collected from the standpipe and it was transferred home, it deteriorated in quality significantly. When local authorities extended the tap to individual compounds and plots, family members used more water, they replenished stored stock of water more often and storing water less often. According to Jagals et al., (1997), improvements in water accessibility resulted in improved microbiological water quality of stored water. However hygiene quality still deteriorated. The cups, buckets and household items used in collecting stored water were kept in unsanitary conditions, exposed to flies, dust and unwashed hands. Thus the water fetching habits still made the water that was stored unhygienic. The study therefore concluded that improvements in access alone may not eliminate bacterial contamination of stored water entirely. A similar study in Peru, by Oswald et al., 2007 concluded that major sources of contamination resulted from poor water storage and hygiene practices in the home.

Vessel design and water handling can influence the microbiologic quality of stored water (Hammad and Dirar, 1982; Pinfold, 1990). Water in covered jerry cans had low rates of e-coli contamination whilst households that did not use a lid on their jerry cans had significantly poor stored water quality (Quick et al., 2002). Studies by Deb et al., (1986) and Roberts et al., (2001) show that improved vessels have an association with decreases in microbiological contamination.

Other researchers were of the view that poor domestic hygiene was the predominant cause of diarrhoeal disease in the home. Curtis et al., (2000) were of the view that any behaviours which prevented stools from getting into the domestic area, the child's main habitat, were likely to have had a greater impact on health than those practices which prevented pathogens in the environment from being ingested. To Curtis et al., (2000) all transmission routes in the F-diagram could be blocked by changes in domestic hygiene practice. They advocated a collective intervention of improved infrastructure and safe hygiene practice in the home. There was an association between hand washing and diarrhoea incidence (Feachem, 1986; Henry and Rahim, 1990; Pinfold, 1990; Haggerty et al., 1994 and Kalthenthaler and Pinfold, 1995). Families that practiced 'good' hygiene behaviours more frequently and more consistently were the families without diarrhoea (Gorter et al., 1998).

A counter argument raised against hygiene interventions alone was that not all members of the household could practice good hygiene effectively and this was particularly true for children under 5 years. Children could still receive infectious doses of pathogens via other routes and because they were considered too young to wash their own hands, they could not stop the transfer of pathogens between their hands and their mouth (Luby et al., 2004). Therefore employing several interventions at a time could have yielded better returns than hygiene interventions alone (Alam et al., 1995). A review by Curtis and Cairncross (2003) of the effect of hand washing behaviour on diarrhoea showed that hand washing interventions decreased diarrhoea by an average of 47%. However, the Curtis and Cairncross (2003) review summarized the reduction rates among all family members. Luby et al., (2004) contended that not all family members were at equal risk of death from diarrhoea but children under 5 years of age were at a much higher risk.

2.7 Childhood Diarrhoea in the Domestic Environment

2.7.1 Etiology of childhood diarrhoea

Childhood diarrhoea refers to the condition in which a child passes three or more watery stools a day (UNICEF, 2010:92). According to UNICEF/WHO (2009), there are three main forms of childhood diarrhoea; 'Acute watery diarrhoea', 'Bloody diarrhoea' and 'Persistent diarrhoea'. Pathogens that are responsible for acute watery diarrhoea include *Rotavirus*, *V. cholerae* and *Escherichia coli* bacteria. Bloody diarrhoea is normally referred to as dysentery. The stool of the sufferer is accompanied by blood and the common pathogen responsible is *Shigella.* Persistent diarrhoea refers to a diarrhoea episode that lasts for 14 or more days. This is common among individuals who have contracted HIV/AIDS. Globally, children under the age of five years experience up to three episodes of diarrhoea per year and acute watery diarrhoea accounts for 80% of the episodes whilst bloody diarrhoea (dysentery) and persistent diarrhoea each accounts for 10% respectively (Bhan, 2000:71)

Children under 5 experience the highest rates of diarrhoeal mortality and are more vulnerable to smaller doses of pathogens than other members of the household due to their under developed immune systems (Mintz et al., 2001; Peletz, 2006). In a prospective cohort study of the incidence of infection with *Enterotoxigenic Escherichia coli* in infants living in Nicaragua, Paniagua et al., (1997) defined the severity of diarrhoea amongst children in three categories; mild, moderate and severe. When the episode lasted no longer than three (3) days without fever and vomiting it was termed mild. If the episode lasted more than three (3) days with fever and or vomiting it was termed moderate. The episode was termed severe when it was accompanied by fever, vomiting, and dehydration with potential need for hospitalization. Diarrhoea episodes were defined if they were preceded by seven consecutive days without diarrhoea and to the end that a child was free from diarrhoeal symptoms for at least twenty four (24) hours (Paniagua et al.,1997).

In a study of the effects of stunting, diarrhoeal disease and parasitic infection during infancy on cognition in late childhood, Berkman et al., (2002) defined diarrhoea episodes as 'at least one day of diarrhoea followed by two (2) or more diarrhoea free days'. Research evidence shows that incidence of diarrhoea is greatest when children are within their weaning period and immediately thereafter.

2.7.2 Factors influencing childhood diarrhoea

The relationship between household socio-economic characteristics and childhood diarrhoea have been elaborated by studies such as Martines and Feachem, (1993); Alam, (1995); Katema and Lulseged (1997); and Timaeus and Lush, (1995). In a study of diarrhoea and other effects of different water sources, sanitation and hygiene behaviour in East Africa by Tumwine et al., (2002), the determinants of diarrhoeal morbidity included poor hygiene (unsafe disposal of faeces and waste water), education level of household head, obtaining water used from surface sources such as wells and per capita water used for cleaning. In a similar study in Egypt, El-Gilany and Hammad, (2005) identified overcrowding, improper refuse disposal and latrine ownership to be significantly correlated with diarrhoeal incidence. Childhood diarrhoea morbidity decreased significantly with higher educational levels of parents owing to the fact that better educated mothers tended to marry similarly advantaged men with higher education resulting in relatively higher standard of living (El-Gilany and Hammad, 2005; Gorter et al.,1991).

Container size also had an association with diarrhoeal disease amongst children. A study by Checkley et al (2004) showed that children in households with small storage containers had 28% more diarrhoea episodes than did children from households with large containers. Yeager et al., (1991) found an association between uncovered water storage and a greater diarrhoeal incidence. A similar study by Wright et al., (2004) also showed that where households covered their water storage containers, faecal coliforms counts were lower. Where households used large mouth vessels to store water, microbial contamination was higher (Mintz et al., 1995) and when water was transferred from the collection vessel to the storage vessel, microbial contamination was higher (Lindskog and Lindskog, 1987). Water storage hours was also found to have been associated with concentration of bacterial counts of faecal coliform in stored tubewell water (Hoque et al., 1995).

Studies by Stanton and Clemens (1987) and Han and Moe (1990) showed that indiscriminate defecation in or near the home was associated with an increase in the incidence of diarrhoea whilst studies by Baltazar and Solon (1989) showed that households where children's stools were inadequately disposed had a 64% increase in diarrhoea. Tumwine et al., (2002) indicated that poor disposal of children's faeces was associated with reported incidence of diarrhoea with an odds ratio of 3.36. The studies lie in the context where by more than 280 million children under 5 years live in households without improved sanitation facilities (Black et al., 2003). Thus children who live in unsanitary households have the highest risk of contracting diarrhoea (Manun'ebo et al., 1994; Ekanem et al., 1991). The unsanitary conditions serve as breeding grounds for flies and other vectors who convey enteropathogens from the environment food and water (El-Gilany and Hammad, 2005).

Mock et al., (1993), Vanderslice et al., (1994); Gataneh et al., (1997) and Root (2001) have shown that lack of excreta disposal facilities, presence of excreta in the yard, lack of latrines and absence of refuse disposal pits were associated with diarrhoeal morbidity. In a recent study of environmental determinants of diarrhoea among children under five years, Regassa et al., (2008) identified two variables that were associated with under five diarrhoeal morbidity; faeces around the pit-hole and absence of refuse disposal facilities. Factors that were investigated included type of water source, distance from the drinking water source (time spent to and from the water source), amount of daily water consumption, availability, type and ownership of toilet facility, housing floor and latrine and compound cleanliness. Latrine ownership or the building of sanitation infrastructure became the prerequisite intervention needed to secure good health. However, Mertens et al., (1992) indicated that latrine ownership on its own may not have prevented disease but ownership had to be accompanied by safe stool disposal.

Globally, 125 million children under 5 years of age live in households without access to improved drinking water sources (Black et al., 2003). To investigate the association between bacteriological drinking water quality and incidence of diarrhoea, Jensen et al. (2004) conducted a 1 year prospective study in the southern Punjab, Pakistan. The study involved children younger than 5 years in 200 households. The study team employed weekly monitoring of diarrhoeal episodes, assessed drinking water sources and drinking water quality as well. The study results showed that there was no association between the incidence of childhood diarrhoea and the number of Escherichia coli in the drinking water samples (The public domain). The number of e-coli in the household storage containers (the domestic domain) and diarrhoeal disease were associated but not statistically significant. In an earlier study by Vanderslice and Briscoe (1993), infant diarrhoea was associated with water contamination in the public domain but not in the domestic domain. The question that arises is that does the results of the Vanderslice and Briscoe (1993) truely reflect what exists in all settings? The conclusions of Jensen et al (2004) indicates the contrary. Since water contamination was more pronounced in the domestic domain than in the public domain it has given justification for attention to be given to both domains and not the public domain alone (Jensen et al., 2004).

Gorter et al., (1991) employed a case control method to study water supply, sanitation and diarrhoeal disease in Nicaragua. A total of 1229 children under 5 years were matched with children of equal number who presented illnesses unrelated to water and sanitation. Main types of water supply were sampled at monthly intervals and tested for faecal coliforms. Childhood diarrhoea was significantly associated with the mother's level of schooling and the quality of water in unprotected wells was better than that of protected wells. The study concluded that transmission of diarrhoea in Nicaragua was predominantly water – washed rather than water borne. The Gorter et al., (1991) study did not sample drinking water from storage vessels in the home (the domestic domain) but rather sampled drinking water from the source (the public domain). Research evidence points to possible post water collection contamination and possible contamination within the water storage vessels (Clasen and Bastable, 2003; Gundry et al., 2004).

2.7.3 Effects of childhood diarrhoea

Diarrhoea is both a cause and an effect of malnutrition (Clasen and Cairncross, 2004), and it could lead to reduced resistance to infection, poor cognitive development

(Guerrant et al., 1999) and linear growth retardation (Berkman et al., 2002; Bhan, 2000). Studies that demonstrated an association between diarrhoea and liner growth included Black et al., (1984), Guerrant et al., (1983) and Sepulveda et al., (1988). In order to investigate childhood diarrhoea and its relationship to the lineal growth of children, Checkey et al., (2004), assessed the effects of water and sanitation on child health in a birth cohort in a Peruvian community. Evidence gathered from the research showed that at 24 months, children with the worst conditions for water source, water storage and sanitation were 1.0 cm shorter and had 54% more diarrhoeal episodes than those in best conditions. Kosek et al., (2003) advocated that attention needed to be given to diarrhoeal morbidity due to its long term effects on lineal growth and cognitive functions.

In order to study the problem of childhood diarrhoea, a household survey approach could be adopted or information could be collected at clinics. Many morbidity cases may be treated at home and never reported at clinics therefore El – Gilany and Hammad (2005) advocated the use of the household survey approach. According to Ferrer et al., (2008), the web of determinants for diarrhoea in children is complex with each factor varying from setting to setting. In order to chart a path in knowing more about childhood diarrhoea and how inter household transmission occurs, Root, (2001) advocated for more qualitative research to be employed to study defecation behaviour, child morbidity, child supervision and hygiene. Thus in this study qualitative data were collected in order to complement quantitative data and shed more light into the motives and reasons for some choices in the household.

2.8 Childhood Diarrhoea in the Ghanaian Context

Approximately, 87% of the Ghanaian population in 2008 used unimproved sanitation facilities whilst only 13% used improved sanitation facilities. Of those who used unimproved facilities, 54% used shared sanitation facilities, 20% practised open defecation and 13% used unimproved facilities (WHO/UNICEF, 2010:42). In 2012, 14% used improved sanitation, 59% used shared facilities, 8% used other forms of sanitation whereas 19% practised open defecation (WHO/UNICEF, 2014:8). The trend with respect to sanitation was that Ghana was not on track to meeting the sanitation targets of the Millennium Development Goals. The precarious sanitation situation in Ghana does not only have negative implications for the general health and well being of the entire populace but it has significant health ramifications for children under-five in particular. Rotavirus, which is known to be of faecal origin, is the leading cause of acute gastroenteritis in Ghanaian children (Mwenda et al., 2010; Armah et al., 1994; Enweronu-Laryea et al., 2014; Reither et al., 2007). According to PATH, Rotavirus is primarily responsible for the deaths of 2,090 under- five year old children in Ghana each year (PATH, 2013:1).

The review of literature suggested that varied risk factors were associated with childhood diarrhoea in Ghana. Boadi and Kuitunen (2005) in their Accra study found that childhood diarrhoea was significantly related with factors such as household wealth, presence of flies in the kitchen, source of drinking water and presence of sanitation facilities. Mensah et al., (1998), in their urban slum study in Accra identified mother's education, mother's employment status, presence of animals in the home and consumption of vended food as significant risk factors of childhood diarrhoea. In northern Ghana, another study found that the sharing of sanitation facilities, dependence on water from vendors and frequent consumption of food prepared by street vendors were significantly associated with childhood diarrhoea (Osumanu, 2007). Another study in northern Ghana indicated that the factors that influenced childhood diarrhoeal prevalence included children with younger mothers, high number of children in a family and lower education level of the mother (Peletz, 2006:20). Thus, from the literature, household socio-economic, environmental and behavioural factors seemed to play significant roles in childhood diarrhoea transmission. Though the literature suggested that the risk factors of childhood diarrhoea had been addressed, these studies were largely cross-sectional and pointed to the need for more longitudinal studies to assess changes over time.

Diarrhoeal diseases ranked 4th on the list of top twenty causes of outpatient morbidity for all ages between 2006 and 2008. In 2008, the total number of cases were 385, 737 representing 3.81% of all cases. In 2007, 539,197 cases were reported representing 4.3% of all cases. In 2006, 345,454 cases representing 3.38% of the total number of cases were reported (GHS, 2009:30). In 2009, diarrhoeal diseases also ranked 4th on the list of top ten causes of admissions for all ages in Ghana. Malaria, pregnancy and related complications and anaemia ranked 1st, 2nd and 3rd respectively. With reference to the top ten causes of death in all ages in Ghana, Diarrhoeal diseases ranked 10th with a proportional mortality rate of 2.3. The top three with mortality rates were Malaria (13.4%), HIV/AIDS related conditions (7.4%) and Anaemia (7.3%) (GHS, 2009: 47).

The 1998 Ghana Demographic and Health Survey (GDHS) revealed that the prevalence of diarrhoea was 19.1% for children under-five years in Ghana. The GDHS, 2003 showed that only 8% of households had all required hand washing materials such as water in a designated location for hand washing, cleaning agent such as soap or ash and a basin to hold clean water (GSS, 2004: 157). Survey results in 2003 and 2008, showed that 36% and 48% of mothers indicated that the stools of their children were uncontained respectively (GSS, 2009:176). This meant that the stools of their children were thrown outside the dwelling or yard, rinsed away or not disposed of. In the two weeks preceding the survey, 15% of children had diarrhoea and the prevalence of diarrhoea was lowest among children whose mothers were highly educated and belonged to the wealthiest quintile (GSS, 2004:160). In 2008 however, one in 5 children representing 20%, had diarrhoea during the two weeks preceding the survey with 3% of children having blood in their stools (GSS, 2009: 172). About 33% of diarrhoea cases peaked within the ages of 12 to 23 months. On a regional scale, the Ghana Statistical Service noted that Northern and Brong Ahafo Regions had higher prevalence rates than children in other regions (GSS, 2009:172). The survey noted that in Ghana, children who lived in households without improved drinking water sources suffered the highest prevalence of diarrhoea. Also the findings suggested that the higher the educational level and income of the mother, the greater her chances of disposing of the stools of her children in an environmentally friendly manner.

2.9 Child Health and Related Policy Perspectives in the Ghanaian Context.

Child health refers to the extent to which individual children or groups of children are able or enabled to develop and realize their potential, satisfy their needs, and develop the capabilities that allow them to interact successfully in their biological, physical and social environments (NRC and IM, 2004). The review identified that amongst the national policies that had been drawn to address health in general, four policies were closely related to domestic water use behaviour and childhood diarrhoea in Ghana. These were the Under Five's Child Health Policy: 2007-2015 written by the Ministry of Health Ghana, the National Environmental Sanitation Policy written by the Ministry of Local Government and Rural Development, the National Water Policy written by the Ministry of Water Resources Works and Housing and the National Health Policy written by the Ministry of Health, Ghana. Amongst the afore mentioned policies, the Under Five's Child Health Policy: 2007-2015 addressed childhood diarrhoea in relatively greater detail. It advocated for the establishment of ORT corners in all facilities for the management of diarrhoea. However little was discussed on deadlines, benchmarks, and how monitoring and evaluation of progress was to be done.

The link between water, sanitation and hygiene and their relationship with childhood diarrhoea was discussed. As part of the key family practices for child health, the Under Five's Child Health Policy advocated the use of improved sources of drinking water and safe water storage. It is worth noting however that the use of 'improved sources' does not guarantee that water will be safe at the point of consumption (Clasen and Bastable, 2003). Furthermore a distinction between the public domain and the domestic domain is very vital to understanding where microbiolgical contamination could take place (Cairncross et al., 1996). Not only must water sources be improved, but they must be safe microbiologically and chemically at the time it is being consumed.

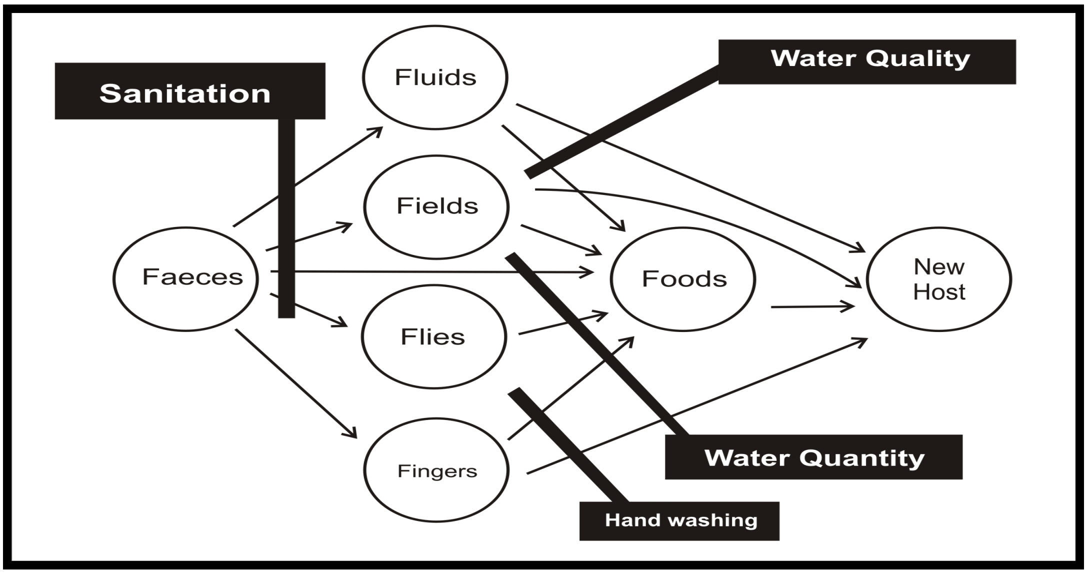
A review of the National Water Policy and the National Health Policy also suggested that little mention was made of water service levels and associated levels of health concern. In general, the review suggested that across the policies, the targets, indicators and benchmarks for measuring progress with respect to reliable water supply, stool disposal and storage of water were minimally discussed. Given the fact that Ghana was not able to achieve the MDG target on sanitation, there is the need to revise all the four policies which were discussed to reflect the targets of the Sustainable Development Goals.

2.10 Conceptual Framework

The review of literature showed that some research work concluded that the quantity of water used for personal and domestic hygiene was more important than its quality in reducing diarrhoeal disease (Esrey et al., 1985; Esrey and Habicht, 1986; Esrey at al., 1991; Vanderslice and Briscoe, 1993). Diarrhoea diseases are transmitted by water washed mechanisms mostly due to inadequate volumes of water to carry out personal and domestic hygiene. The paradigm of supplying adequate volumes of water to curb diarrhoeal disease has been a theoretical underpinning for water projects at the global, national, regional and district levels.

Due to the increasing evidence of faecal contamination of water during collection, transportation and storage within the household (Clasen and Bastable, 2003; Wright et al., 2004; Trevett et al., 2004 and Gundry et al., 2006) another paradigm or theoretical frame of reference has emerged and argues that securing water quality at source and within the household is more important because diarrhoeal diseases are transmitted by water borne mechanisms as well. Diarrhoeal diseases can be transmitted by both water borne and water washed mechanisms, therefore the framework which holds much significance for transmission must be identified and given priority when scarce resource are to be used to appropriately place interventions.

Fig.2.4 Barriers to faecal - oral transmission routes of diarrheal disease.



Source: EHP (2004:7).

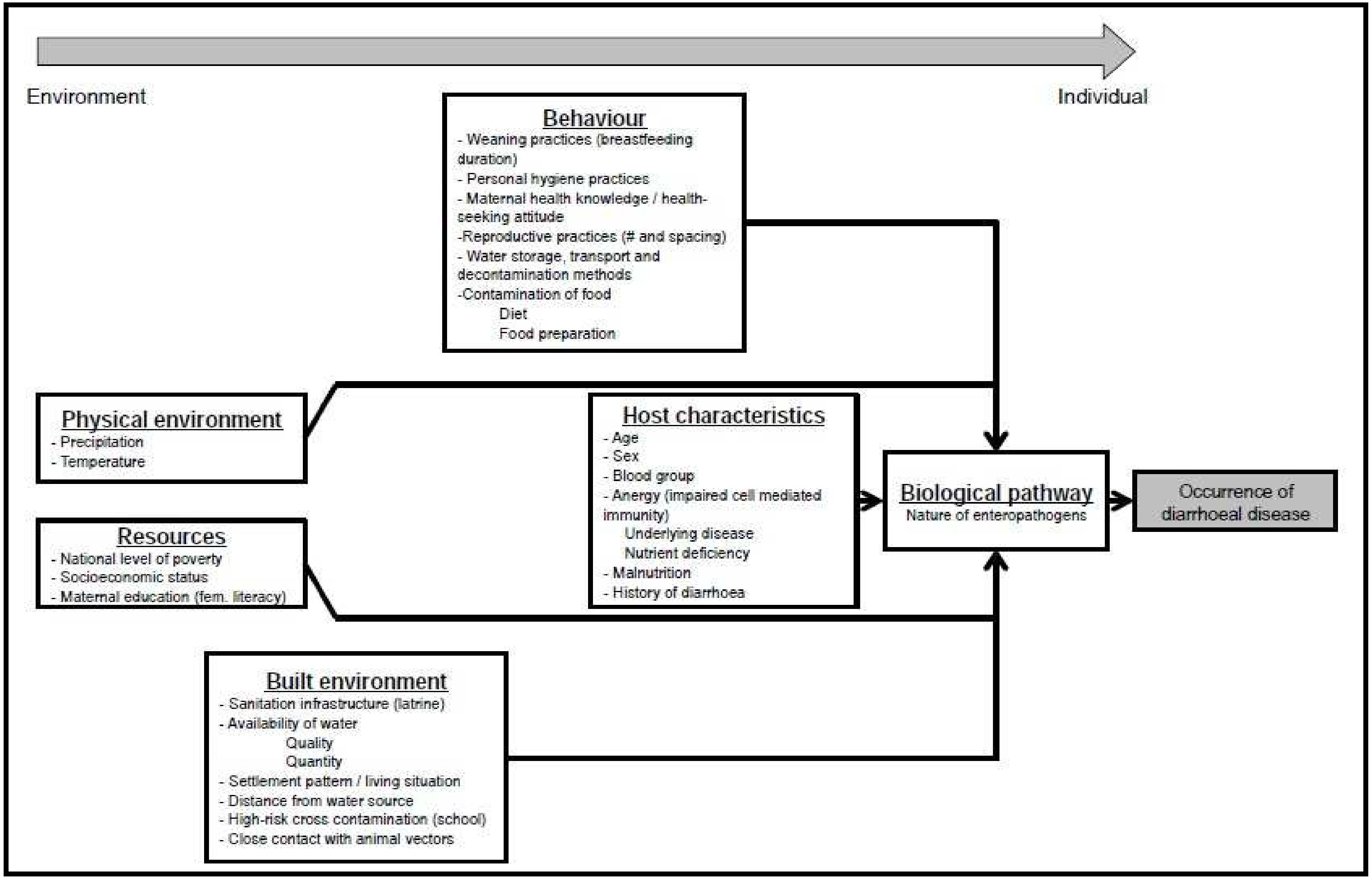
Fig. 2.4 shows a model of the barriers to faecal - oral transmission routes of diarrheal disease developed by the Environmental Health Project (EHP) of the U.S. Agency for International Development (USAID). Sanitation serves as a primary barrier whilst water quality, water quantity and hand washing (Hygiene) serve as secondary barriers.

The model shown in Fig 2.4 is generalized and not specifically drawn to depict reality in any geographical context. The neighborhood environment and the household environment are crucial elements that need to be considered. Furthermore, the host is not identified. This is of critical importance because members of the household include adults, the aged, and children. Children are the most vulnerable due to their low immunity levels (Mintz et al., 2001).

Ramani et al., (2012) carried out a review of literature in order to build a comprehensive model to identify the known determinants of diarrhoea in developing countries and understand the established interrelationships amongst the determinants. Based on their literature review, Ramani et al., (2012) placed all the identified factors into physical environment, resources, built environment, behaviour and host characteristics. They explained that though all persons have a high risk of diarrhoea disease in developing countries, others have higher individual risk and that the risk factors could be positioned in a spectrum ranging from the more distal to more proximal individual level. They therefore developed a model of the determinants of diarrhoeal disease occurrence in which risk factors influence enteropathogens and cause diarrhoeal disease as shown in Fig. 2.5. However, the model provided by Ramani et al., 2012 also has some limitations. First the sufferer or host of the diarrhoeal disease is not identified. Secondly, the spatial context of predisposition to the disease is not delineated. Third, the model does not take into account interrelationships amongst risk factors. Also, the framework provided by Ramani et al., 2012 lacks government policy perspectives hence the conceptual frame work for this study makes an adaptation of the Ramani et al., (2012) model (Fig 2.6) taking into account the limitations which have been highlighted.

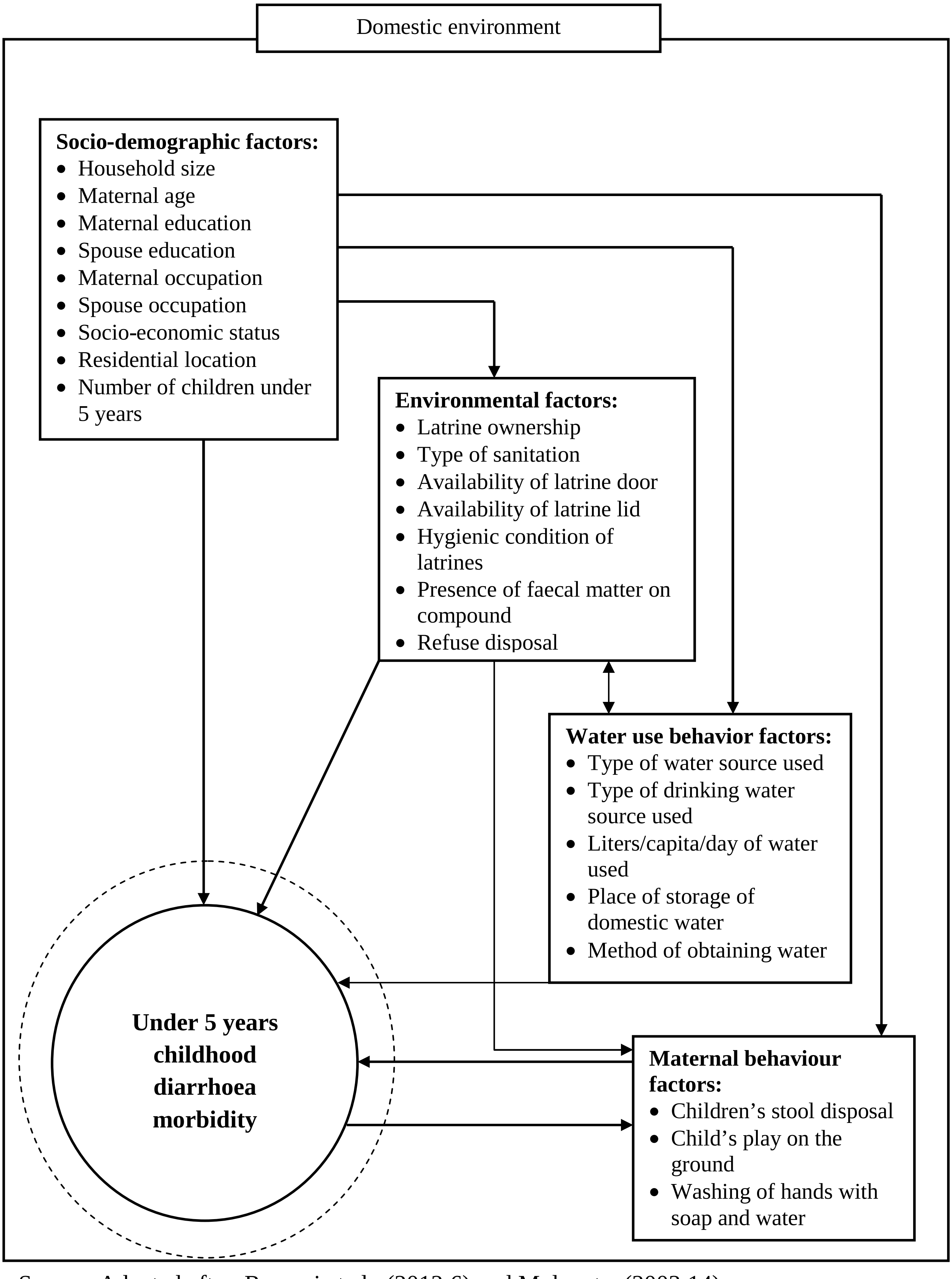
The model drawn in Fig 2.6 shows the conceptual framework of the hypothesized risk factors of childhood diarrhoea in this study. The framework identifies the under 5 year old child as a sufferer of diarrhoea morbidity in the domestic environment. Childhood diarrhoea is depicted as a function of socio-demographic, environmental, water use as well as maternal behavioural factors.

Fig.2.5 Determinants of diarrhoeal disease occurrence.



Source: Ramani et al., (2012:6)

Fig. 2.6 Conceptual framework of hypothesized risk factors of childhood diarrhoea.



Source: Adapted after Ramani et al., (2012:6) and Mulugeta, (2003:14)

In Fig. 2.6, socio-demographic factors play a key role because they affect all environmental water use and maternal behavioural factors. For example, household socio-economic status influences latrine ownership and use. Also, Environmental factors are shown to have a reciprocal relation with water use behaviour. For example, owning a water closet suggests that water will be needed to dispose of faecal matter thereby adding to the demand for water in the household for the use of water closets. On the other hand, the level of 'access' to domestic water for example influences the ability to safely dispose of faecal matter and practice good hygiene (Cairncross and Feachem, 1983). Maternal factors are influenced by socio-demographic factors as well as environmental factors. For example, the availability of latrines in the household influences a mother's decision on the method to use to dispose of children's stools. An inter-relationship between childhood diarrhoeal morbidity and maternal behavioural factors is also shown. Unsafe disposal of children's stools is likely to lead to the transmission on diarrhoeal pathogens in the domestic environment leading to childhood diarrhoeal morbidity. On the other hand, an episode of childhood diarrhoea necessitates safe stool disposal and washing of hands with soap and water.

Vulnerability is a key factor that must be taken into consideration with respect to diarrhoeal risk factors in the domestic environment. Under-five year old children are more vulnerable than other members of the household. They have lower immune levels (Mintz et al., 2001), cannot appropriately wash their hands and therefore cannot adequately prevent pathogen transfer from their hands to their mouth (Luby et al., 2004). Hence in the framework depicted in Fig. 2.6, the dashed circle indicates that the child's immune system is breached which then predisposes the child under-five years to pathogens that cause diarrhoea.

2.11 Chapter Summary.

Research evidence showed that water could be polluted/contaminated not only at source but within the domestic environment as well. The contamination of household water meant that household members could have been at risk of contracting water related diseases such as diarrhoea. Diarrhoea was noted to be responsible for 4 billion morbidity cases per year and 1.8 million deaths globally. Over 90% of them being children under 5 years (UNICEF, 2011). Research evidence suggested that diarrhoea was more precarious for children under 5 years of age who had lower immune systems (Mintz et al., 2001).

With respect to research gaps it emerged from the review that much needed to be learnt about domestic water use behaviour, and its relationship with childhood diarrhoea using longitudinal research approaches. Some researchers were of the view that an understanding of the relationships was important in the design and implementation of environmental health policies and programmes (Sandiford, 1990; Thompson et al., 2001:4; Makoni et al.,2004). Also the review suggested there were few published reports on the association between water consumption and diarrhoea (Aiga, 1999). Furthermore there appeared to be little consensus on measuring water use in un-metered households (Arbués et al., 2003; Wutich, 2009).

The reviewed literature showed that in the Ghanaian context though childhood diarrhoea risk factors had been given attention, much needed to be learnt about seasonal or long term variations.

CHAPTER THREE

3.0 PROFILE OF THE ATWIMA NWABIAGYA DISTRICT

3.1. Introduction

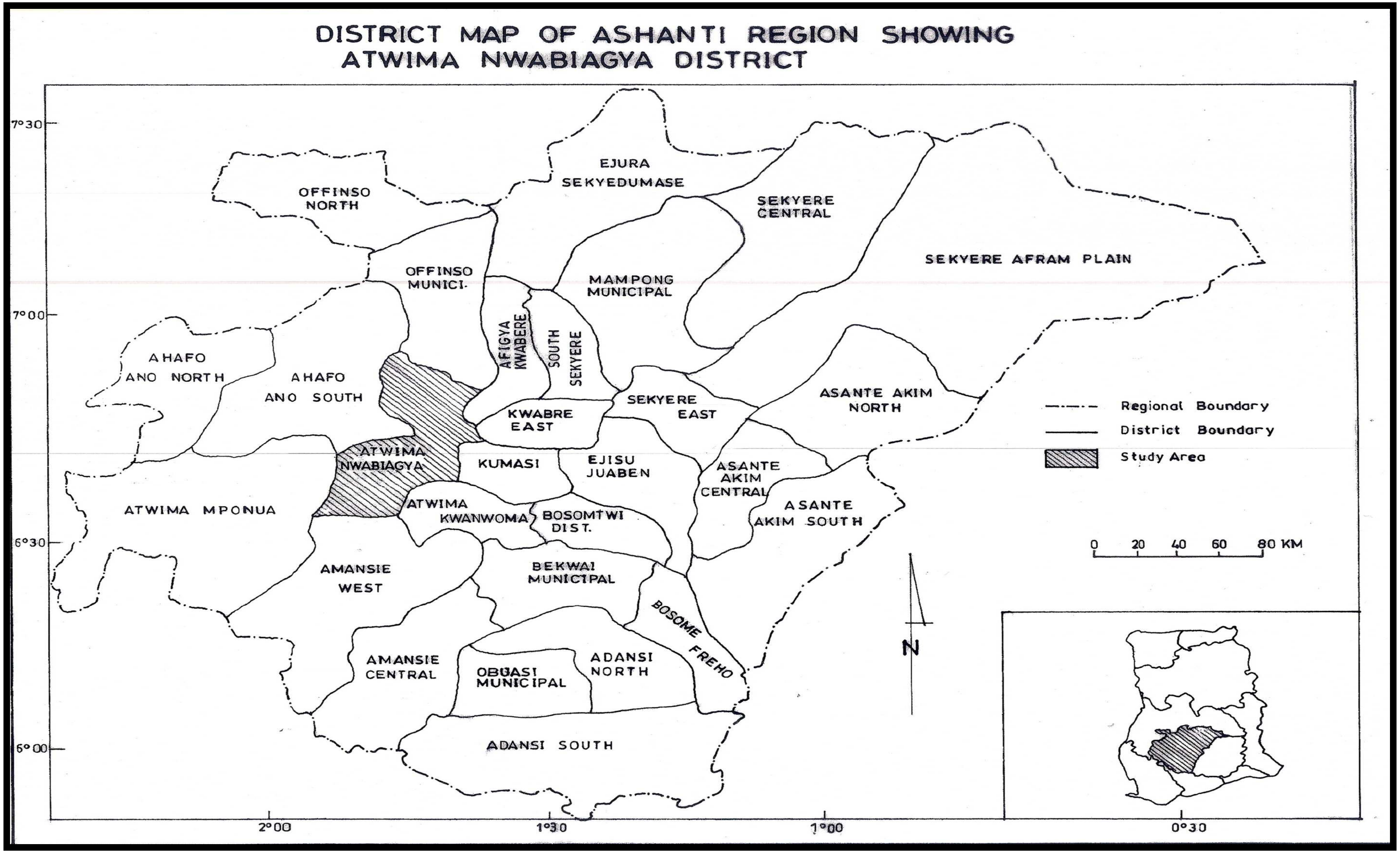
This chapter discusses the physical and socio-demographic characteristics of the Atwima Nwabiagya district. These include relief and drainage, climate, vegetation, soils, and socio-demographic characteristics such as population, household size, water and sanitation as well as health.

The study communities were Nkawie, Asuofua, Barekese and Abuakwa (Fig. 3.3). Spatially, Nkawie and Abuakwa are urban communities whereas Asuofua and Barekese are peri-urban. Kobeng is a community located to the southern part of the district where pre-testing and research training was conducted (Fig. 3.3).

3.2 Location and Size

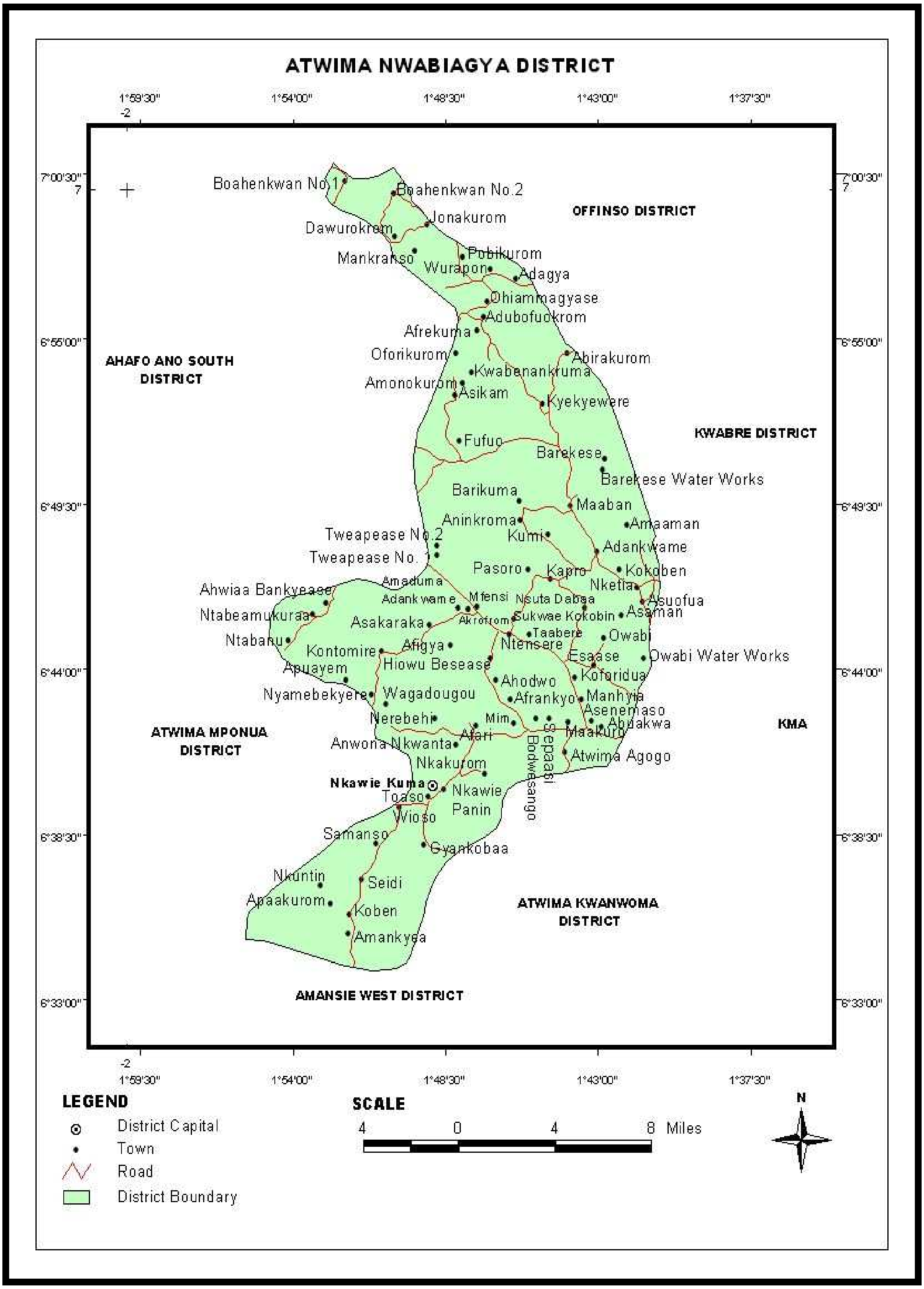
The Atwima Nwabiagya District is located on latitude 6^{o} 75'N and between longitude 1^{o} 45' and 2^{o} 00' West (Fig. 3.1) and covering an area of 294.84 sq km (ANDA, 2012:7). It is one of the 21 political and administrative districts in the Ashanti Region (Fig. 3.1) and its capital is Nkawie (Fig. 3.2; Fig. 3.3). The neighboring districts are Ahafo Ano South and Atwima Mponua Districts to the West, Offinso Municipal to the North, Amansie–West and Atwima Kwanwoma Districts to the South, Kumasi Metropolis and Afigya Kwabre Districts to the East (Fig. 3.1).

Fig. 3.1



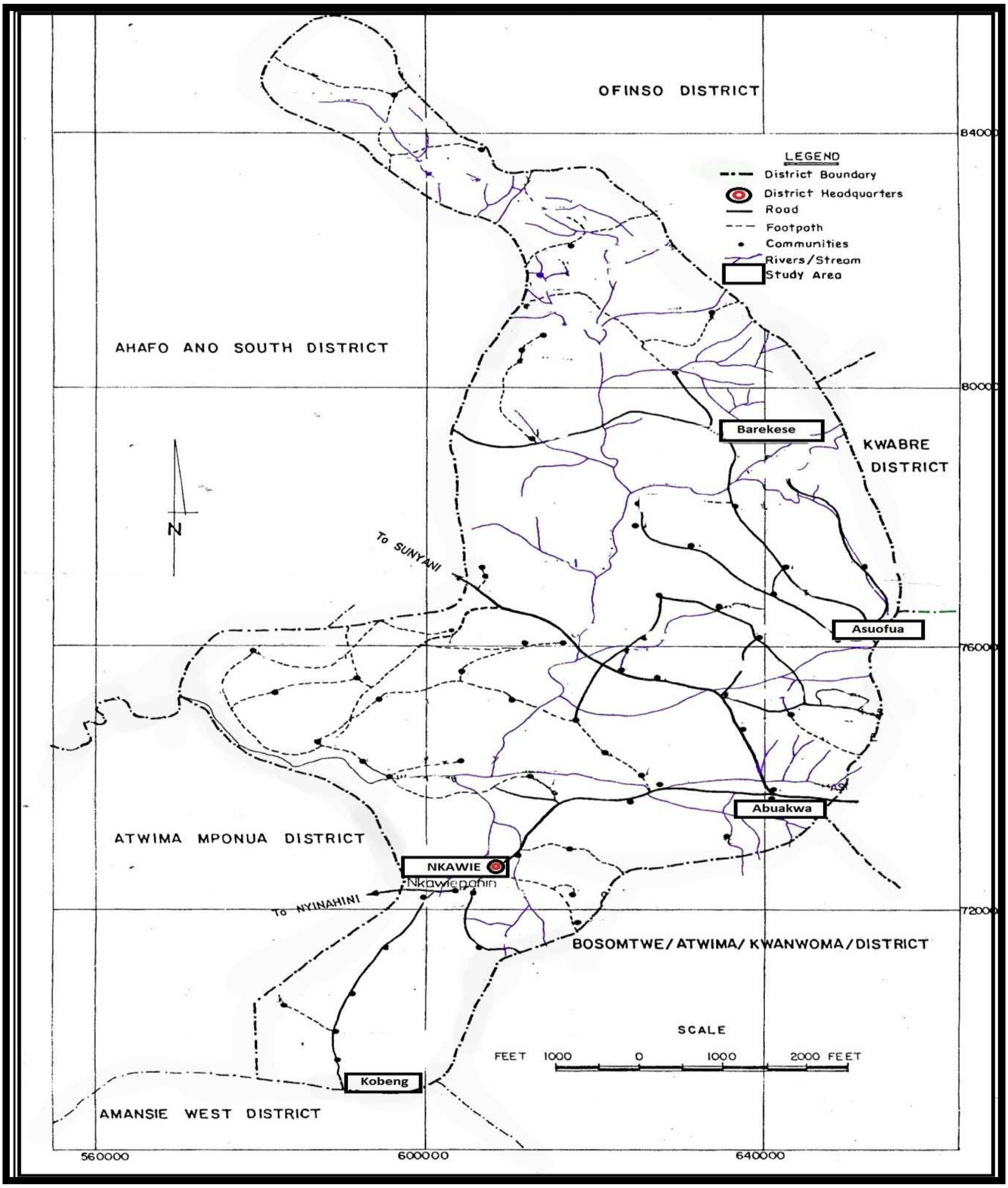
Source: Department of Geography, KNUST, (2013)

Fig. 3.2 Map of the Atwima Nwabiagya District showing major communities.



Source: ANDA (2011:1)

Fig. 3.3 Map of the Atwima Nwabiagya District showing the study communities.



Source: Department of Geography and Rural Development, (2011)

3.3 Physical Features

3.3.1 Relief and drainage

The district has an undulating topography. The lands have average heights of about 77 metres above sea level and the high lands have gentle to steep slopes. The highest points in the district can be found in the Barekese and Tabere areas. There are a number of wider valleys with no evidence of stream flow (ANDA, 2011:2). The Offin and Owabi are the main rivers which drain the surface area of the District. There are however, several streams in the District. These include Kobi and Dwahyen. Two major dams, Owabi and Barekese have been constructed across the Owabi and the Offin rivers respectively. These dams supply pipe borne water to the residents of Kumasi and its environs.

The Offin and its tributaries becomes flooded and over flow their banks causing damage to crops within the confines of the floods, in years of above average rainfall. On the other hand in years of below average rainfall, the level of these rivers are considerably lowered, sometimes being reduced to a series of disconnected pools. The small streams completely dry out in the dry seasons (February –March) (ANDA, 2011). There is increasing eutrophication and siltation levels in some streams due to farming activities that are practised along their banks especially those which flow through major settlements have also been polluted due to the discharged of liquid and solid waste into them (ANDA, 2011).

3.3.2 Climate and Vegetation

The District lies within the wet semi-equatorial zone marked by double maximum rainfall ranging between 170cm and 185cm per annum. The major rainfall season is from Mid-March to July and minor season is between September and mid-

November. Average temperatures also range between 27ºC (August) and 31ºC (March) with a mean relative humidity of about 87 to 91 percent. The lowest relative humidities usually occurs in February/April when they are between 83 -87 in the morning and 48-67 in the afternoon (MOFA, 2013:12).

The vegetation found in the district is predominantly the semi-deciduous type. The vegetation type has largely been disturbed by human activities such as logging, farming and bush fires thus, depriving it of its original valuable tree species like Odum, Sapele, fauna and other forest products. The Owabi Water Works Forest Reserves and Barekese Water Works Forest Reserve, serve as water shed protection for the Offin and Owabi rivers. In addition, part of the Gyemena Forest Reserve is located in the district and small fuel wood reserves and plantations have also been established to protect the Owabi and Barekese water reservoirs. These plantations are composed of entirely exotic species consisting mainly of *Teak, Acassia, Gumelina* and *Eucalyptus* (ANDA, 2011).

3.4 Socio-Demographic Characteristics

3.4.1 Population

The total population of the district, according to the 2010 Population and Housing Census was 149,025 which represented 3.1% of the Ashanti Regional population (GSS, 2014: 13). The district was noted to be the third most populated district in the Ashanti following after Obuasi Municipal and Kumasi Metropolis which accounted for 3.5% and 42.6% of the Ashanti Regional population respectively (GSS, 2013b:22). Table 3.1 shows a distribution of population and household characteristic of the Atwima Nwabiagya District compared to regional and national estimates.

Table. 3.1 Distribution of selected 2010 population and household characteristics for the Atwima Nwabiagya District.

Characteristic	**Total country (2010)**	**Ashanti Region (2010)**	**District (2010)**	**Urban (2010)**	**Rural (2010)**
Total population	24,658,823	4,780,380	149,025	46,891	102,134
Total household population	24,076,327	4,671,982	146,076	45,960	100,116
Number of households	5,467,054	1,126,205	35,205	11,305	23,900
Average household size	4.4	4.1	4.1	4.1	4.2
Number of houses	3,392,745	574,066	16,532	4,927	11,605
Average households per house	1.6	2	2.1	2.3	2.1
Population per house	7.1	8.1	8.8	9.3	8.6
Number of children 0-4 years old	3,405,406	640,571	20, 010	5, 972	14,038

Source: (GSS, 2014:34; GSS 2013:1)

In Table 3.1, the average household size in the district was recorded as 4.1 persons which was lower than the regional average of 4.4 persons. In terms of spatial distribution, there were higher estimates for rural areas compared to urban with respect to total population, total household population, number of households, average household size, number of houses and the number of children between 0-4 years of age. There were a total of 20,010 children between 0-4 years representing 13.4% of the total population in the district. In respect of this research, a total of 378 index children were studied constituting approximately 2% of the number of children between 0 – 4 years in the Atwima Nwabiagya District (GSS, 2014:13).

Table 3.2 Population by Area councils

Area Council	**Population, 2000**			**Population, 2009**			**2013**
	Male	**Female**	**Total**	**Male**	**Female**	**Total**	**Total**
Abuakwa	17177	17272	34449	21,821	21,943	43,764	48,684
Akropong	17723	17567	35290	22,645	22,455	45,100	50,169
Nkawie-Toase	10393	9722	20115	14,198	13,286	27,484	30,585
Barekese	10,244	10,041	20,285	16,392	16,730	33,122	36,855
Afari	4519	4410	8929	6,456	6,300	12,756	14,214
Adankwame	10297	10010	20307	14,002	13,615	27,617	30,734
Total	70,353	69,022	139,375	95,514	94,329	189,843	211,241

Source: ANDA (2011:8)

Table 3.2 shows a population distribution by Area councils. Akropong Area Council had the highest population of 45,100 in 2009. Afari had the lowest population of 12,756 (ANDA, 2011:8). Major settlements in the District include Abuakwa, Nkawie, Toase, Asuofua, Barekese, Atwima Koforidua, Asenemaso Akropong.

With respect to the age structure of the population in the district, it was skewed towards the youth. The number of children within the age groups 5-9 years was estimated to be 12.78% whereas 10-14 years was 12.61%. Thus approximately 39% of the population in the district were reportedly below 15 years. About 3.6% population were above 64 years (GSS, 2014:13).

3.4.2 Education

There were one hundred and twenty-five (125) kindergarten/nursery schools, one hundred and thirty-six (136) primary schools, ninety-six (96) Junior High Schools, and four (4) Senior High Schools in the district as at 2011. In addition, there were four (4) Vocational schools and one (1) Theological University in the district. The vocational schools are located at Nerebehi, Sepaase, Maakro and Toase, whiles the university is located at Abuakwa (ANDA, 2011).

3.4.3 Housing and the built environment

The 2000 Population and Housing Census indicated that the district had 11,156 houses and in 2009 the number increased to 12,272 (ANDA, 2011:5). In 2010, the number was estimated at 16, 532 which represents an increase of about 48%. Most houses in the rural part of the district are of relatively poor quality. Some houses, in Asakraka and Fufuo have their foundations exposed, thereby exposing the inhabitants to the risk of losing their houses and their lives.

3.4.4 Water and Sanitation

The main sources of water supply for domestic use in the district are boreholes and pipe systems. The district potable water supply coverage was about 95 % (ANDA, 2011:31). Urban and Peri-urban areas of the district rely mainly on pipe water systems, whiles the rural population rely mainly on boreholes. The rural potable water supply coverage in the district increased significantly from 49.9% in 2006 to 70.35% in 2009 (ANDA, 2011:31). Development partners such as Kreditanstalt fur Wiederaufbau (KfW) and the African Development Bank (AfDB) supported the district to drill over 200 boreholes for rural communities between 2006 and 2009 (ANDA, 2011:31).

The results of the 2010 population and housing census indicated that improved drinking water supply coverage was 90% for both urban and rural communities. Across the district, a total of 93.2% of households used improved drinking water sources which comprised of borehole/pump/tube well (29.8%), pipe-borne outside dwelling (23.1%), pipe- borne inside dwelling (16.5%), protected well (16.1%) and public tap/stand pipe (7.7%). (GSS, 2014:40). The high proportion of borehole/pumb/tube well usage could have been a reflection of the extensive drilling of over 200 boreholes as reported by the Atwima Nwabiagya District Assembly. With respect to spatial distribution, most households in urban and rural communities relied on pipe-borne outside dwelling (22.6%) and borehole/pump/tube well (36.4%) respectively (GSS, 2014: 40). An implication of the usage of drinking water sources that were not located inside the dwelling suggests that some households engaged in transporting drinking water from the public domain to the domestic domain. It also suggests that there could be bacteriological contamination during transport and storage as has been noted by studies such as Clasen & Bastable, 2003; Wright et al., 2004; Trevett et al., 2005; Gundry et al., 2006.

With respect to sanitation, the 2010 population and housing census suggested that improved sanitation coverage was less than 50% in the Atwima Nwabiagya District. This was because public toilet usage accounted for by 42.2% of housheolds, pit latrine usage 24.2%, Water closet (W.C) 17.8%, KVIP 10.3% whereas open defecation was practised by 5.2% (GSS, 2014:41). The ramification of open defecation practice is that uncontained faeces serve as the primary source of faeco-oral pathogens which are responsible for the transmission of faeco-oral diseases such as childhood diarrhoea.

The District Assembly is responsible for solid waste management in the district. About 70% of the solid waste generated in the district is organic. The Assembly performs this responsibility through the District Environmental Health Unit and a private company called Zoom Lion Limited. Table 3.3 shows the number of household and public latrine holes in the various Area Councils, and the respective population they served. Access to safe toilet facilities in the district was approximately 33%. Adankwame town council had the highest coverage of safe toilet facilities (46%) whereas the Barekese Area Council had the least coverage (16%) (ANDA, 2011:32). However, only 64 public basic schools had safe toilet facilities, and only two markets had toilet facilities (ANDA, 2011:32).

Table 3.3 Percentage coverage of safe toilet facility by area council.

Area Council	**2008 Total Population**	**No. of Toilet Holes**			**Total Pop. Served**	**Total Coverage**
		HH VIP	**HH WC**	**Public Toilet**		
Abuakwa	42,613	103	283	260	16,860	39.6%
Akropong	43,914	187	87	200	13,020	29.64%
Nkawie-Toase	26,761	125	137	130	9,817	36.68%
Barekese	32,251	54	50	82	5,130	15.91%
Afari	12,421	21	82	60	4,040	32.5%
Adankwame	26,891	197	222	166	12,450	46.30%
District Total	184,851	687	861	898	61,317	33.17%

Source: ANDA (2011:32).

3.4.5 Health

The Atwima Nwabiagya district has one (1) Hospital known as the Nkawie/Toase Government Hospital located in Nkawie the district capital. In addition, there were four (4) Health Centres, six (6) Private Maternity Homes and four (4) private clinics, which were located in Abuakwa, Akropong, Nkawie, Toase, Adankwame and Barekese as at 2011. The number of Medical Doctors in the district increased from 3 in 2005 to 5 in 2009 resulting in an increase in the Doctor/Population ratio from 1: 51,013 in 2005 to 1: 37,969 in 2009. The number of nurses in the district also increased from 51 in 2005 to 80 in 2009 which improved the nurse patient ratio from 1:3,001in 2005 to 1:2,373 in 2009 (ANDA, 2011:27).

Antenatal service coverage increased from 43.3% (3,102) in 2005 to 110% (8,736) in 2009 with average visit of 3 per client. Coverage for late teenagers increased from 12.3% (382) in 2005 to 24.8% (1,006) of the total antenatal registrants in 2009. Pregnant women registered with Anaemia reduced slightly from 22.7% in 2005 to 21.7% (1,722). The District in its efforts to make health care services accessible to majority of people, has established a District-Wide Mutual Health Insurance scheme. The scheme is fully operational. The total number of registered members has increased from 90,412 people (60% of the total population) in 2005 to 155,260 (81% of the total population) in 2009 (ANDA, 2011: 29).

In the Atwima Nwabiagya district, in 2006, diarrhoea ranked 3rd on the list of top ten outpatient mortality with 6070 cases. However in 2007, 3161 cases of diarrhoea were reported at outpatients departments of hospitals in the district. This placed diarrhoea at the 5th position on the list of top 10 diseases recorded in 2007. In 2008 however, there was an increase in diarrhoea cases with a total of 8, 695 cases being recorded whilst in 2009, 8626 cases were recorded. Thus in both 2008 and 2009, diarrhoea ranked third in the top ten outpatient morbidity for the Atwima Nwabiagya District (ANDA, 2011).

With respect to childhood diarrhoea cases, Table 3.4 shows a distribution of the recorded cases in the district.

Table 3.4 Total number of childhood diarrhoea cases recorded in the Atwima Nwabiagya District, 2010 – 2014.

Gender of child	**Full Year**				
	2010	**2011**	**2012**	**2013**	**2014**
Male	2077	2105	2181	1888	1607
Female	1733	2062	1835	1849	1374
Total	3810	4167	4016	3737	2981

Source: Atwima Nwabiagya District Health Directorate, 2015.

Male children under – five years of age were observed to have relatively higher cases that their female counterparts. Generally, childhood diarrhoea cases in the district rose from 2010 to 2012 and declined from 2013 to 2014. In 2014 the number of childhood diarrhoea cases represented a decrease of approximately 22% from the number recorded in 2010.

3.5 Economic Activities

The top three industries within which the employed population worked included wholesale and retail (25.1%), Agriculture, forestry and fishing (24.8%) and Manufacturing (11.2%). Approximately 22% of urban households and 42% of rural households were engaged in agriculture (GSS, 2014: 32). Economic activities in the district were reported to be largely informal with over 80% of the employed population working in the private informal sector and with respect to employment status, approximately 61% of the employed population were self-employed without employees (GSS, 2014:34). Whereas the predominant occupation was service and sales work (28.3%), less than 10% of the working population were managers or professionals (GSS, 2014:32). Small-scale manufacturing activities dominated the industrial sector. Examples of small scale industries included local soap making, tie and dye production, gari processing, carpentry, block making, sachet water production as well as oil palm and palm kernel oil extraction (ANDA, 2012).

3.6 Chapter Summary

This chapter discussed the socio-demographic characteristics of the Atwima Nwabiagya District which shares a boundary to the west of the Kumasi Metropolis. Its capital is Nkawie. The population of the district was 149, 025 with 68.5% of the total population residing in rural areas. The economically active population constituted 68.7% of the population aged 15 years or older. The highest proportion of females (34.9%) were engaged in wholesale and retail trade whereas their male counterparts were predominantly engaged in Agriculture forestry or fishing (27.7%) (GSS, 2014:33).

Results of the 2010 population and housing census indicated that across the district, the most frequent source of drinking water for households were boreholes (29.8%), with 23.1% obtaining drinking water outside their dwelling. Also, pipe-borne inside the dwelling and protected wells accounted for 16.5% and 16.1% respectively. Improved drinking water supply coverage was high with over 90% coverage for both urban and rural localities. With respect to sanitation, the most widely used facility by households was the public toilet (42.2%) (GSS, 2014:41).

In the next chapter, chapter 4, characterization of domestic water use behaviour is discussed.

CHAPTER FOUR

4.0 CHARACTERIZATION OF DOMESTIC WATER USE BEHAVIOUR

4.1. Introduction

In the previous chapter, chapter three, a background of the study area was presented indicating the relevant geo-physical and socio-economic information. This chapter presents a characterization of domestic water use behaviour and it is written as a comparative analysis of data gathered from the panel survey conducted in the wet and dry seasons. It is discussed under seven major themes; the household environment, housing characteristics, primary water sourced used by households, domestic water collection, levels of service of households, the cost of domestic water and domestic water storage.

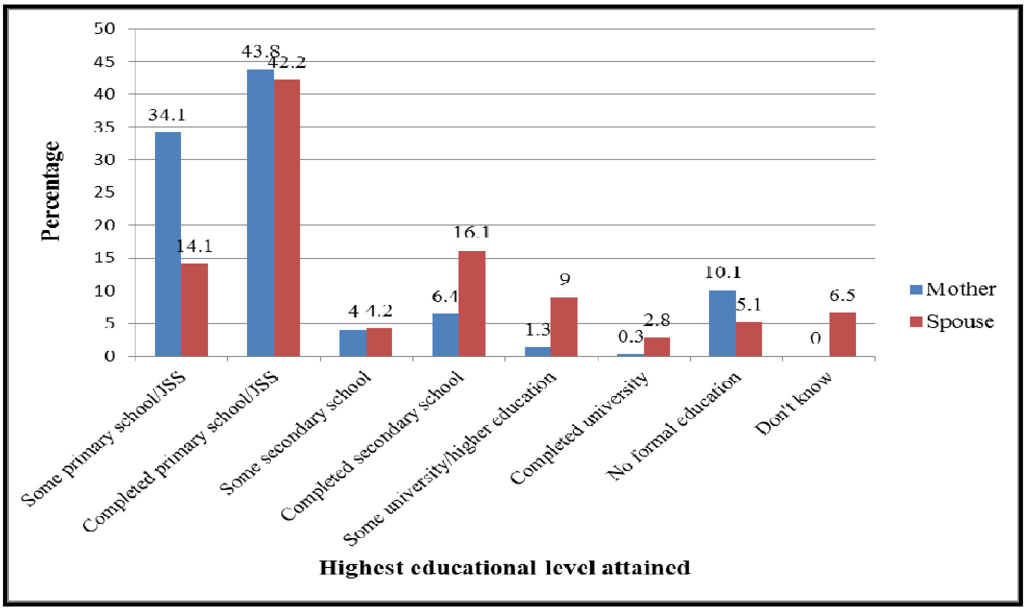
4.2. The Household Environment

According to the International Epidemiological Association (IEA) (2008:78), 'the environment is all that is external to the individual human host, can be divided into physical, biological, social, cultural, etc. any or all of which can influence the health status of populations'. Much attention has been given to the environment because not only does it provide the needs of man but it is significantly associated with the health of people living in it. The household most often lives within a home environment and it is that place within which environmental problems can have the most immediate impacts to health (Songsore et al., 2005). Within the context of this study, all households had at least one child under the age of five years living in it. For both wet and dry seasons, the dwelling floor, home roof and dwelling wall material were assessed. In addition, factors pertaining to housing and socio-demographic characteristics of the households were examined. A total of 378 mothers were interviewed using interviewer administered questionnaires in the wet and dry season. The survey results showed that the mean age for mothers was 31 years (±7 SD) whilst that of their spouses was 38 years (±9 SD). Majority 327 (87%) of mothers were married, and 20 (5%) were living with their partners/cohabitating. A total of 13(3.4%) respondents were single whilst widowed and divorced respondents each constituted (2.4%).

4.2.1. Education.

In terms of education, reports from the respondents suggested that their spouses were relatively more educated. The modal level of education attained by mothers was the ‘completion of basic education’ and this modal level was the same for their spouses (Fig. 4.1).

Fig. 4.1 Highest educational level attained by heads of the household.



Source: Authors field survey, 2012.

From Fig.4.1, though majority of mothers and their spouses had had basic education, this was not so for tertiary education. Only 0.3% of mothers and 2.8% of spouses had completed university education whereas a total of 6.5% of mothers could not tell the highest educational level their spouses had attained. The number of persons who had no formal education was also higher amongst mothers 38 (10.1%) than ‘spouses’ 18 (5.1%). A Chi-square test of independence showed that the relationship between the gender of the head of the household and educational level was statistically significant χ^2 (7, n=732) = 105.67, $p \leq 0.00$. This suggests that respondents and their spouses differed significantly in terms of educational attainment.

4.2.2 Occupation and estimated household wealth of respondents

The occupations of the respondents as well as that of their spouses were investigated. Whereas 151 (40%) respondents were predominantly engaged in trading and 120 (32%) in self-employment, spouses were predominantly engaged in self-employment 157 (43%) and commercial driving 81 (22%) (Table 4.1).

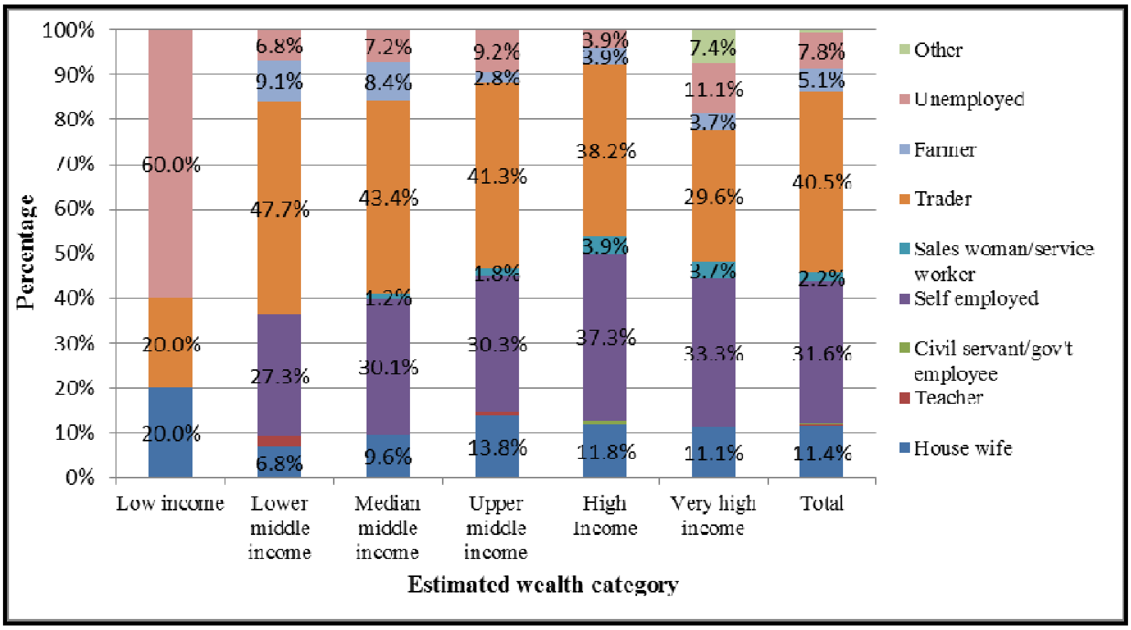
Table 4.1 Occupation of respondents and their spouses.

Occupation of mother	**(n)**	**%**	**Spouse (n)**	**%**
Self-employed	120	32	157	43
Commercial driver	0	0	81	22
Civil servant/Gov’t. employee	1	0	35	10
Farmer	20	5	32	8
Trader	150	40	29	8
Professional (Doc/lawyer/Banker, etc)	0	0	7	2
Teacher	2	1	6	2
Unemployed	31	8	4	2
Home maker	42	11	0	0
Others	12	3	15	3
Total	378	100	365	100

Source: Authors field survey, 2012 ; n-frequency.

A very small proportion of the respondents and their spouses were trained professionals such as Lawyers or Doctors (Table 4.1; Fig. 4.2). This result may probably stem from the fact that over 40% of respondents indicated that the highest level of educational they and their spouses has attained was the completion of basic education. In the study communities there was a widely held cultural belief that the responsibility for home making was for the female whereas the headship or upkeep in terms of provision of money for the maintenance of the household was for the male. This could have accounted in part for the reason why no respondent indicated that her spouse was the 'home maker'. The relationship between occupation and household wealth was also explored and it was observed that majority of households 236 (64%) fell within the 'Middle income category'. 'Lower middle income' households constituted 44 (11.9%), 'median middle income' households 83 (22.4%) whereas 'upper middle income' households constituted 109 (29.5%).

Fig. 4.2 Distribution of estimated household wealth by occupation of the respondent.



Source: Author's field survey, 2012

The proportion of households which were in the 'high income' and 'very high income' categories was relatively low constituting 102 (27.6%) and 27 (7.3%) respectively. The wealth category with the least percentage of households 5 (1.4%). was 'low income'. Expectedly, unemployment amongst mothers was observed in low income households than very high income. Three out of every five respondents who belonged to a low income household were unemployed. Though this study could not ascertain the incomes of respondents, the results suggest that employment seemed to have a role to play in the wealth category to which households belonged. It must however be noted that a mother's employment status alone may not be adequate in explaining the wealth category to which her household belongs. Other factors such as the occupation of her spouse/husband, as well as the relative contributions of other members of the household to household income and expenditure could have also accounted for inclusion or exclusion in a particular household wealth category.

4.3. Housing Characteristics

4.3.1 Household membeship and room occupancy

The mean household size in this study was 5 members (±1.7 SD). This figure was higher than the national average of 4.4 members and higher than that of the Ashanti Regional average of 4.1 in 2010 (GSS, 2012:22). Also, the modal number of household members was 5 with the minimum being 2 and the maximum being 11 members. In the study area, the concept of the household was not restricted to husband, wife and children only but rather inculded persons, related or non-related by blood, who were catered for as one unit.

Table 4.2 Distribution of number of rooms occupied by estimated household wealth

Number of rooms	Estimated household wealth						Total (%)
	Low income (%)	Lower middle income (%)	Median middle income (%)	Upper middle income (%)	High Income (%)	Very high income (%)	
1	5 (100.0)	43 (97.7)	63 (75.9)	97 (89.8)	80 (78.4)	21 (77.8)	309 (83.7)
2	0 (0.0)	1 (2.3)	17 (20.5)	6 (5.6)	21 (20.6)	4 (14.8)	49 (13.3)
3	0 (0.0)	0 (0.0)	3 (3.6)	5 (4.6)	1 (1.0)	1 (3.7)	10 (2.7)
5	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.7)	1 (0.3)
Total	5 (100)	44 (100)	83 (100)	108 (100)	102 (100)	27 (100)	369 (100)

Source: Author’s field survey, 2012.

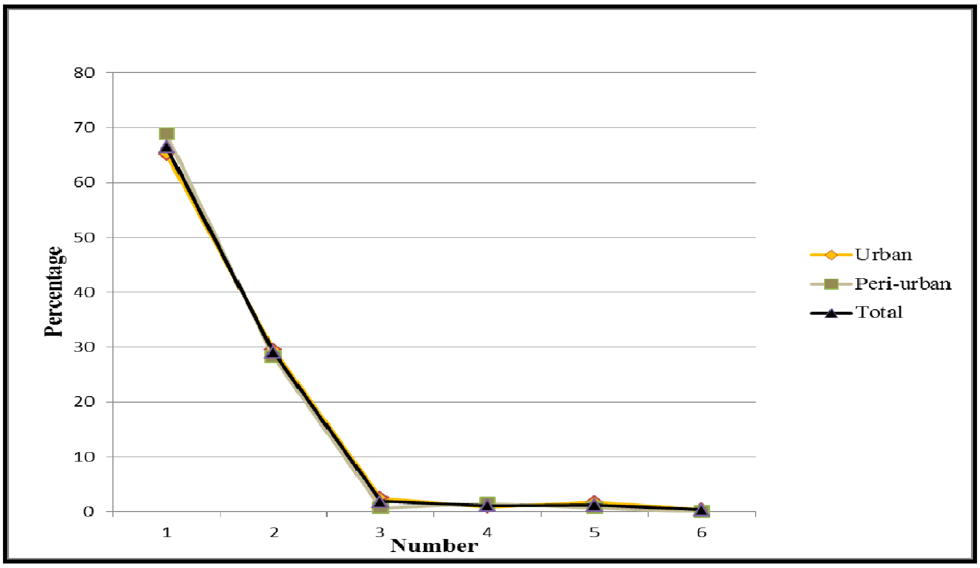
With respect to room occupancy, the distribution was skewed towards single room apartments. Approximately 84% of respondents lived in one room appartments, 14% lived in two rooms, 3% lived in 3 rooms whereas 0.3% lived in five rooms (Table 4.2). The study results suggested a significant relationship existed between the number of rooms occupied and estimated wealth χ^2 (15, n=369) = 36.59, p = 0.001. Compared to ‘Very high income’ households, a higher proportion of ‘Low income’ households lived in single room appartments. On the otherhand no Low income household was reported to have occupied between two to five rooms perhaps due to relatively higher monetary costs of renting and maintaining 2 to five bedroom appartments.

The analysis also revealed that household size did not have a statistically significant relationship with the number of rooms χ^2 (6, n=375) = 10.52, p = 0.10. However 81% of housheolds with 5 or more members lived in single room appartments and could have resulted possibly in croweded conditions in the dwelling.

4.3.2 Number of children in the household

The number of children in the household is very significant in an attempt to assess health risks that children in the household may be exposed to. There was only one under-five year old child in 250 (66.5%) households (n = 376) whilst 109 (29%) households had two children and 17 (4.5%) households had three or more in the study population.

Fig.4.3 Percentage of under-five year old children in households per residential location.



Source: Author's field survey, 2012.

From Fig 4.3, the number of under-five year old children in households showed a similar trend in urban and peri-urban households. There were more households with at most two children under-five years than there was with households that had three or more. For the urban study population (n=239), there was one under-five year old in 155 (64.8%) households, two under-five year olds in 71 (29.7%) households and three under-five year old children in 13 (5.5%) households. In peri-urban households (n =137) however, there was one under-five year old in 95 (69.3%) households, two under-five year olds in 38 (27.7%) households and three under-five year old children in 4 (3%) households. There was no difference in the distribution of the number of under five year olds between urban and peri-urban households χ^2 (5, n=376) = 3.51, p = 0.62.

Table 4.3 Distribution of the number of under-five year old children by estimated household wealth.

Number of under 5 year old children	**Estimated household wealth**						**Total (%)**
	Low income (%)	**Lower middle income (%)**	**Median middle income (%)**	**Upper middle income (%)**	**High Income (%)**	**Very high income (%)**	
1	4 (80)	33 (75)	51 (61.4)	67 (62)	72 (71.3)	19 (70.4)	246 (66.8)
2	1 (20)	10 (22.7)	28 (33.7)	36 (33.3)	28 (27.7)	6 (22.2)	109 (29.6)
3	0 (0)	0 (0)	3 (3.6)	1 (0.9)	1 (1)	2 (7.4)	7 (1.9)
4 and above	0 (0)	1 (2.3)	1 (1.2)	4 (3.7)	0 (0)	0 (0)	6 (1.6)
Total	5 (100)	44 (100)	83 (100)	108 (100)	101 (100)	27 (100)	368 (100)

Source: Author’s field survey, 2012.

With respect to estimated houshold wealth, it was found that compared to high income households, a higher proportion of households belonging to lower middle income and low income categories had one child under-five years of age. Households in the middle income categories or better were more likely to have three or four children under-five years (Table 4.3). The relationship between estimated wealth and the number of under-five year old children was not found to be statistically significant χ^2 (15, n=368) = 16.82, p = 0.33. Nevertheless, the study results suggests that the number of under-five year old children had a positive relationship with estimated household wealth.

4.3.3 Dwelling materials

The dwellings of respondents were predominantly built with permanent materials such as cement and concete. From table 4.5, the dwelling roofs were predominantly made of metal roofing sheets 365 (97%) whilst few roofs 7 (1.9%) were made of concrete, 4 (1.1%) thatch, and 2 (0.5%) mud. A total of 329 (96.2%) household dwelling walls were predominantly made of cement whilst the floors of 183 (53.2%) household dwellings were cement screed and 161 (46.8%) earth (Table 4.4)

Table 4.4 Materials used in the structure of the dwelling.

Walls		**Roof**		**Floor**	
Material	**Total (%)**	**Material**	**Total (%)**	**Material**	**Total (%)**
Cement	329 (96.2)	Metal	365 (96.6)	Cement screed	183 (53.2)
Burnt brick	6 (1.8)	Concrete/tar	7 (1.9)		
Concrete	3 (0.9)	Thatch	4 (1.1)	Earth	161 (46.8)
Pole & mud	2 (0.6)	Mud	2 (0.5)		
Iron sheet	2 (0.6)	Total	378 (100)	Total	344 (100)
Total	342 (100)				

Source: Author's field survey, 2012.

Electricity coverage was very high in a total of 227 (93.4%) urban households and 130 (96.3%) peri-urban households. A total of 357 (94.4%) households had access to electricity whreas 21 (5.6%) did not. The nature of materials used in constructing the roofing and walls of dwelling structures seemed to conform to that on the national scale. This is because the 2010 population and housing census reported that about 70%

of 0-9 year olds lived in houses with metal sheet roofing. Also 74% and 21% of children between the ages of 0 – 9 were reported to have lived in houses with cemented floor and earth floors respectively (GSS, 2013a:28). In terms of the housing structure, a variation with this study was seen. Whereas majority (96%) of index children in this study lived in houses built with cement, the findings of the 2010 populaiton and housing census suggeted that in Ghana, almost the same proportion of children between 0 – 9 years lived in houses built with cement material (47%) and mud (46%) (GSS, 2013a:26).

4.4 Primary Water Sources used by the Household

4.4.1 Improved and unimproved water sources

A water source is expected to provide adequate, reliable, safe water for drinking and other domestic purposes. When a household does not have a water source from which safe water can be drawn in adequate quantities, it is most likely that the household will find it difficult to maintain good hygiene. By virtue of their design, some water sources are able to adequately prevent faecal matter from contaminating the source and these are known as 'improved sources'. The JMP defines an 'improved drinking water source' as 'one that by the nature of its construction adequately protects the source from outside contamination in particular with faecal matter' (WHO/UNICEF, 2010:34). The JMP further explain that bottled water is only considered to be improved when water for cooking and personal hygiene are drawn from an improved source and if that information was not available, bottled water was classified on a case-by-case basis

Table 4.5 Improved and unimproved sources of water.

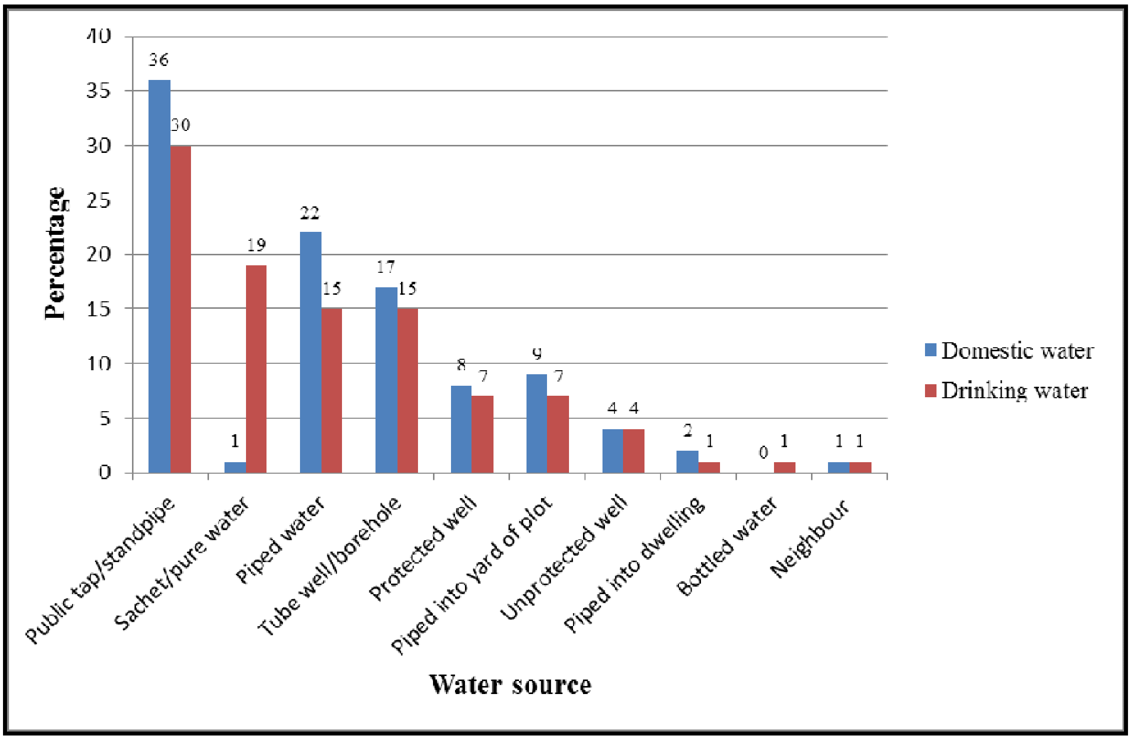
Improved sources	**Unimproved sources**
Piped water into dwelling, yard or plot	Unprotected dug well
Public tap or stand pipe	Unprotected spring
Tube well or bore hole	Cart with small tank or drum
Protected dug wells	Tanker truck
Protected spring	Surface water (river, dam, lake, pond, stream, canal, irrigation channel)
Rain water collection	Bottled water
-	Sachet

Source: WHO/UNICEF, (2010:34)

Relying on the definitions provided by the JMP, this study classified the primary domestic and drinking water used by households in the year as improved or unimproved (Table 4.5; WHO/UNICEF, 2010). In this study, improved water sources included water sources located inside the user's dwelling, plot or yard, public taps or stand pipes, tube wells or boreholes, protected dug wells, protected springs and rainwater collection (WHO/UNICEF, 2013). On the other hand, unimproved water sources included unprotected dug well, unprotected spring, cart with small tank/drum, tanker truck, bottled water, sachet water and surface water (river, dam, lake , pond, stream, canal, irrigation channels) (WHO/UNICEF, 2013).

Fig 4.4 shows the distribution of improved and unimproved domestic and drinking water source users respectively. A total of 355 (94%) households reported the use of improved sources of domestic water whilst 285 (76%) households reported the use of improved sources for drinking water respectively.

Fig.4.4 Proportion of water sources used by households for domestic and drinking purposes.



Source: Author's field survey, 2012.

From Fig 4.4, it was observed that the most used water source for domestic activities by the study households was the public tap/stand pipe which constituted 135 (36%) of all domestic water sources. The trend of use of drinking water sources was similar to that of domestic water use (Fig.4.4). Fig 4.4 shows that the primary means of domestic water was the public tap/ stand pipe which constituted 111 (29.6%), approximately 30% of all domestic drinking water sources. A Chi-square test of independence showed that water sources were distributed differently across the purpose for which they were used, χ^2 (9, n=753) = 74.68, p ≤ 0.00. In other words, a statistically significant relationship was found. Water source was not independent of purpose.

Table 4.6 Distribution of estimated household wealth by drinking water source type.

Household drinking water source type	Estimated household wealth						Total (%)
	Low income (%)	Lower middle income (%)	Middle income (%)	Upper middle income (%)	High Income (%)	Very high income (%)	
Improved	5 (100)	40 (90.9)	65 (78.3)	82 (77.4)	70 (68.6)	18 (66.7)	280 (76.3)
Unimproved	0 (0)	4 (9.1)	18 (21.7)	24 (22.6)	32 (31.4)	9 (33.3)	87 (23.7)
Total	5 (100)	44 (100)	83 (100)	106 (100)	102 (100)	27 (100)	367 (100)

Source: Author's field survey, 2012.

The results in Table 4.6 suggests that there was a statistically significant relationship between the drinking water source type and estimated wealth χ^2 (5, n=367) = 11.70, p = 0.039. Over 60% of all wealth categories used improved drinking water sources. It was however surprising to observe that no household belonging to the low income category used unimproved sources. Rather 'Very high income households' were more associated with unimproved water sources than 'Low income' ones.

Also surprising was the fact that the proportion of unimproved drinking water source users increased with estimated wealth of the household. A possible reason that could have accounted for the trend was the use of sachet water as primary means of drinking water. Approximately 27% and 30% of high income and very high income households used it as the primary drinking water source. At the time of conducting the study, sachet water was popularly called 'pure water'. It consisted of water packaged in 500ml transparent rubber sachets. One sachet water cost GhC 0.10/$ 0.05.

Table 4.7 Distribution of household size by drinking water source type.

Household drinking water source type	**Household size is 5 and above**		**Total (%)**
	Yes (%)	**No (%)**	
Improved	148 (80.4)	135 (71.4)	283 (75.9)
Unimproved	36 (19.6)	54 (28.6)	90 (24.1)
Total	184 (100)	189 (100)	373 (100)

Source: Author's field survey, 2012.

An assessment of the relationship between household size and drinking water source type revealed that there was a statistically significant relationship χ^2 (1, n=373) = 4.13, p = 0.05 (Table 4.7). Households with 5 or more members were more likely to use improved water sources than households which had less than 5 members. The results from the study also suggests that approximately 24% of households with at least one child under-five relied on unimproved drinking water sources. The reliance, by households, on unimproved sources for drinking water presents a worrying picture. This is because though Ghana has been reported to have achieved the MDG target 7.C of halving the proportion of the population without access to 'safe drinking water', results from this study showed that some households were relying on unimproved sources which were considered unsafe by the JMP (UNDP, 2015).

4.4.2 Uses to which primary water sources were put in the domestic environment

The water drawn from the primary water sources were used for varied purposes such as bathing, cooking, drinking, cleaning the house, laundry and gardening as shown in Table 4.8.

Table 4.8 Most frequent use of water by water source type.

Source		Most frequent use of water from primary source (%)					Total (%)
		Bathing	Cooking	Drinking	Cleaning	Other	
Improved	Piped water	24 (25.0)	26 (17.3)	16 (16.7)	1 (12.5)	0 (0)	67 (19.1)
	Piped into dwelling	2 (2.1)	1 (0.7)	1 (1.0)	0 (0)	0 (0)	4 (1.1)
	Piped into yard or plot	7 (7.3)	18 (12.0)	8 (8.3)	0 (0)	0 (0)	33 (9.4)
	Public tap/stand pipe	39 (40.6)	56 (37.3)	35 (36.5)	2 (25)	1 (100)	133 (37.9)
	Tube well/borehole	11 (11.5)	35 (23.3)	18 (18.8)	0 (0)	0 (0)	64 (18.2)
	Protected well	11 (11.5)	5 (3.3)	12 (12.5)	3 (37.5)	0 (0)	31 (8.8)
Unimproved	Unprotected well	2 (2.1)	7 (4.7)	6 (6.2)	1 (12.5)	0 (0)	16 (4.6)
	Sachet/ pure water	0 (0)	2 (1.3)	0 (0)	1 (12.5)	0 (0)	3 (0.9)
Total		96 (100)	150 (100)	96 (100)	8 (100)	1 (100)	351 (100)

Source: Author's field survey, 2012.

From Table 4.8, the public tap/standpipe was the predominant source of water for domestic purposes. Majority, 133 (37.9%) of households used it as the primary source of water for all domestic purposes. The sachet water was least used for domestic purposes as only 3 (0.9%) households used it as their primary source of water for domestic purposes. With respect to the use of public taps/stand pipes, a total of 39 households (40.6%) indicated that total water collected for bathing purposes was drawn from the public tap/stand pipe. Also, total water collected for cooking purposes was drawn from the public tap/stand pipe by 56 (37.3%) households whilst total water collected for drinking purposes was drawn from public taps/stand pipe by 35 (36.5%) households. Two (25%) households indicated the public tap/stand pipe as their primary source of water out of the total sources of water meant for cleaning purposes whilst 1(100%) indicated that the public tap/stand pipe was their primary source of water for other domestic purposes in the household. Thus, for the 133 (100%) households who indicted the use of the public tap/stand pipe as their primary water source for all domestic purposes, 56 (42.1%) used it for cooking, 39 (29.3%) for bathing, 35 (26.3) for drinking, 2 (1.5%) for cleaning the home and 1 (0.8%) for other domestic purposes.

Ninety-six (100%) households indicated that varied water sources were primarily used for bathing purposes (Table 4.8). Thirty-nine (40.6%) households indicated that water meant for bathing purposes was drawn from the public tap/stand pipe, from piped water by 24 (25.0%) households, from tubewell/borehole by 11 (11.5%) households, from protected wells by 11 (11.5%) households, piped into yard/plot for 7 (7.3%) households, from water piped into dwelling by 2 (2.1)% of households and from unprotected wells by 2 (2.1%) of households. Water for cooking purposes was also drawn from varied sources as shown in Table 4.7 and a total of 150 (100%) households indicated varied sources of water as primarily used for cooking purposes. Water for cooking was primary drawn from the public tap/stand pipe by 56 (37.3%) of households, from tubewell/borehole by 35 (23.3%) households, from piped water by 26 (17.3%) households, from unprotected well by 7(4.7%) households, from water piped into yard or plot by 18 (12%) households, sachet water by 2(1.3%) and from water piped into dwelling by 1 (0.7%) households respectively. An observation of public health concern made from the data was that 6 (6.2%) of all domestic water meant for drinking water purposes were derived from unprotected wells which were unimproved sources.

Table 4.9 Reported primary reasons for the choice of primary domestic water sources.

Community	**Primary reasons**					
	1st	**%**	**2nd**	**%**	**3rd**	**%**
Abuakwa	Distance	41.3	Availability	18.6	Best quality	16.8
Nkawie	Distance	26.8	Best quality	21.4	Cost	17.9
Asuofua	Distance	67.2	Best quality	14.8	Availability	3.9
Barekese	Distance	41.7	Best quality	30.6	Availability	13.9
All households	Distance	43.5	Best quality	19.9	Availability	13.8

Source: Author's field survey, 2012.; % – Percentage of households

A cross-tabulation of the reasons given by respondents indicated that of the total of 133(100%) respondents who gave reasons for the use of public tap/stand pipe as domestic sources, distance emerged the primary reason which accounted for 65 (48.9%). Quality accounted for 25 (18.8%), 24 (18.0%) availability, 6 (4.5%) reliability and 7 (5.3%) the only source. Cost and other undisclosed reasons accounted for 5 (3.8%) and 1 (0.8%) respectively. However across the entire study population (n= 356), the top three factors that were reported by the respondents to primarily influence their household's choice for a water source were distance 155 (43.5%), quality 71 (19.9%) and availability 49 (13.8%) as shown in Table 4.9. Likewise, the most frequent reason accounting for the use of both improved 148 (44.2%) and 7 (33.3%) unimproved domestic water sources respectively was distance (Table 4.10).

Table 4.10 Reasons accounting for the use of improved and unimproved domestic water sources.

Reason	Domestic water sources (%)		Total (%)
	Improved (%)	Unimproved (%)	
Distance	148 (44.2)	7 (33.3)	155 (43.5)
Best Quality	67 (20.0)	4 (19)	71 (19.9)
Available	46 (13.7)	3 (14.3)	49 (13.8)
Cost	21 (6.3)	4 (19)	25 (7.0)
Reliability	21 (6.3)	2 (9.5)	23 (6.5)
Only source	15 (4.5)	1 (4.8)	16 (4.5)
Only tap	15 (4.5)	0 (0)	15 (4.2)
Others	2 (0.6)	0 (0)	2 (0.6)
Total	335 (100)	21 (100)	356 (100)

Source: Author's field survey, 2012.

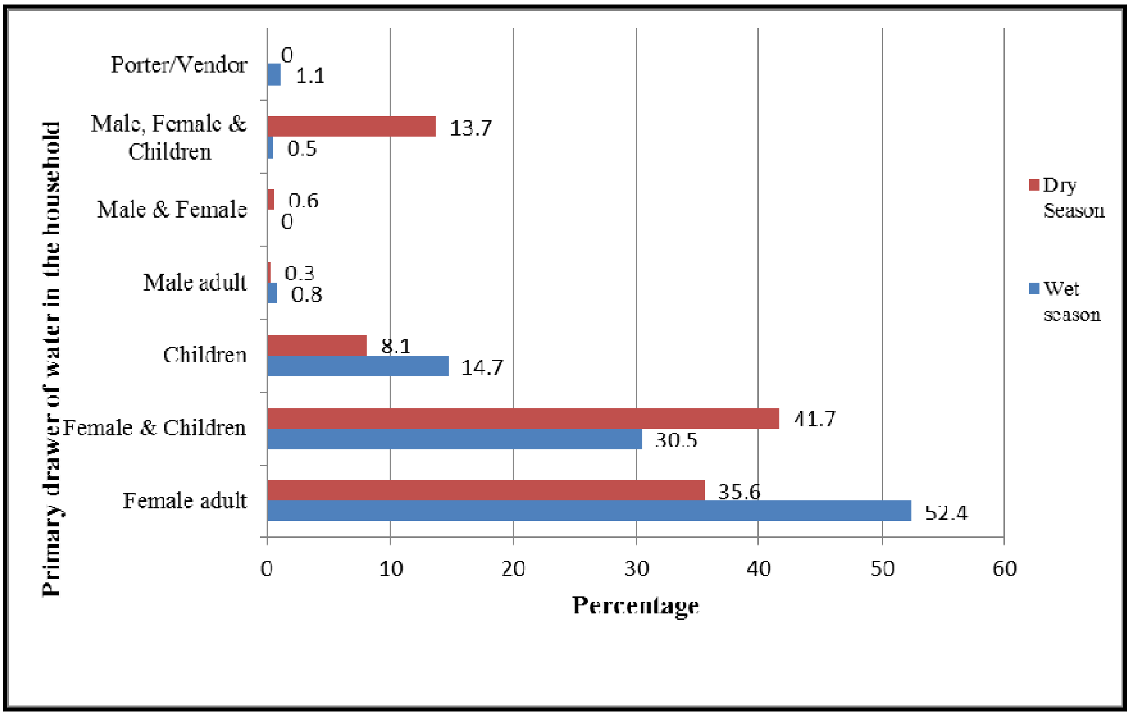
In order of decreasing frequency, the reasons that accounted for the use of improved domestic water sources included distance 148 (44.2%), best quality 67 (20%), availability 46 (13.7%), cost 21 (6.3%), reliability (6.3%), the only source 15 (4.5%), and others 2 (6%). On the other hand, for unimproved sources reasons that accounted for their use in decreasing order included distance 7 (33.3%), best quality 4 (19%), cost 4 (19%), availability 3 (14.3%) , reliability 2 (9.5%) and only source 1 (4.8%). A chi-square test of independence suggested that there was a statistically significant relationship between type of domestic water source and reasons for use. Improved and unimproved domestic water source users were distributed differently with respect to the reason for use, χ^2 (7, n=356) = 142.59, p ≤ 0.00.

4.5. Domestic Water Collection

4.5.1 Primary drawer of water to the household.

Women played a major role as drawers of water for the household. A total of 196 (52.4%) and 127 (35.6%) households indicated that the female adult was primarily responsible for water collection for the household in the wet and dry seasons respectively. Other water drawers for the household in the wet season included 'Female and children 114 (30.5%), 'children' 55 (14.7%) and porters 4 (1.1%). Male adults were least involved in water collection for the household and constituted only 3 (0.8%) of primary drawers whereas 'Males, Females and children' also constituted 0.5% (Fig. 4.5).

Fig. 4.5 Distribution of the primary drawer of water by season.



Source: Author's field survey, 2012 and 2013

On the other hand, in the dry season, the primary water drawer was different. Whereas most of the primary water drawers were female adults 196 (52.4%) in the wet season, most frequent water drawers were 'Female and children' 149 (41.7%) in the dry season (Fig.4.5). In the dry season, Male, female and children accounted for 49 (13.7%), children 29 (8.1%), male and female 2 (0.6%), and male adult 1 (0.3%). A chi square showed that χ^2 (6, n=731) = 81.09, $p \leq 0.00$ and it suggests that the primary drawers of water for the household in the wet season were distributed differently from the primary drawers in the dry season and the difference was statistically significant. In other words, there was a statistically significant relationship between the primary drawer of water and the season. More female adults were the primary drawers of water for their households in the wet season than in the dry season, 52.4% and 35.6% respectively.

A respondent's completion of SHS and the primary drawer for the household was cross tabulated to investigate whether the relationship was statistically significant in both wet and dry seasons (Table 4.11a; Table 4.11b). Chi square analysis showed that the relationship was not statistically significant in the wet χ^2 (5, n=373) = 4.79, p = 0.44 and dry seasons χ^2 (5, n=356) = 2.08, p = 0.84. However it is worth noting that over 80% of all drawers of water, lived in households where the mother had not completed SHS (Table 4.11a). By the completion of SHS in Ghana, an individual would have gained a minimum of six years of basic primary education and six years of high school education. The results also suggested that in households where the mother had completed SHS, the primary drawer was more likely to be the 'Female adult' in her household.

Table 4.11a Distribution of the primary drawer of water in the wet and dry seasons by mothers' educational status.

Mother completed SHS	**Primary drawer - Wet season**			**Primary drawer - Dry season**		
	Female adult	**Others**	**Total**	**Female adult**	**Others**	**Total**
Yes	15 (7.7)	23 (13)	38 (10.2)	13 (10.2)	23 (10)	36 (10.1)
No	181 (92.3)	154 (87)	335 (89.8)	114 (89.8)	206 (90)	320 (89.9)
Total	196 (100)	177 (100)	373 (100)	127 (100)	229 (100)	356 (100)

Source: Author's field survey, 2012 and 2013

Though the burden of water collection seemed to be disproportionately placed on the female adult, it is worth noting that in few cases, children and men were reported to engage in water collection.

Table 4.11b Distribution of the primary drawer of water by the age of the mother

Mother's age was 35 years and below	**Primary drawer - Wet season**			**Primary drawer - Dry season**		
	Female adult	**Others**	**Total**	**Female adult**	**Others**	**Total**
Yes	171 (87.7)	119 (67.2)	290 (78.0)	107 (84.3)	171 (74.7)	278 (78.1)
No	24 (12.3)	58 (32.8)	82 (22.0)	20 (15.7)	58 (25.3)	78 (21.9)
Total	195 (100)	177 (100)	372 (100)	127 (100)	229 (100)	356 (100)

Source: Author's field survey, 2012 and 2013

Further exploration of the primary drawer of water for the household revealed that in both wet (χ^2 (1, n=372) = 22.60, p = 0.001) and dry seasons (χ^2 (1, n=356) = 4.38, p = 0.036, there was a statistically signifcant relationship between the age of the mother and the primary drawer for the household (Table 4.11b).

Over 80% of the mothers who were aged 35 years or younger lived in households where the primary drawer of water were female adults. Approximately 22% of households had mothers who were aged above 35 years. Across both seasons, the proportion of 'other' water drawers increased in households where the mother was older than 35 years. The findings suggests that as a mother's age increased beyound 35 years, her household was more likely to have other members such as children also engaging in water collection.

Table 4.12 Distribution of the primary drawer of water by the marital status of the mother.

Mother's marital status	**Primary drawer - Wet season**			**Primary drawer for dry season**		
	Female adult	**Others**	**Total**	**Female adult**	**Others**	**Total**
Mother was married	169 (86.2)	155 (87.1)	324 (86.6)	116 (91.3)	194 (84.3)	310 (86.8)
Mother was not married	27 (13.8)	23 (12.9)	50 (13.4)	11 (8.7)	36 (15.7)	47 (13.2)
Total	196 (100)	178 (100)	374 (100)	127 (100)	230 (100)	357 (100)

Source: Author's field survey, 2012 and 2013

With respect to marital status, it emerged that the relationship between the mothers' marital status and the primary drawer for the wet and dry seasons were not statistically significant. Nevertheless, in over 80% of households where the female adult was the primary drawer, the mothers living in those households reported they were married (Table 4.12). This finding may be due to the high proportion of married respondents and the disproportionate burden that is place on the female members of the household for water collection. Findings from the Focus Group Discussions suggested that socio- cultural factors could have partly accounted for the gender of the primary drawer. Culturally, there was widely held view in the study communities that water collection was primarily the duty of women. With respect to age groupings, socio-culturally, adolescents rather than adults were expected to engage in water collection if they lived in households with adults.

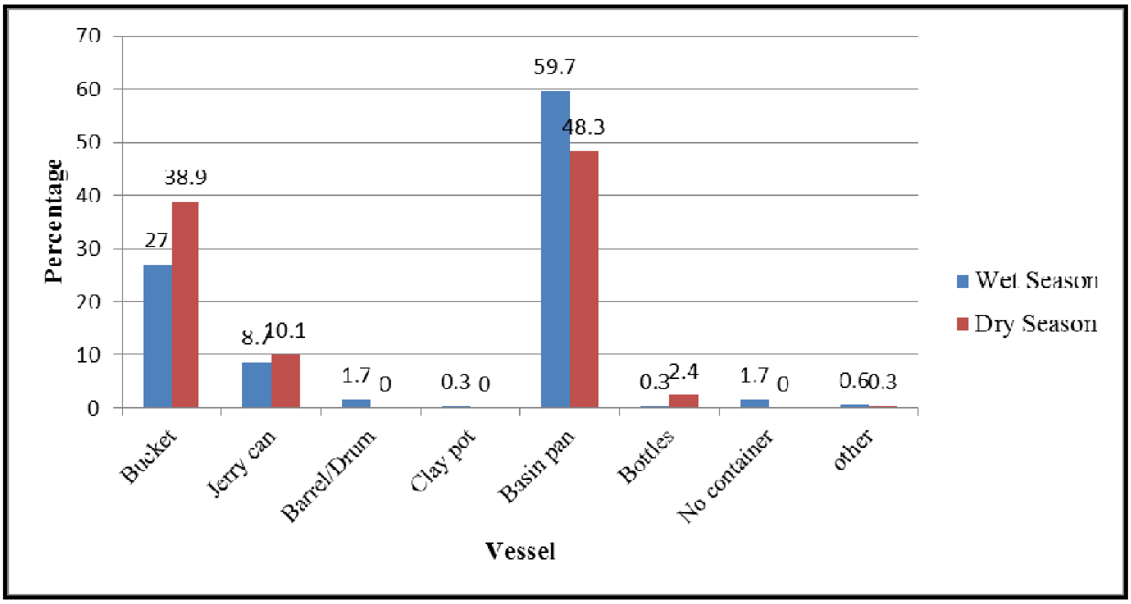
Transportation of water to the home was labour intensive as it was regularly done by carrying the filled water vessel on the head and sending it to the home by walking. This mode of transportation was practised by 365 (95%) of households whereas the use of bicycle was minimal as it constituted 2 (0.5%) of households. Other means of transportation such as animal drawn cart, hand drawn carts and water tankers were not used by the study population. Water tankers were deemed to be expensive because water containers were filled, disposing off the excess water was a problem for the household that requested the tanker services.

Water collection vessels were essential as they served as the media through which water was collected to the home. These included basin pans, buckets, gallons, barrel/drums and jerry cans (See Appendix III). Though households used vessels of varied shapes and sizes to draw water to the household, the vessel which was frequently used was the basin pan for both wet and dry season (Fig. 4.6). In the wet season, a total of 212 (59.7%) of households used basins as their primary water collection vessel, 96 (27%) of households used buckets, 31 (8.7%) used gallons whilst 10 (4.5%) used other means such as clay pots and jerrycans.

On the otherhand, in the dry season, the picture was different. A total of 181 (48.3%) used basin pans, 146 (38.9%) used buckets, 38 (10.1%) gallons, 9 (2.4%) bottles and 1 (0.3) other vessel such as clay pots (Fig. 4.6). With respect to the use of basins in communities in the dry season, by decreasing percentage order, basins were mostly used by 34 (54%) of households in Asuofua, 90 (51.4%) Abuakwa, 32 (45.1%)

Barekese and 25 (37.9%) households resident in Nkawie. On the other hand, in the wet season, by decreasing percentage order, 48 (68.6%) of households in Barekese used basins, 103 (66%) Abuakwa,

Fig. 4.6 Water collection vessels used in seasons.



Source: Author's field survey, 2012 and 2013

40 (62.5%) Nkawie and 21 (32.3%) Asuofua. A chi-square test confirmed that in the wet and dry seasons, households were distributed differently across the primary water collection vessels used for water collection for the household χ^2 (7, n=730) = 32.7, $p \leq 0.00$. This result suggests that there was a statistically significant relationship between the primary water collection vessel and the season. Though basins were used widely across all communities and seasons, its use was predominant in the Barekese community 48 (68.6%) in the wet season and Asuofua 34 (54%) in the dry season. A reason that participants in a focus group discussion in Abuakwa, Nkawie and Asuofua gave for the use of basins was that a basin was preferred in order to allow for the fetching of a comparatively larger volume of water, to reduce the frequency of water collection, to save time and to releive the burden of water collection for the mother.

A total of 206 (62.9%) and 153 (42.2%) of the total number of households in the wet and dry seasons respectively indicated that their primary water collection vessels had a capacity of 40 liters or more (Table 4.13). For households (1%), which reported the use of barrels and claypots in the dry season, none was able to indicate the corresponding volume of the vessel.

Furthermore in the dry season, the least range of volume for water collection vessels was 20l – 29l and no household indicated that its water collection vessels had a capacity below 20 liters. A comparison of water collection vessels revealed that basin pans with capacities of 40L or more were mostly used. This finding suggests that the basin pan played a predominant role in domestic water collection. (Table 4.13).

Table 4.13 Seasonal distribution of primary water collection vessels which were 40 L or more.

Primary water collection vessel, ≥ 40 L	**Wet season (%)**	**Dry season (%)**
Basin Pan	176 (86%)	134 (88%)
Bucket	21 (10%)	2 (1%)
Gallon	9 (4%)	16 (10%)
Other containers	0 (0%)	1 (1%)
Total	206 (100)	153 (100)

Source: Author's field survey, 2012 and 2013

In a Focus Group Discussion in Nkawie, a mother indicated that:

> *'The distance from my home to the water point is far and therefore I use the bigger basin to fill my water barrel faster.'*

A chi-square analysis showed that the volume of the primary water collection vessel was distributed differently across the two seasons, χ^2 (4, n=689) = 92.53, p ≤ 0.00. In other words, there was a statistically significant relationship between the volume of the primary water collection vessel and the season (Table 4.13).

4.5.2 Number of water collection trips per day

An assessment of the number of water collection trip per day was made due to its relationship with the volumes of water used per day. An estimation of the volume of water collected per day can be done by multiplying the volume of the vessel by the number of water collection trips it is used. The data analysis revealed that 104 (30%) of the study households embarked on water collection on 5 or more trips per day, 89 (26%) 3 trips, 72 (21%) 1 trip, 66 (19%) 2 trips and 12 (3.5%) 4 trips in the wet season. Furthermore, more than half of hosueholds 59 (56.7%) which collected water on 5 or more trips per day, used the basin pan as the prefered method of collecting water to the home.

On the other hand, in the dry season, 220 (60%) households collected water on 5 or more trips per day. Also, 71 (19.6%), 42 (11.6%) and 18 (5%) collected water on 1, 2 and 4 trips per day respectively. Few households 12 (3.3%) collected water on 3 trips per day. Thus, the data suggests that in both the wet and dry seasons, most households prefererd to collect water on 5 or more trips per day. This may be partly due to the number of members of the household who needed water for domestic purposes such as bathing and laundry. The results are comparable to other studies in East Africa in which average number of trips per day for water collection was a approximately 4 times a day (Thompson et al., 2001: 60).

In the wet and dry seasons, households were distributed differently across the number of trips per day for water collection and a chi square test of independence showed that χ^2 (4, n=706) = 106.29, $p \leq 0.00$. Thus the differences between the wet and dry seasons were statistically significant and is also indicative of a statistically significant relationship between the season and number of trips per day for water collection. There were more households which used a basin to go for four water collection trips a day in the dry season than in the wet season, 88.9% and 66.7% respectively.

Table 4.14 also shows the distribution of the number of water collection days in the week by the vessel used for water collection in the wet and dry seasons. In the wet season, 195 (55.5%) households collected water five days or more in the week whilst 77 (22%), 37 (10.5), 29 (8.2%) and 13 (3.7%) collected water three days, one day, two days and four days in the week respectively.

In the dry season however, the nature of water collection in the week manifested differenty. Whereas more than half of hosueholds 195 (55.5%) collected water five days or more in the week in the dry season, majority 323 (89%) colleccted water five days per week in the wet season.

Table 4.14 Primary vessel used for water collection five days or more a week.

Primary vessel used for water collection five days or more a week	**Wet season (%)**	**Dry season (%)**
Basin Pan	129 (66%)	148 (46%)
Bucket	43 (22%)	136 (42%)
Gallon	129 (12%)	37 (12%)
Total	195 (100)	323 (100)

Source: Author’s field survey, 2012 and 2013

In Table 4.14, similar characteristics were portrayed with respect to the water vessesls used for daily water collection. The basin pan emerged as the most frequently used vessel for water collection 5 days or more in the week.

Households were distributed differently in the wet and dry seasons across the number of days of water collection per week. χ^2 (4, n=714) = 123.91, p $\leq$ 0.00. In other words, there was a statistically significant relationship between the season and number of water collection days.

With respect to the weight of the vessels, volumetric analysis showed that 1 liter of water was equivalent to 1 kilogramme. This meant that 40 liters of water was equivalent to 40kg. Field observations showed that some public stand pipes were fitted with two outlets for water collection (Fig. 4.7). One was taller and the other short. The taller one was used by water drawers who wanted to fetch water whilst standing underneath with the water collection vessel on their heads. With this method, the water drawer avoided the difficulty associated with lifting, for example, a fully filled 40kg water vessel from the ground unaided (Fig 4.7). In Fig 4.7, a woman is using the shorter water outlet to fetch water into a gallon and the shorter outlets were prefered when the vessel was convenient to be carried unaided.

Fig 4.7 An example of a water supply point.

Source: Author's field survey, 2012

Focus group discussions revealed that at some water sources such as protected dug wells, some households used containers on site or borrowed containers from friends or neighbours and used them to draw water from the primary water source in cases where the vessel used to collect water to the home was not able to reach the water. This raises concern about the risk of contamination since one may not be privy to where the water withdrawal container was placed or how microbiogically safe that vessel may have been.

The water collection times for the wet and dry season were assessed and results from the field survey showed that there were differences in the water collection times between the wet season and dry season and between urban and peri-urban residents. Within the household, water collection took place at varied times in the day. However trips for water collection in the wet season were mostly done in the mornings by approximately 40% of households. Focus group discussions revealed that 'nursing mothers' preferred the mornings in order to make enough time for other domestic activities such as washing and cooking during the day. Discussants also asserted that the demand for water for domestic activities such as bathing, cleaning and cooking was higher in the mornings than at any other period during the day. The time period within which water collection was least done was in the afternoons. Only 12 (2.2%) of respondents indicated that the 'afternoon only' was the period of day they collected water the most. However, for 87 (23.2%) of households, they could not single out one most important period. For them water collection was done in the 'morning, afternoon and evening' For both urban and peri-urban households, the dominant period for water collection was 'morning only' however the least period by which water was collected for the household differed between urban and peri-urban residents. The least period for urban residents was 'morning and afternoon' 5 (2.1%) whereas that for peri-urban households was 'Afternoon only' 2 (1.5%)

Within the dry season, water collection times also differed. The most dominant water collection time was 'Morning, Afternoon and evening' for 190 (50.5%) of households as opposed to 'mornings only' 148 (39.5%) for the wet season. Thus in decreasing percentage order, in the dry season, households collected water 'morning, afternoon and evening'190 (50.5%), 'mornings only' 82 (21.8%), 'afternoon and evening' 74 (19.7%), 'morning and afternoon' 9 (2.4%) with the least utilized period for collection in the dry season being 'afternoon only' 1 (0.3%). There was a statistically significant difference in the distribution of households in the wet and dry seasons across the period of day for water collection, χ^2 (7, n=751) = 149.14, p $\leq$ 0.00. This therefore suggests that the relationship between the season and period for water collection was significant. The period of day for water collection was dependent on the season

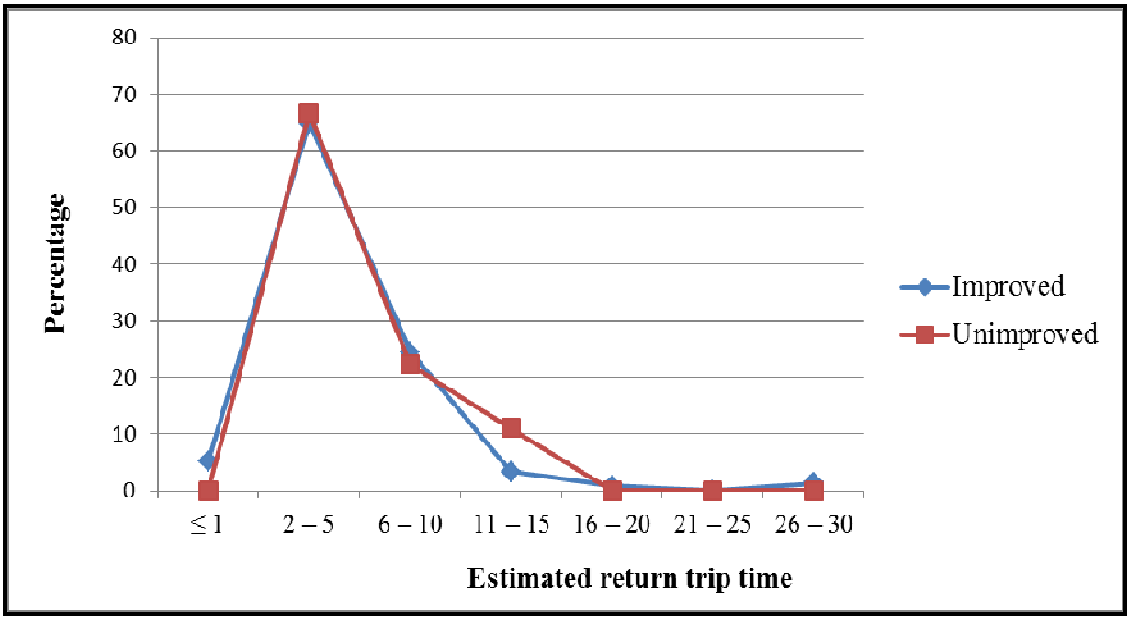
4.5.3. Distance and its relationship with domestic water collection

Distance is noted to be a key indicator of access to water (Williams, 2013) and in this study, the distances from the home to the primary water source was reported in meters by the respondents. A total of 200 (56.5%) of respondents indicated that their primary source of water was less than 10 meters (< 10m) from their dwelling. Also, 20 (5.6%) indicated that their dwellings were less than 100m (<100m), 3 (0.8%) indicated between 100m – 500m, whilst 0.3% indicated between 1000 – 1500m. A total of 126 (35.6%) of respondents could not give an estimate of the distance from their dwellings to their primary water sources (Fig. 4.12). With respect to urban households, the study found that 115 (70.6%) of all respondents residing in Abuakwa reported that they lived less than 10m away from their primary water sources making Abuakwa the community with the greatest percentage of its respondents living less than 10m from their primary water source. In Nkawie, 16 (28.6%) lived less than 10m away from their primary source whilst in Asuofua and Barekese, 32 (49.2%) and 37 (52.9%) lived less than 10m respectively.

Also, almost 60% of urban residents 131 (59.8%) reportedly lived 10m away from their primary water source whereas 69 (51.1%) of peri-urban households reportedly lived less than 10 meters from their primary water sources. Responses from respondents therfore suggests that 220 (62.1%) of respondents lived less than 100 meters away from their primary water sources and only 8 (2.3%) lived more than 100m away. Chi-square test also showed that urban and peri-urban households were distributed diferently across the distances from their dwellings to their primary water sources, χ^2 (5, n=354) = 12.24, p = 0.03. Which suggests that a statistically significant relationship existed between residential location and distance to the primary source. Distance to the primary source of water was dependent on residential location. Households which were located in urban communities were relatively closer to their primary water sources than their peri-urban counter parts. A likely reason for the low return trip time is the over 80% water coverage reported by the District Assembly (ANDA, 2011).

A tabulation of the total return trip time and the primary domestic water source type used in the year is also presented in Fig 4.8 to aid in depicting how they were distributed.

Fig. 4.8 Distribution of return trip time by domestic water source type



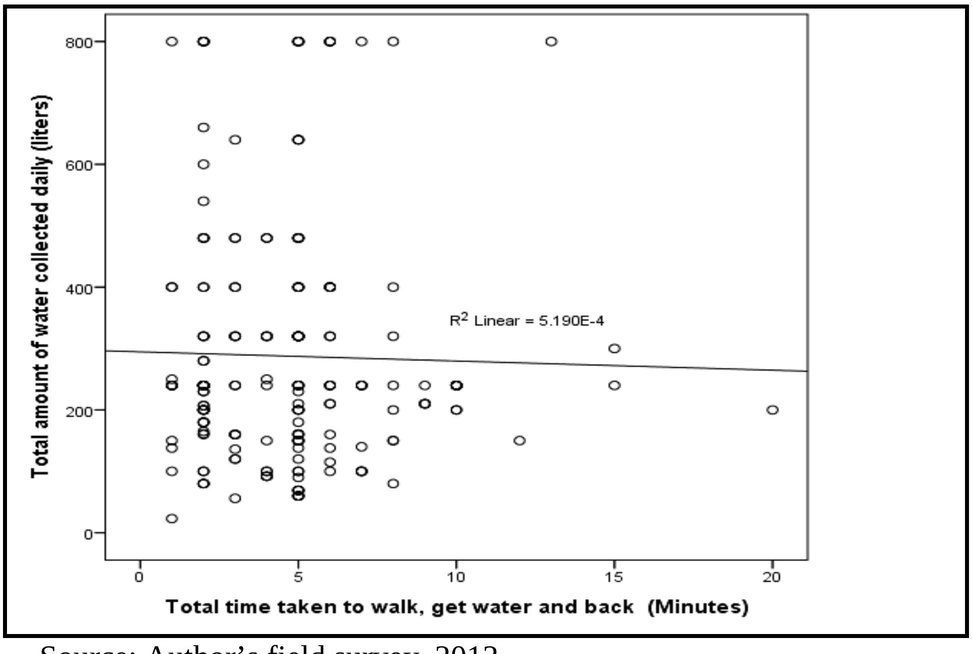
Source: Author's field survey, 2012.

Total return trip time data was available for 255 households which comprised 237 (93%) which used improved sources and 18 (7%) which used unimproved sources. Most households which used improved sources of domestic water 154 (65%)

made their return trips for water collection within 2 – 5 minutes but the percentage was higher 12 (66.7%) for households which used unimproved domestic water sources. Whereas 3 (1.3%) households made return trips in 26 – 30 minutes, none of the study households which used unimproved sources made return trips beyond 15 minutes.

Analysis of the data showed that households which used unimproved domestic water sources were not distributed differently from ones which used improved sources with respect to total return trip time, χ^2 (5, n=255) = 3.89, p = 0.57. Therefore there was no statistically significant relationship between domestic water source type and average return trip time. In other words, the type of water source that a household used, whether it was improved or not, did not have any major influence on the average return trip time.

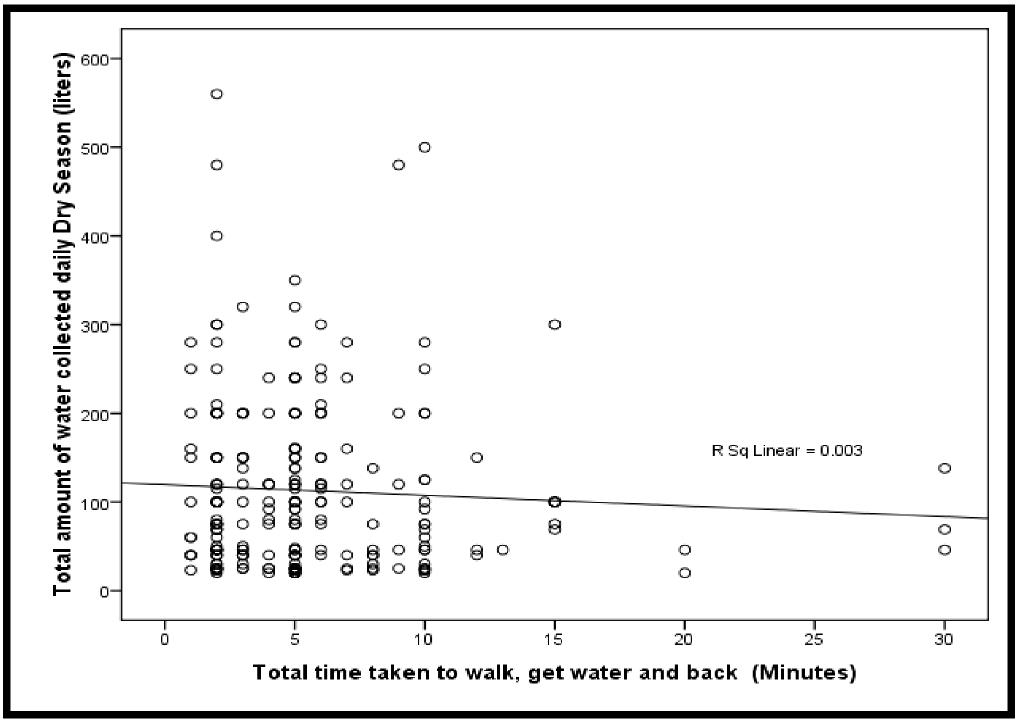
Fig. 4.9 A scatter plot of the total amount of water collected daily and the total return trip time in the wet season.



Source: Author’s field survey, 2012.

The relationship between the return trip time and the volume of water collected per day for the households in the wet and dry season were investigated using simple correlation and linear regression analysis and Figures 4.9 and 4.10 show the results for wet and dry seasons respectively. In Figures 4.9 and 4.10, a relatively higher proportion of mothers indicated that members of their households collected water within the return trip range of 0 – 10 minutes. Correlation analysis suggested that there was no statistically significant correlation between total water collected per day and the reported round trip time in the wet season $r(203) = -0.023$, $p = 0.75$. Furthermore, a linear regression of the amount of water collected daily (dependent variable) and the total return trip time (independent variable) showed that total return trip time was not a strong predictor ($r^2 = 0.001$).

Fig 4.10 A scatter plot of the total amount of water collected daily and the total return trip time in the dry season.

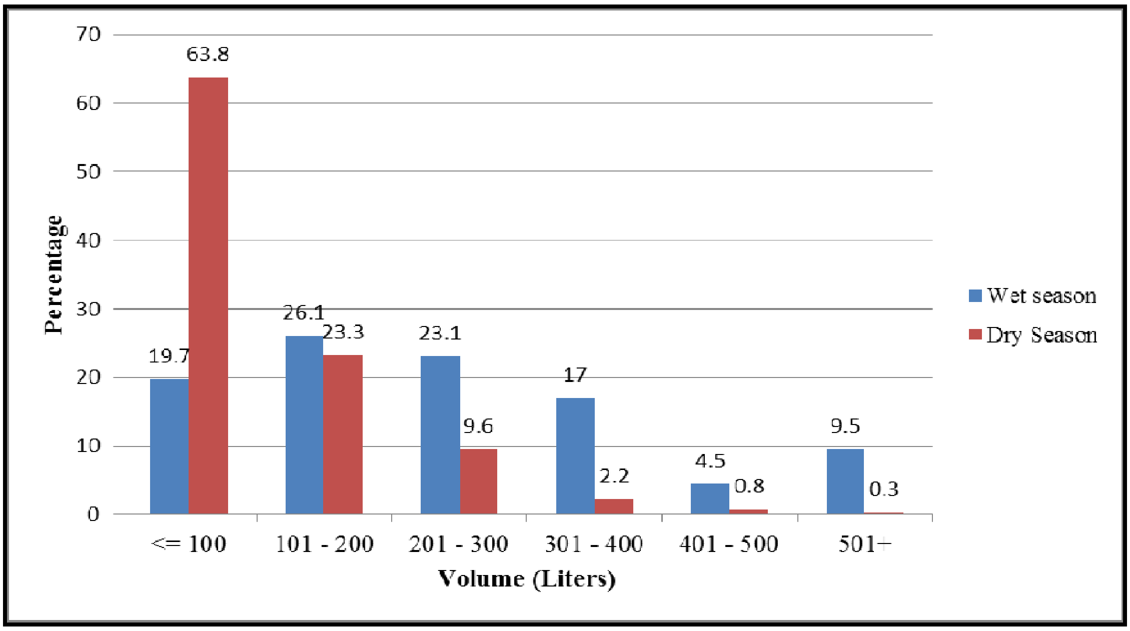


Source: Author's field survey, 2013

On the other hand, in the dry season results of correlation analysis between the amount of water collected daily and the total return trip time showed a similar trend to that of the wet season. There was no statistically significant correlation between total water collected and the reported round trip time $r(246) = -0.05$, $p = 0.39$. Linear regression showed the total return trip time (independent variable) was not a strong predictor of amount of water collected daily (dependent variable) in the dry season ($r^2 = 0.003$). The findings suggests that there could have been other factors which were responsible for variations in the amount of water collected and not necessarily the return trip time. Households with lesser return trip times were not observed to have collected more water per day than their counterparts with relatively higher return trip times. The finding of this study corroborates that of Evans et al., (2013) who, in their Ghana study, found that there was no statistically significant relationship between self-reported or measured round-trip time and water quantity.

The estimated amount of water collected daily for the household in the wet season and the dry season were investigated. Data on the total amount of water collected for all domestic purposes was available for 264 (69.8%) study households in the wet season and 365 (96.6%) households in the dry season. In the wet season, the mean amount of water collected daily by households was estimated at 267.71 liters, mode 240 liters, maximum 800 liters, minimum 20 liters. On the other hand, in the dry season, the mean amount collected daily was estimated at 107.00 liters, approximately 160 liters less than that of the wet season. The mode, maximum and minimum were 40 liters, 560 liters and 20 liters respectively suggesting that during the dry season, households collected less water compared to the wet season. Fig. 4.8 shows a distribution of the total daily household water collected by season.

Fig. 4.11 Total daily household water collected by season.



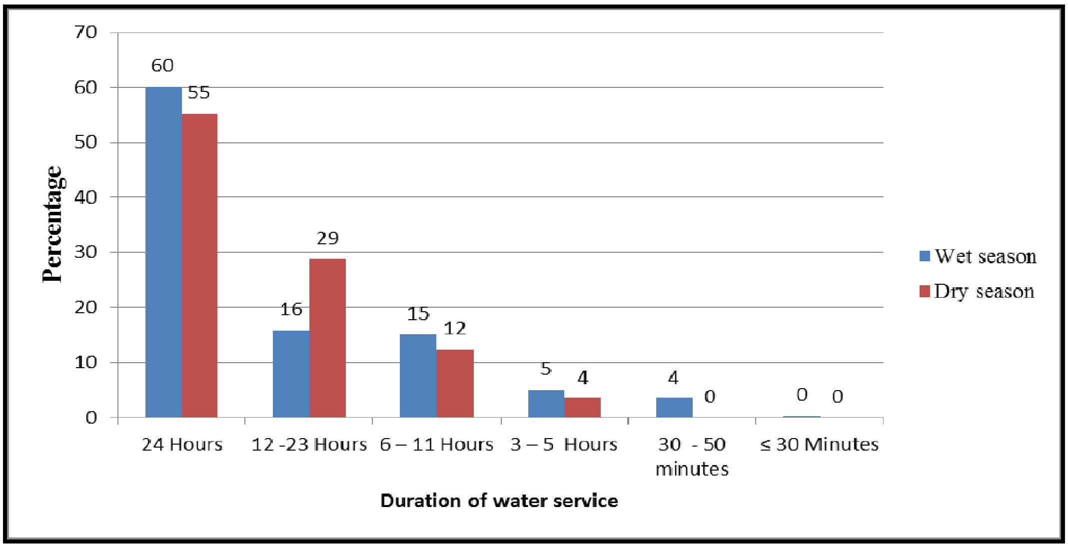
Source: Author's field survey, 2012 and 2013

A total of 52 (19.7%) and 233 (63.8%) households in the wet and dry season collected ≤ 100 liters of water per day respectively. Also an almost equal proportion of households collected between 101 – 200 liters per day. Compared to the wet season, there were fewer households which collected 301 liters or more in a day. (Fig 4.11). A study of water demand in the Volta Basin of Ghana also estimated daily water consumption in the wet and dry season to be 219 liters and 181 liters respectively (Asare, 2004: 52). These findings suggest that in general households in Ghana collect more water in the wet season than the dry. A chi-square test showed that there was a statistically significant difference between total daily household water collected in the wet season and total daily household water collected in the dry season, χ^2 (5, n=629) = 165.08, $p \leq 0.00$. This result suggests that the total amount of water collected (dependent variable) had a statistically significant relationship with the season (independent variable). Amount collected was season dependent. Furthermore, a paired samples *t*-test showed; t(256) = 12.06, $p \leq 0.001$, indicating that that there was a large difference between total daily household water collected in the wet season (M = 269.56 liters , SD 191.53, N = 257) and total daily household water collected in the dry season (M = 110.11 liters, SD 92.46, N = 257).

4.5.4 Duration of water service and mean daily per capita water use

Duration of water service at water sources varied across the study communities and also varied between the wet and dry seasons. In the wet season, more than half of the households interviewed, 223 (60.1%) had water service on their primary water source available 24 hours a day. A total of 59 (15.9%) households had service hours between 12 – 23 hours a day whereas 56 (15.1%) households had service hours from 0 – 9 hours a day (Fig. 4.12). Whereas 77 (20.6%) households were of the view that service hours had an effect on the quantity of water they collected to the household, majority of respondents (79.4%), were of the view that the number of service hours did not affect the quantity of water that they collected.

Fig. 4.12 Duration of water service at the primary water source by season.



Source: Author’s field survey, 2012 and 2013

For the latter, this was probably because the households were willing to seek for alternative water sources in the vicinity if there was a shortage or if the service at their primary water source had stopped. On the other hand, in the dry season, more than half 209 (55.3%) had 24 hour services and 378 (100%) of households had not less than 3 hours of service at their primary water sources (Fig 4.12). Also, 109 (28.8%), 47 (12.4%) and 13 (3.4%) households were served 12 – 23 hours, 6 – 11 hours and 3 – 5 hours respectively. The respondents in Barekese had the greatest percentage of households 44 (62%) who had 24 hour services whereas in the wet season, Nkawie had the greatest proportion of its residents 47 (70.1%) receiving 24 hour services.

A Chi-square test of independence showed that in the wet season, there was a significant difference in the distribution of urban and peri-urban households across service hours for the wet season, χ^2 (5, n=371) = 24.82, $p \leq 0.00$. In other words, in the wet season, hours of water service was dependent on residential location. More urban households enjoyed 24h hour service than their peri-urban counterparts, 62.3% and 56% respectively. However in the dry season, there was no difference in the distribution of urban and peri-urban households across service hours, χ^2 (5, n=378) = 1.47, p = 0.92. Also the results suggest that there was no statistically significant relationship between residential location and service hours. The overall picture was that there was a statistically significant relationship between the season and duration of water service, χ^2 (5, n=749) = 31.18, $p \leq 0.00$. Duration of water service was dependent on the season. The duration of water service did not appear to be statistically significantly related to the primary domestic water source type χ^2 (1, n=371) = 0.082, p = 0.775. However, households which used improved domestic water sources were more likely to have had 24 hours of water service. There was relatively little variation in the proportion of households which used improved sources and unimproved ones with respect to 24 hour water service (Table 4.15).

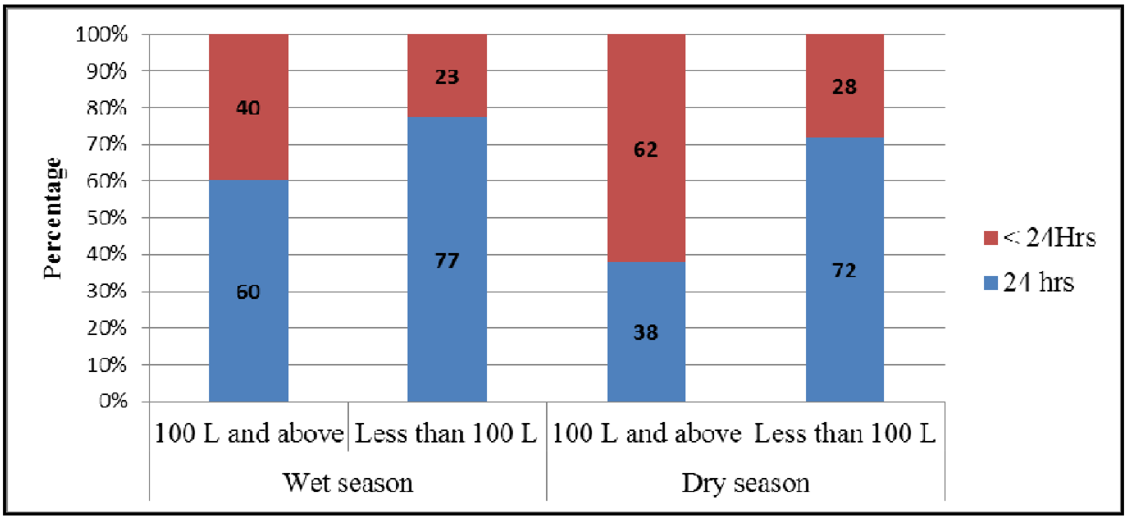
Table 4.15. Distribution of domestic water source type by duration of water service

Duration of water service was 24 hours	Primary domestic water source type		Total
	Improved	Unimproved	
Yes	211 (60.3)	12 (57.1)	223 (60.1)
No	139 (39.7)	9 (42.9)	148 (39.9)
Total	350 (100)	21 (100)	371 (100)

Source: Author's field survey, 2012 and 2013

On the other hand, it was observed that in households where 24 households of water service was enjoyed (n = 223), approximately 95% used improved domestic water sources. The findings therefore suggests that improved water source usage was positively related with duration of water service.

Fig. 4.13. Distribution of the total amount of water collected daily by duration of water service.

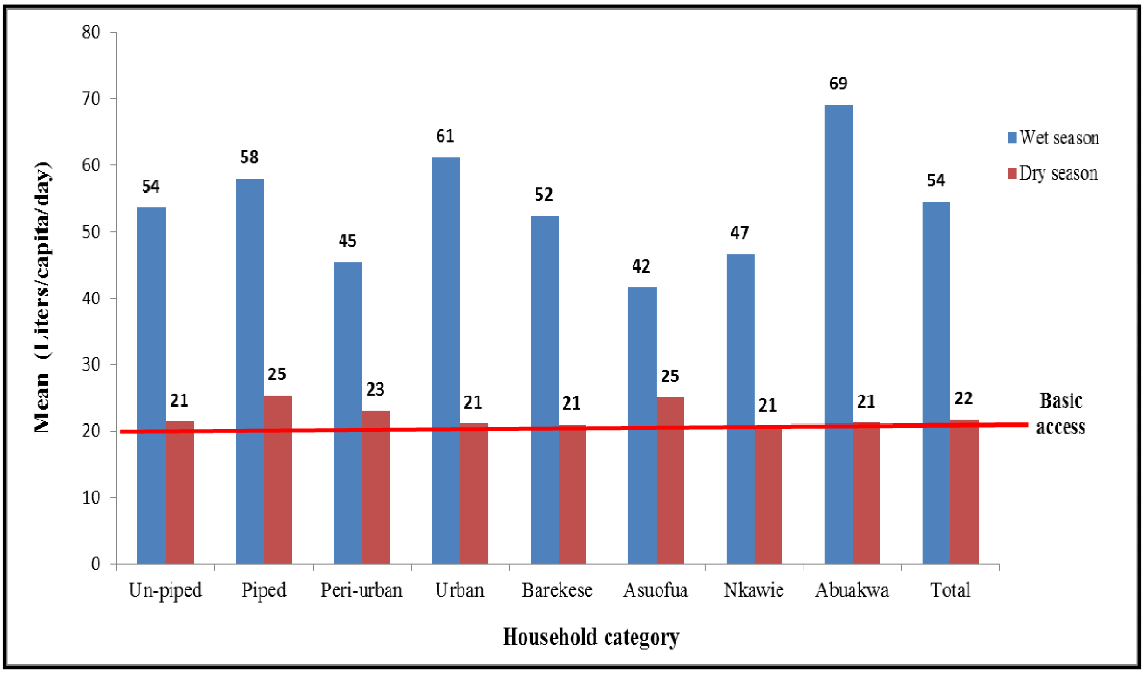


Source: Author's field survey, 2012 and 2013

With respect to the relationship between amount of water collected daily a trend was observed (Fig. 4.13). Similar to the wet season, the proportion of households, in the dry season, which collected less than 100L and enjoyed 24 hours of water service was higher than households which collected 100L and above. The data analysis also suggested that the dry season was more associated with having less than 24hours of water service. In general , over 70% of households which were collecting less than 100L a day did so from sources which had 24hours supply. This finding may have been a reflection of household preferences.

Households may have preferred sources that were readily available to supply water as a source of security. Sources with intermittent/erratic supply may have given a sense of insecurity especially if households did not know when supplies would have been cut or when supplies would have resumed. From the literature, it was noted that intermittent piped supplies could have led to the potential recontamination of water due to back-pressure conditions. Back-pressure conditions are created when pressure within the pipeline falls allowing pressure outside the pipe to force contaminants through cracks and seeps in the walls or joints of the pipeline (Vacs Renwick, 2013). In Fig 4.14, the data suggests that there were seasonal variations in the mean per-capita water use across the seasons. On the average, in the wet season, per capita water use was observed to be highest amongst households in Abuakwa. This was followed by Barekese, and Nkawie. The average amongst households in Asuofua was least (42 Liters/ capita/day). In the dry season, the average in each household category did not exceed 25 liters per capita per day.

Fig. 4.14 Mean daily per-capita water use in the wet and dry seasons.



Source: Author's field survey, 2012 and 2013

Having observed that the average amount of water collected daily in the wet season was higher than the dry, it was expected that per-capita water use would follow the same trend. The data suggests that mean daily per-capita water use was also generally higher in the wet season (54 liters) compared to the dry season (22 liters). Whereas estimated per-capita water use amongst the household categories ranged between 42 liters - 69 liters in the wet season, it was between 21 liters – 25 liters in the dry season. The results of Asare (2004:52) in his Volta Basin of Ghana study also appeared to follow a similar trend. Asare (2004:52) estimated per-capita water consumption in the wet and dry seasons to be 32 liters and 25 liters respectively. A study in Benin also found that which water use in the rainy season was significantly greater than in the dry season, $t = 17.18$, $p \leq 0.01$ (Arouna and Dabbert, 2009).

In terms of urban and peri-urban differences, the data suggests in the wet season, mean per capita water use was higher in urban households (61 liters) than in peri-urban ones (45 liters). In general, the survey results suggested that in both wet and dry seasons, piped households also used more water per capita than their un-piped counterparts. This finding is consistent with studies by Thompson et al., (2001) in East Africa in which piped households used more water per capita than un-piped households.

In chapter one (See section 1.4, pg.7) the hypothesis 'a' was stated as a guide to investigate whether households in the wet season and dry season statistically differed significantly in the mean daily per capita water use:

"H_0: There is no difference between mean daily per capita water use in the wet season and mean daily per capita water use in the dry season".

A paired sample t-test was conducted to evaluate whether a statistically significant difference existed between the mean daily per capita water use in the wet season and mean daily per capita water use in the dry season. The results of the paired sample t-test were significant; $t(255) = 10.92$, $p \leq 0.001$, indicating that there was a significantly large decrease in daily per capita water use from the wet season (M = 58.90 liters , SD 45.38, N = 256) to the dry season (M = 25.37 liters, SD 24.76, N = 256). The mean decrease was 34 liters with 95% confidence interval for the difference between the means of 39.58 – 27.48. This study therefore failed to accept the null hypothesis. Mean daily per capita water use was season dependent.

4.6 Levels of Service of Households

Improving the availability or access to water for households has health benefits (Kennedy, 2006). Studies such as Gleik (1996), WELL (1998) and WHO (2000) have made efforts at arriving at a definition of what adequate access to water was. For example, according to the WHO, 'reasonable access' to water was defined as the 'availability of at least 20 liters per person per day from a source within one kilometer of the user's dwelling' (WHO, 2000: 77). Howard and Bartram (2003) were of the view that volume of water could be associated with different levels of service and proceeded to define four levels of service which were synonymous to levels of access.

According to Howard and Bartram (2003) service level definitions, 'No access' suggests the collection of less than 5 liters per capita per day (lpcd) and also suggests that household members do not have enough water per day to perform basic hygiene tasks such as washing of hands. Therefore the level of concern for household health is 'very high'. 'Basic access' suggests that the household may collect 20 (lpcd) or less and may be living within 5 – 30 minutes or 100 – 1000m away from the water source. This level suggest that not all water needs will be met hence the health concern level is rated as 'medium'. Thirdly, intermediate access suggests that the water source may be on the plot of the household, affording the household the chance to collect around 50 (lpcd) which also allows household members the ability to meet basic hygiene and consumption needs (Howard and Bartram, 2003:22; Kennedy, 2006:12).

Optimal access refers to one in which the household has multiple functioning taps within the house, are likely to collect 100 liters to ≥ 300 (lpcd). With this level of access, all uses are met and the health concerns are low. Based on the definitions of service levels defined by Howard and Bartram (2003), and the estimated quantities of water collected, the levels of service for the study households were assessed and the results are shown in Tables 4.16 and 4.17 for wet and dry seasons respectively.

Results from the study suggested that the service levels and levels of health concern for households varied between the wet and dry seasons. Majority of the study households 199 (72%) had intermediate access in the wet season and likely had enough water per capita to meet most basic hygiene and consumption needs (Table. 4.16).

Table. 4.16 Level of service and level of health concern in the wet season.

Service level	**Quantity definition**	**Number of households (%)**	**Level of health concern**
No access	Less than 5 L/capita/	2 (1)	Very high
Basic access	Unlikely to exceed 20 L/capita/day	35 (13)	Medium
Intermediate access	Around 50 L/capita/day	199 (72)	Low
Optimal access	Likely to be 100 L and up to 300 L/capita/day	38 (14)	Very low
Total	-	274 (100)	-

Source: Author's field survey, 2012.

On the other hand, in the dry season, there was a 33% decrease in the proportion of households that had intermediate access 133 (37%). Most households in the dry season, 47%, had basic access which and it suggested that not all household water needs were likely to be met in their respective households (Table.4.17).

Table. 4.17 Level of service and level of health concern in the dry season.

Service level	Quantity definition	Number of households (%)	Level of health concern
No access	Less than 5 L/capita/	45 (13)	Very high
Basic access	Unlikely to exceed 20 L/capita/day	166 (47)	Medium
Intermediate access	Around 50 L/capita/day	133 (37)	Low
Optimal access	Likely to be 100 L and up to 300 L/capita/day	11 (3)	Very low
Total	-	355 (100)	-

Source: Author's field survey, 2013

Whereas over 80% of households had intermediate access or optimal access in the wet season, in the dry season, it was only 40% of households. One reason that could possibly have accounted for the seasonal variations was the variation in volume of collected by the households in the wet and dry season. As was observed, water collection per household per day was higher in the wet season than dry season. A chi-square test of independence showed that there was a statistically significant relationship between the season and levels of service, χ^2 (3, n=626) = 143.67, $p \leq 0.01$. This finding suggests that the level of service was season dependent. Households in the wet season were more likely to have intermediate access whereas in the dry season, they were more likely to have basic access. The results suggest that in both wet and dry seasons, water uses were inadequately met and water quality was not readily assured for 1% and 13% of households respectively.

Table 4.18 Distribution of the level of service in the wet and dry seasons by estimated household wealth

Household wealth was above middle income	**Level of service (Wet season)**			**Level of service (Dry season)**		
	Below basic access	**Basic access or better**	**Total**	**Below basic access**	**Basic access or better**	**Total**
Yes	15 (51.7)	140 (61.1)	155 (60.1)	128 (64)	101 (64.3)	229 (64.1)
No	14 (48.3)	89 (38.9)	103 (39.9)	72 (36)	56 (35.7)	128 (35.9)
Total	29 (100)	229 (100)	258 (100)	200 (100)	157 (100)	357 (100)

Source: Author's field survey 2012 and 2013

A distribution of the level of service by estimated household wealth is presented in Table 4.18. The study results suggests that the relationship between household wealth and the levels of service was not statistically significant.in the wet χ^2 (1, n=258) = 0.951, p = 0.33 and dry seasons χ^2 (1, n=357) = 0.004, p = 0.948. Nevertheless, it was observed that over 60% of households which enjoyed basic access or above lived in households whose wealth were estimated to be above middle income. A household which belonged to middle income or lower status was more likely to have had basic or better access in the wet season than in the dry season (Table 4.19). The variations in service levels and levels of health concern suggests the need for water and health authorities to regularly monitor and ensure that per-capita consumption does not fall short of the internationally recognized minimum needed for basic consumption and hygiene needs which is 20L / c / d. In general, research findings in the literature suggested that high volume consumers of water likely to be wealthier (Syme et al., 2004; Kenney et al., 2008; Fox et al., 2009). Higher wealth levels may imply having a relatively larger number of water consuming appliances such as taps, showers and lawns that need watering to keep green.

Table 4.19 Distribution of the level of service in the wet and dry seasons by estimated household wealth

Household wealth was above middle income	Level of service (Wet season)			Level of service (Dry season)		
	Below basic access	**Basic access or better**	**Total**	**Below basic access**	**Basic access or better**	**Total**
Yes	15 (51.7)	140 (61.1)	155 (60.1)	128 (64)	101 (64.3)	229 (64.1)
No	14 (48.3)	89 (38.9)	103 (39.9)	72 (36)	56 (35.7)	128 (35.9)
Total	29 (100)	229 (100)	258 (100)	200 (100)	157 (100)	357 (100)

Source: Author's field survey 2012 and 2013

An assessment of the primary drinking water source type used in the year and the levels of service showed statistical significance in the wet season χ^2 (1, n=263) = 4.44, p = 0.035 whereas that for the dry season did not, χ^2 (1, n=360) = 3.05, p = 0.81.

Table 4.20 Distribution of the level of service and level of health concern in the wet and dry seasons by types of drinking water source.

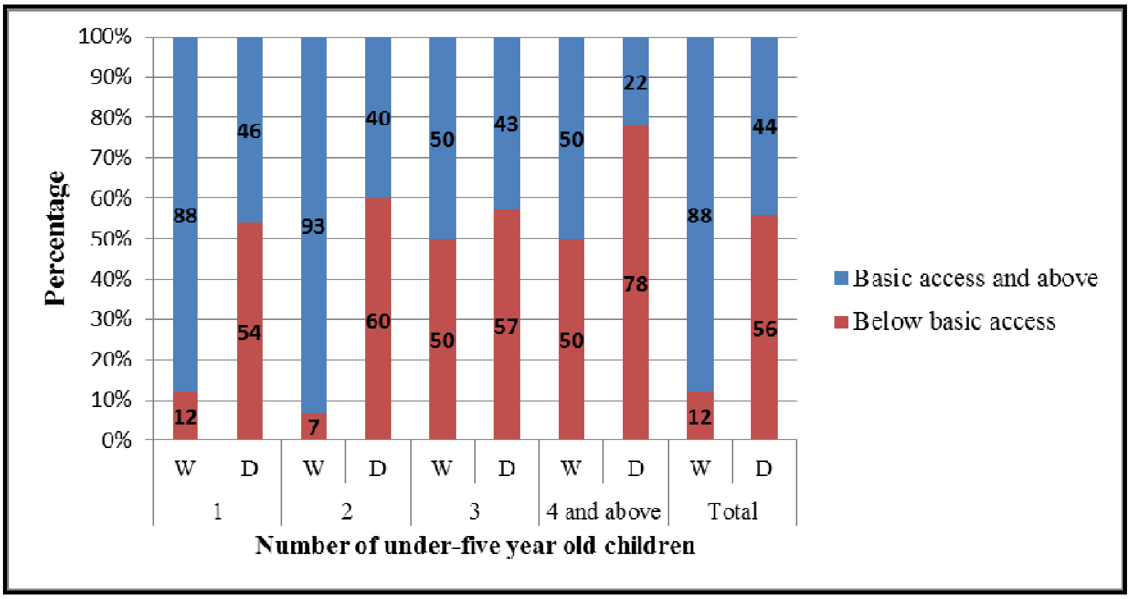
Household drinking water source type	Level of service & Health concern (Wet season)				Level of service & Health concern (Dry season)			
	Below basic access	**Very high**	**Basic access or better**	**Medium to very low**	**Below basic access**	**Very high**	**Basic access or better**	**Medium to very low**
Improved	28 (90.3)		169 (72.8)		160 (79.6)		114 (71.7)	
Unimproved	3 (9.7)		63 (27.2)		41 (20.4)		45 (28.3)	
Total	31 (100)		232 (100)		201 (100)		159 (100)	

Source: Author's field survey 2012 and 2013.

In general over 70% of households used improved drinking water sources. However in both wet and dry seasons, a higher proportion of households with basic access or better used unimproved sources, 27% and 28% respectively. In other words, compared to households which had less than 20l/c/day (Below basic access), approximately 28 households which had 20l/c/day or above (Basic access or better) used unimproved drinking water sources. On the other hand, 24% of households in the wet and 12% of households in the dry season who used unimproved sources had basic access This finding painted a surprising picture of unimproved drinking water source usage and accessibility (Table 4.20).

According to Howard and Bartram's (2003) classification, the level of health concern for consumers of 20L an above was expected to range from 'medium' to 'very low' as larger volumes of water were consumed per capita. However when water service levels were juxtaposed to the types of drinking water sources, the level of health concern for households which consumed unimproved water sources still ranged between medium to low. When a household water service level increases, an observation of the type of water source that providing the increased level of service needs to be made. This is because gaining basic access or better did not necessarily mean that the water was drawn from an improved source. Conversely, a household's use of improved sources did not necessarily mean that the minimum required for consumption and hygiene purposes were met.

Fig.4.15 Distribution of the level of service by the number of under-five year old children in the household.



Source: Author's field survey 2012 and 2013; W- Wet season, D- Dry season.

From Fig. 4.15, the data suggest there was relatively little variation in service levels across the seasons for households which had three children. However, compared to households which had one child under-five years old, a household with four or more children was more likely to have its service level below basic access. The number of under-five children appeared to be positively related with levels of service. This finding may be probably due to the fact that all things being equal, the demand for water was expected to be higher in households with four children under-five than households with one.

4.7 The Cost of Domestic Water

The monetary cost of water collection for the household was investigated and Table 4.21 shows the water usage fee payment scheme by the rates that were charged per scheme. The most patronized scheme for paying for water was 'per bucket/basin' which was practised by 221 (71.5%) households whereas the least patronized scheme was the 'residential rate based on income' which was reported by 3 (1.0%) of households (Table 4.21).

Table 4.21 Water payment scheme by amount regularly paid by households.

Payment scheme	**Amount in Ghana cedis (GH₵) (%)**						**Total (%)**
	≤ 0.10	**0.11 – 0.50**	**0.51 – 1.00**	**1.01 – 3.00**	**3.01 – 5.00**	**> 5**	
Per vessel rate (E.g. Bucket/ Basin)	141 (75.4)	77 (77.8)	0 (0)	0 (0)	0 (0)	3 (18.8)	221 (71.5)
Block/Flat rate	28 (15)	4 (4.0)	0 (0)	3 (100)	3 (100)	11 (68.8)	49 (15.9)
Proportional rate (According to consumption)	1 (0.5)	2 (2)	1 (100)	0 (0)	0 (0)	2 (12.5)	6 (1.9)
Residential rate (According to income)	3 (1.6)	0 (0)	0 (0)	0 (0)	0 (0)	3 (18.8)	3 (1.0)
Other means	14 (7.5)	16 (16.2)	0 (0)	0 (0)	0 (0)	0 (0)	30 (9.7)
Total	187 (100)	99 (100)	1 (100)	3 (100)	3 (100)	16 (100)	309 (100)

Source: Author's field survey, 2012.

There were 49 (15.9%) that paid for water by the block or flat rate whilst 6 (1.9%) and 30 (9.7%) of households paid by the 'proportional rate' and 'other means' respectively. Furthermore, from Table 4.21, the data shows that 286 (92.6%) households paid for water between ≤ GH₵ 0.10 and ≤ GH₵ 0.50 whereas 23 (7.4%) paid more than GH₵ 0.50. The 'per-vessel' rate of payment for was the most dominant form of payment practised in the study areas partly because, few households had a piped connection to their dwellings in which case they would have paid the

‘Proportional rate’. With this method, households usually made payments each time a vessel was used to fetch water at the source, to an attendant who was stationed at the water source to collect the monies. At the time of the research, the prevailing trend was that the attendant visually identified the volume of the water container and charged its corresponding rate. Accounts were then rendered to the WASH Committees on behalf of the District Assembly. In the case of public water sources such as District Assembly bore holes or metered public stand, the WASH Committee of the community selected one community member and tasked him or her with collecting the monies for maintenance and repairs. With respect to private sources, the owner of the water source or his/her representative sold water to the public at the prevailing volume rates.

A greater proportion (98%) of the households which paid the ‘per vessel rate’ of water ranging between GH₵ 0.10 - GH₵ 0.50 per vessel (Table 4.21). Discussants at the FGDs who paid the block or flat rate indicated that monies ranging between GH₵ 0.10 to GH₵ 10.00 were collected monthly, or at the beginning of the year depending on the discretion of the WASH committee and the agreements reached for payment. With this method, households were clustered into blocks and households belonging to each block were made to pay the flat rate which was collected by the WASH committee or its representative. Households which paid by ‘other means’ included ones in which the respondent indicated that they paid according to ‘informal amounts’ given to them by their land lords as bills to be paid. Field investigations revealed that a total of 249 (75.9%) households indicated ‘yes’ to the appropriateness of the amounts they paid whereas 79 (24.1%) indicated no, meaning that most households considered that the amounts that their household paid for water was appropriate.

Table 4.22 Amount paid for water per vessel and estimated household wealth

Amount paid for water (GH Cedis)	Estimated household wealth						Total (%)
	Low income (%)	Lower middle income (%)	Median Middle income (%)	Upper middle income (%)	High Income (%)	Very high income (%)	
≤ 0.10	0 (0)	30 (73.2)	35 (52.2)	52 (58.4)	53 (60.2)	12 (63.2)	182 (59.7)
0.11 - 0.50	1 (100)	11 (26.8)	31 (46.3)	30 (33.7)	22 (25.0)	5 (26.3)	100 (32.8)
0.51 - 1.00	0 (0)	0 (0)	1 (1.5)	0 (0)	0 (0)	0 (0)	1 (0.3)
1.01 - 1.50	0 (0)	0 (0)	0 (0)	0 (0)	2 (2.3)	0 (0)	2 (0.7)
1.51 - 2.00	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
3.00 and above	0 (0)	0 (0)	0 (0)	7 (7.9)	10 (11.4)	2 (10.5)	19 (6.2)
Total	1 (100)	41 (100)	67 (100)	89 (100)	88 (100)	19 (100)	305 (100)

Source: Author's field survey, 2012.

From Table 4.22, the estimated wealth of households did not show any statistical significance with the amount paid for water per vessel, , χ^2 (25, n=305) = 32.37, p = 0.147. Nevertheless, over 50% of all households from all estimated wealth categories regularly paid GhC 0.10 per vessel. It was observed that only 19 households paid GhC3.00 or above per vessel. Of this number, 10 representing 53% belonged to the high income wealth category whereas upper middle income and very high income accounted for 37% and 10% respectively. Therefore with respect to prices, the highest payments per vessel were predominant in high income households compared to low income ones. Further analysis of the data also revealed that the amount paid per vessel did not have a statistically significant relationship with household size (Table 4.23). The data suggested that, a household having five members or more, did not strongly influence the amount paid per vessel. It was observed that approximately 58% of all households which paid 3.00 or more had their household sizes below 5 members. This finding stresses the fact that household size did not significantly influence amount paid per vessel. This result may be partly due the fact that water prices were based on the volume of the collection vessel.

Table 4.23. Distribution of the amount paid per vessel by household size.

Household membership is 5 or more	**Amount paid for water (GH Cedis)**						**Total**
	≤ 0.10	**0.11 - 0.50**	**0.51 - 1.00**	**1.01 - 1.50**	**1.51 - 2.00**	**≥ 3.00**	
Yes	97 (51.6)	46 (46)	0 (0)	2 (100)	0 (0)	8 (42.1)	153 (49.2)
No	91 (48.4)	54 (54)	1 (100)	0 (0)	1 (100)	11 (57.9)	158 (50.8)
Total	188 (100)	100 (100)	1 (100)	2 (100)	1 (100)	19 (100)	311 (100)

Source: Author's field survey, 2012.

It is worth noting however that the relationship between the amount of water paid per vessel and the type of domestic water source was found to be statistically significant, χ^2 (5, n=312) = 23.96, p = 0.001 (Table 4.24).

Table 4.24. Distribution of the amount paid per vessel by type of domestic water source.

Type of domestic water sources	**Amount paid for water (GH Cedis)**						**Total**
	≤ 0.10	**0.11 - 0.50**	**0.51 - 1.00**	**1.01 - 1.50**	**1.51 - 2.00**	**≥ 3.00**	
Improved	181 (95.8)	96 (96)	1 (100)	2 (100)	0 (0)	19 (100)	299 95.8
Unimproved	8 (4.2)	4 (4)	0 (0)	0 (0)	1 (100)	0 (0)	13 (4.2)
Total	189 (100)	100 (100)	1 (100)	2 (100)	1 (100)	19 (100)	312 (100)

Source: Author's field survey, 2012.

The cost implications of collecting water for the household may not only be expressed in monetary terms but can also be expressed in terms of time and health implications. In this study time was identified by mothers as a very crucial factor in their daily lives. This is because a mother had to combine nursing her children with domestic chores such as cooking, washing, general cleaning, fetching water for the household as well as work all of which take time to execute. In some cases, all the afore mentioned activities had to take place in the mornings especially when children were below 5 years and could not bath themselves or get ready for school unaided. In an FGD in Asuofua, a mother indicated that:

'Time is very important because we need to use the time to do other domestic chores and not only to fetch water.'

In the FGDs and field surveys, there was evidence of queuing in the mornings. For that matter some mothers indicated that they woke up as early as 5am in the morning to avoid the queues and fetch water to start the day's activity.

In a recent research in the study area, Evans et al., (2013), did not find strong evidence to suggest negative musculo-skeletal effects from carrying water amongst those who carried or who had previously carried water. However, in this study, FGDs revealed that mothers overwhelmingly held the view that drawing water to the home was a "physically painful" activity. A mother in Nkawie commented that:

Going for water at the water source is very difficult. One develops waist problems as one bends to pick up the water and place it on the head.

In Asuofua, a housewife who shared her experience with water collection said that:

> *‘I had once finished fetching water at the stream. As I lifted and was about to place the basin on my head, it slipped out of my hands and landed on my chest. I had to visit the hospital and I was told not to lift any heavy object over my head again due to the injury I sustained.*

An inference that could be made from the FGDs is that some mothers perceived water carrying to have negative health effects such as waist problems and possible injuries.

4.8 Domestic Water Storage

4.8.1 Water storage duration

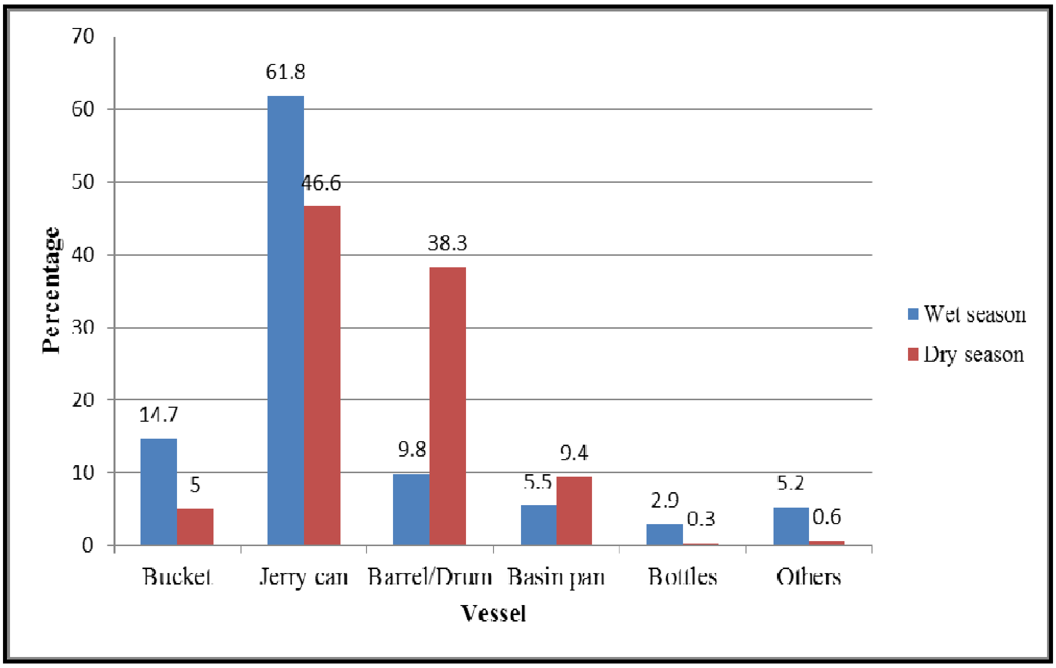
Water storage holds significance for households, for example, in the context where there are recurrent water shortages, irregular supply of water and uncertainty about the number of service hours at the primary water source (WEDC, 2002). The act of water storage gave the household a sense of water security and period of time for storing water varied by households and also varied by seasons. Water was either stored daily, weekly, more than a week, or more than a month. In the wet season, a total of 338 (89.4%) households practised domestic water storage whereas 40 (10.6%) did not do so. On the other hand, 359 (95%) practised whereas 19 (5%) did not practice in the dry season.

In the wet season, in decreasing percentage order, 194 (57.4%) households stored water daily, more than a week 102 (30.2%), weekly 37 (10.9%) and more than a month 5 (1.5%). In addition, there was no difference in the distribution of urban and per-urban residents across water storage frequency χ^2 (3, n=338) = 5.7, p = 0.13. On the other hand in the dry season , in decreasing percentage order, 174 (48.5%) households stored water daily more than once a week 76 (21.5%), weekly 45 (12.5%), and more than once a month 64 (17.8%). The data therefore suggests that approximately 60% of households in the wet season and 50% in the dry season practised daily water storage. There was a significant difference in the distribution of urban and per-urban residents across water storage frequency χ^2 (3, n=359) = 13.51, $p \leq 0.00$ in the dry season.

A Chi-square test of independence showed that water storage frequency was season dependent, χ^2 (3, n=697) = 55.5, $p \leq 0.00$. This result suggests that there was a statistically significant relationship between the season and water storage frequency. Research evidence from earlier studies suggested that when water was regularly transferred from collection vessels to storage vessel, there was a likelihood of contamination (Lindskog and Lindskog 1987; Clasen and Bastable, 2003). Data from the field work suggested that when water was sent to the household, it was either transferred into an alternate water storage vessel or it was kept in the collection vessel that was used to draw water to the home.

Fig 4.16 shows that varied vessels were used to store water in the domestic environment in both wet and dry seasons. The vessels included buckets, jerry cans, gallons, barrel/drum and basin pans. A total of 132 (38.2%) used two water storage vessels, 94 (27.2%) used one, 56 (16.2%) used three, 25 (7.2%) four and 39 (11.3%) used five or more vessels (Fig. 4.17).

Fig. 4.16 Primary water storage vessel type by season.

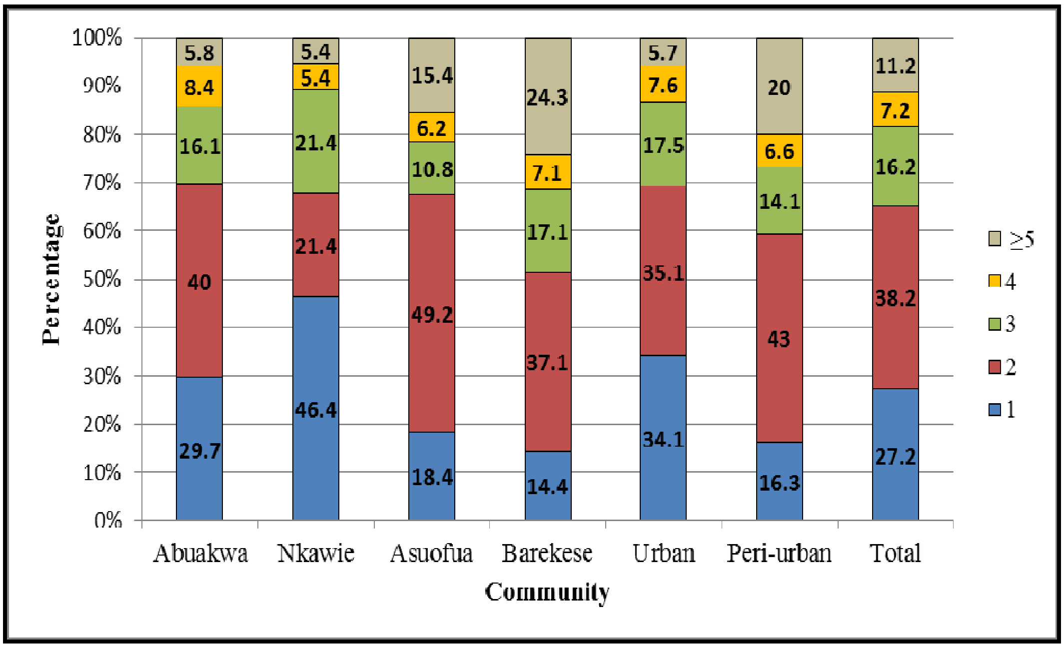


Source: Author's field survey, 2012 and 2013

It was observed that Barekese was the community with the largest percentage (24.3%) of its study population having five or more water storage containers (Fig. 4.17). Furthermore, urban and peri-urban households showed a statistically significant difference across the number of water storage vessels, χ^2 (4, n=346) = 26.64, $p \leq 0.001$. It was observed that residential location had a statistically significant influence on the number of water storage vessels. Peri-urban households were more likely to use 5 vessels or more than their urban counterparts, 20% and 5.7% respectively.

The general picture was that whereas the basin pan featured prominently as the modal means of drawing water to the household, the modal means of water storage were 'jerry cans'. In the FGDs, it came to light that mothers preferred to have plastic jerry cans with lids rather than metallic barrels to store water. Metal barrels were perceived to rust quickly and considered too difficult to prepare it as a means of water storage. The practice that existed at the time of the study was that the interior and exterior of a metal barrel (usually 200 liters) was coated with coal tar and left to dry. When dry, the coated barrel was used to store water. Metal barrels on the market were usually without lids and un-coated with tar. One had to purchase a wooden or metallic lid, purchase coal tar, and paint the interior and exterior. These processes were considered laborious and time consuming hence they preferred the plastic jerry can which was supplied with a lid and did not require laborious, time consuming preparation.

Fig. 4.17 Number of water storage vessels used by households.



Source: Author’s field survey, 2012.

Correlational analysis revealed that the number of water storage vessels was not significantly associated with the number of under-five year old children r(343) = 0.06, p=0.27, the number of under 15 year olds r(341) = 0.06, p=0.10, the number of functional taps in the household r(345) =0.01, p = 0.90 and household size r(345) = 0.04, p = 0.46. Likewise, the number of water storage vessels was not significantly associated with the estimated wealth of the household χ^2 (20, n=342) = 27.49, p = 0.12. Nevertheless, compared to their high income counterparts, a higher proportion of lower income households had at least 2 water storage vessels. No low income household reported having 3 or more water storage vessels (Table 4.25)

Table 4.25. Distribution of estimated wealth and number of water storage vessels.

Number of water storage vessels	**Estimated household wealth**						**Total (%)**
	Low income (%)	**Lower middle income (%)**	**Median Middle income (%)**	**Upper middle income (%)**	**High Income (%)**	**Very high income (%)**	
1	1 (25)	14 (31.8)	24 (32.4)	25 (24.3)	24 (25.8)	5 (20.8)	93 (27.2)
2	3 (75)	15 (34.1)	24 (32.4)	44 (42.7)	34 (36.6)	10 (41.7)	130 (38)
3	0 (0)	3 (6.8)	17 (23)	21 (20.4)	14 (15.1)	1 (4.2)	56 (16.4)
4	0) (0)	3 (6.8)	3 (4.1)	8 (7.8)	8 (8.6)	2 (8.3)	24 (7)
5 and above	0 (0)	9 (20.5)	6 (8.1)	5 (4.9)	13 (14)	6 (25)	39 (11.4)
Total	4 (100)	44 (100	74 (100)	103 (100)	93 (100)	24 (100)	342 (100)

Source: Author's field survey, 2012.

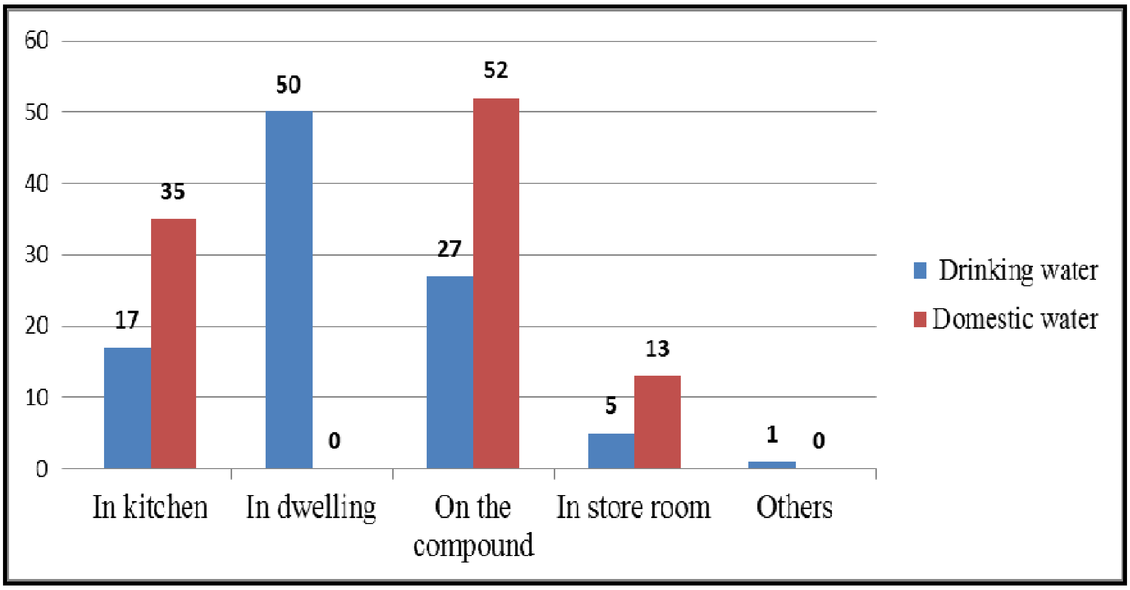
Of the number of households which used 5 vessels or more (n = 39), 19 households representing 49% belonged to the very high income or high income wealth categories.

4.8.2 Location of drinking water storage vessels in the home

Varied households stored water meant for drinking and that meant for other domestic purposes such as cooking at varied locations within the household in the year of the study. Knowledge of the places of water storage is very crucial due to the possibility of stored water contamination from microbiological contaminants like

Escherichia coli within the domestic environment. Fig 4.18 suggests that the frequent place of water storage varied with respect to drinking purposes and domestic purposes.

Fig 4.18 Place of regular storage of the primary drinking water storage vessel.



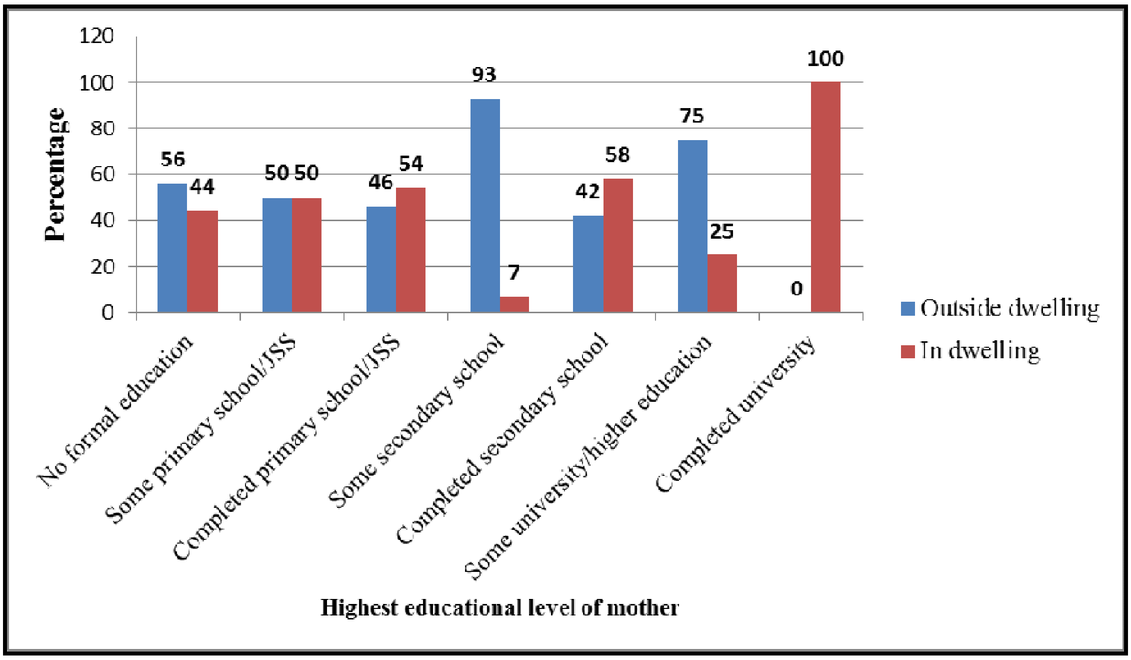
Source: Author's field survey, 2012 and 2013

The most frequent place of storing drinking was in the dwelling (50%) whereas that for domestic water was the compound (52%). Places such as the kitchen, and store rooms were observed to be more associated with domestic water storage than drinking water storage. The survey results suggested that the place of water storage was segregated based on what the water was to be used primarily for. This was echoed by one discussant in the FGD held in Nkawie. When asked why her household stored drinking water and water meant of other domestic purposes in separate places, she indicated that;

> *'I live a compound house. When I am not around, someone else can fetch or put something in it. So what we drink is inside the dwelling and the one I use to wash and cook is outside.'*

The study explored the relationship between the regular place of drinking water storage and socio-demographic variables such as the mother's educational level, the number of rooms, household size as well as the estimated wealth of the household. The highest level of education of mothers had a statistically significant relationship with the location of the primary drinking water storage vessel χ^2 (6, n=354) = 15.50, p = 0.017.

Fig. 4.19 Place of regular storage of drinking water by the highest educational level of the mother.



Source: Author's field survey, 2012 and 2013

From Fig.4.19 it was observed that with respect to storing drinking water in the dwelling, the highest proportion of households which practised had mothers who had completed university (100%). On the other hand, storing drinking water outside the dwelling was mostly practised by households whose mothers hand some secondary schooling (93%). The proportion of households which stored drinking water in their dwellings was seen to have increased as mothers highest education progressed from ‘no formal education’ to ‘completed primary school/JSS’. It was also observed that compared to mothers who had completed university, mothers without formal education were likely to have stored their drinking water outside their dwelling. The findings therefore suggest that storage of drinking water in the dwelling was more associated with lower educational levels whereas storage in the dwelling was more associated with higher educational levels.

Also, household size was found to have had a strong statistically significant relationship with the place of storage of drinking water χ^2 (1, n=354) = 12.33, $p \leq 0.001$. Households with five or more members were more likely to store their drinking water outside their dwelling. On the other hand, households with less than five members were more likely to have stored drinking water in their dwelling (Table 4.26).

Table 4.26. Distribution of the household size by the location of the primary drinking water storage vessel.

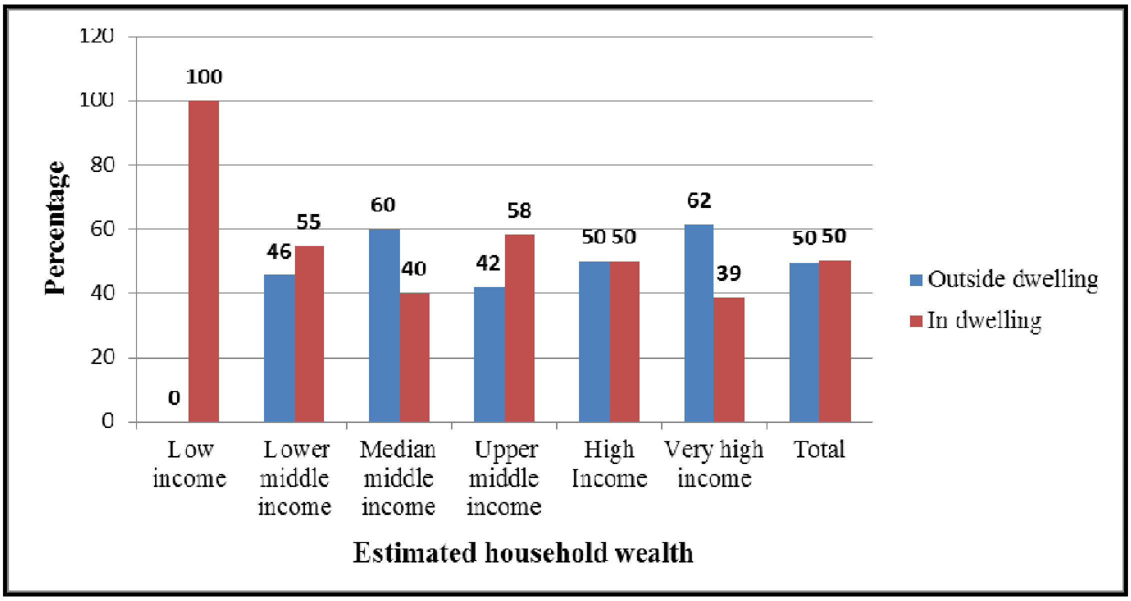
Location of primary drinking water storage vessel	Household membership was 5 or more		Total (%)
	Yes (%)	No (%)	
In dwelling	69 (40.1)	107 (58.8)	176 (49.7)
Outside dwelling	103 (59.9)	75 (41.2)	178 (50.3)
Total	172 (100)	182 (100)	354 (100)

Source: Author’s field survey, 2012

A reason that could have partly accounted for this finding is that water storage vessels may have competed with other household members as well as other household items for space in the dwelling given the fact that over 80% of households lived in one room apartments.

The relationship between estimated wealth and the location of the primary drinking water storage vessel was seen to be statistically significant χ^2 (5, n=350) = 11.54, $p \leq 0.042$. The findings suggest that the storage of drinking water in the dwelling was mostly practised by households with relatively lower incomes. On the other hand, Very high income households were more likely to have stored their drinking water outside their dwelling (Fig.4.20). A factor that could have possibly accounted for the observed trend was that households with relatively higher wealth may have lived in multiple room apartments and could therefore afford to store their drinking water in alternative places such as the kitchen or store room.

Fig 4.20 Distribution of the primary drinking water storage vessel's location by estimated household wealth.



Source: Author's field survey, 2012

Though Chi-square analysis revealed that the number of rooms and the place of storing drinking water were not significantly related, χ^2 (5, n=354) = 0.63, p = 0.73, the analysis revealed that 63% of all households with 3 rooms or above kept their drinking water outside their dwelling whereas 49% of households with one room kept theirs outside their dwelling.

Some reasons were adduced to have partly accounted for the variation in the place where drinking water was stored. At Focus Group Discussions which were held in Nkawie, Asuofua and Abuakwa, varied reasons were given for the location of drinking water storage vessels were placed. Others mentioned that it was more convenient for them to place their drinking water storage vessels on the compound due to the lack of 'space' in their dwellings. Others also placed their water storage vessels in their dwellings due to the perception that the water might be poisoned or stolen by neighbors. Results from the discussions therefore suggest that the type of residential accommodation and nature of social relations with neighbors seemed to play a role in determining where their drinking water storage vessels were kept. With respect to the place of regular storage of water, urban and peri-urban residents showed a statistically significant difference, χ^2 (4, n=355) = 21.14, $p \leq 0.00$, In other words, the place of regular storage of water was dependent on residential location. The survey results suggested that Asuofua had the highest proportion of its study population, 63.5%, engaging in the practice of storing water in the dwelling. A total of 98 (44%) urban households, kept stored water in their dwellings whilst most peri-urban households, approximately 60%, kept drinking water in their dwellings.

The placement of covers on water storage vessels is essential for the prevention of contamination. The cover serves as a barrier and the absence of the cover predisposes the water to contamination in the location within which the storage container is placed. Respondents were asked to indicate whether their primary water storage containers had covers. In the wet season, 24 (6.3%) of storage vessels did not have a cover whereas 354 (93.7%) had covers. On the other hand, in the dry season, 66 (18.1%) did not have covers whereas 298 (81.9%) had covers (Table 4.30). A Chi-square test of independence suggested that there was a statistically significant relationship between the season and whether their primary water storage vessels had a cover, χ^2 (1, n=742) = 24.1 , $p \leq 0.00$. In other words, the presence of a vessel cover was season dependent. However, the availability of a water storage vessel cover did not necessarily mean the storage vessel was covered at the time of interview. Therefore, households were asked to indicate if their water storage vessels were covered or not and the responses have been tabulated in Table 4.27.

Table 4.27 A cross tabulation of observed and reported responses for the state of the cover of the primary water storage vessel.

Responses	**Respondent Reported (%)**		**Interviewer Observed (%)**	
	Wet (%)	**Dry (%)**	**Wet (%)**	**Dry (%)**
Yes	302 (79.9)	288 (79.3)	210 (63.4)	151 (69.9)
No	65 (17.2)	70 (19.3)	46 (13.9)	60 (27.8)
Partially	11 (2.9)	5 (1.4)	75 (22.7)	5 (2.3)
Total	378 (100)	363 (100)	331 (100)	216 (100)

Source: Author's field survey, 2012 and 2013.

In Table 4.27, reported cases for the wet season shows that 302 (79.9%) households approximately 80%, reported that their vessels were covered whilst 65

(17.2%) indicated that their vessels were not covered. An additional 11 (2.9%) households further indicated that their vessels were covered partially. However in the dry season, when households were revisited, the percentage of households that had reportedly covered that vessels reduced from 302 (79.9%) to 288 (79.3) indicating a reduction by 14 (4.6%). Also, there was an increase in the percentage of households whose vessels were not covered from 65 (17.2%) in the wet season to 70 (19.3%) in the dry season whilst households with partially covered vessels also decreased from 11 (2.9%) to 5 (1.4%) in the wet and dry seasons respectively.

On the other hand, data on the structured observation was available for 331 and 216 households in the wet and dry seasons respectively. Observations showed that 210 (63.4%) of household water storage vessels were covered whilst 46 (13.9) were not and an additional 75 (22.7%) were partially covered in the wet season. In the dry season, 151 (69.9%) approximately 70% indicated that their vessels were covered, 60 (27.8%) not covered and 5 (2.3%) partially covered (Table 4.31). The results of a Chi-square test of independence for reported responses and structured observations were χ^2 (2, n=709) = 64.58, $p \leq 0.00$ and , χ^2 (2, n=579) = 6.63, $p = 0.03$ respectively. The results suggests that there was a statistically significant relationship between the responses given by respondents and observations of their homes in each season.

4.9 Chapter Summary

This chapter presented socio-demographic data on the study households and proceeded to characterize domestic water use behaviour within the household with respect to broad themes such as the household environment, housing characteristics, primary water sourced used by households, domestic water collection, levels of service of households, the cost of domestic water and domestic water storage.

There was no difference in the distribution of urban and peri-urban residents with respect to number of rooms occupied, number of under five year olds. However, there was a statistically significant difference in the distribution of urban and peri-urban households with respect to the number of years resident in the dwelling and number of under fifteen year olds. Mothers and their spouses also differed significantly with regards to occupation.

With respect to water sources, there was a statistically significant difference between improved and unimproved sources. There was a statistically significant difference between water sources used for domestic purposes and drinking purposes. Chi-square tests showed that in the wet season and dry season, households were significantly distributed differently across variables such as primary drawer for the household, primary water collection vessel, number of trips per day for water collection, number of days for water collection per week, total daily volume of household water collected and period of day for water collection. In addition, households were significantly distributed differently across number of water service hours per day at the primary water source, frequency of water storage, frequency of water transfer, place of water storage and covering of the primary water storage vessel.

CHAPTER FIVE

5.0 DETERMINANTS OF DOMESTIC WATER USE

5.1. Introduction

In the preceding chapter, a discussion on the characterization of domestic water use behaviour was presented. In this chapter, the determinants of domestic water use are examined. Specifically, it examines the determinants of self-reported water use in the wet and dry seasons, determinants of water use in piped and un-piped households and determinants of water use in urban and peri-urban households.

5.2 Determinants of Domestic Water Use

Globally, there has been a gradual change in focus of development practitioners from the implementation of water supply systems to understanding the factors that affect water demand (Gleick, 2003). The literature suggested that the influence of economic factors such as income and water price on demand had been discussed extensively (Arbues and Villanua, 2006; Arbues et al., 2010; Domene and Sauri, 2006; Campbell et al 2004). However, there were some socio-demographic factors in literature that were noted to have influenced water use at the household level. Examples included ownership of water appliances, education (House-Peters et al., 2010;) , number of bedrooms (Fox et al ., 2009) and household size (Keshavarzi et al., 2006; Arbues and Villanua, 2006). Table 5.1 shows the variables that were hypothesized to be the determinants of per-capita water use in households with children less than five years following the reviewed literature.

Table 5.1 Hypothesized determinants of water use in the household environment.

Variable	PASW indicator	Scale	Coding
Household socio-economic status	Household is middle income or lower	Categorical	Yes – 1 No – 0
Mother's educational level	Mother is not educated	Categorical	Yes – 1 No – 0
Hours of water service	Water service is 24hrs	Categorical	Yes – 1 No – 0
Volume of the primary water storage vessel. > 40 L	Storage vessel is above 40 liters	Categorical	Yes – 1 No – 0
Amount paid for water per vessel (GH₵)	Amount paid for water	Continuous	-
Household size	Household size	Continuous	-
Time taken to make a return water collection trip (Minutes.)	Total time taken to walk, get water and back (Minutes).	Continuous	-
Number of functional taps	Number of functional taps	Continuous	-
Number of under-five year old children	Number of under-five year olds	Continuous	-
Number of water storage vessels (Irrespective of size)	Number of water storage vessels	Continuous	-
Length of water storage (days)	Length of water storage (days)	Continuous	-

Source: Author's field survey, 2012 and 2013; Sandiford et al., (1990) and Thompson et al., (2001).

Variables such as household socio-economic status, mother's educational level, hours of water service and volume of primary water storage vessel were categorized into 'Yes' and 'No' and coded Yes-1 and No-0 for the multiple regression analysis.

In order to assess the variables and their ability to adequately predict water use, 'enter' and 'stepwise' methods of multiple regression were employed. With respect to the enter method, all the hypothesized variables were entered as one model and the success of the model in predicting per capita water use (l/c/d) was assessed.

On the other hand, in the stepwise method, each variable was entered in sequence and its value assessed. Where the variable contributed significantly to the model, it was retained. All the other remaining variables were re-entered to assess their contributions to the success of the model and if they did not contribute significantly to the model, they were removed. The stepwise method ensured that only a small possible set of determinants were included in the model and therefore it also gave the minimum number of variables needed to determine water use (Sandiford et al., 1990; Gazinelli et al., 1998).

5.3 Determinants of Water Use in Households with Children Under-Five Years During the Wet and Dry Seasons

In Table 5.2, the wet season correlation matrix of the relationship between water use and the 11 hypothesized variables is shown. The table indicates that in the wet season, water use per-capita was negatively correlated with household socio-economic status, mother's educational level, household size, number of functional taps in the household, number of under-five year olds and number of water storage containers. However, water use was positively correlated with duration of water service, the volume of primary water storage vessel, time taken to make a return water collection trip and length of water storage.

Table 5.2 Correlation matrix of the relationship between water use and 11 variables in **all study households** in the **wet season.**

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
L / capita / day (Wet season) (1)	1											
Household is middle income or lower (2)	-0.178*	1										
Number of service hours is 24hrs (3)	0.046	-0.093	1									
Mother had no formal education (4)	-0.058	0.162*	-0.148*	1								
Storage vessel is above 40 liters (5)	0.202*	-0.146*	0.031	-0.112	1							
Amount paid for water (GH Cedis) (6)	0.066	-0.156*	0.083	-0.051	0.084	1						
Household size (7)	-0.237*	0.021	-0.156*	0.212*	0.046	-0.129*	1					
Total time taken to walk, get water and back (Minutes) (8)	0.004	-0.054	0.007	-0.027	0.000	-0.118	0.121	1				
Number of functional taps in household (9)	-0.073	-0.062	0.163*	-0.099	0.012	0.247**	-0.192**	-0.103	1			
Number of under 5 year olds (10)	-0.091	0.104	-0.079	0.042	-0.161*	-0.114*	0.209*	-0.006	-0.063	1		
Number of water storage containers (11)	-0.017	0.101	-0.092	-0.013	-0.081	0.057	0.076	0.089	0.05	0.018	1	
Length of water storage (days) (12)	0.001	-0.052	0.014	-0.078	0.162*	0.240**	-0.151*	0.062	0.00	-0.231*	0.160*	1

Source: Author’s field survey, 2012; * $p \leq 0.05$; ** $p \leq 0.01$

Table 5.3 Correlation matrix of the relationship between water use and 11 variables for **all study households** in the **dry season.**

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
L / capita / day (Dry season) (1)	1											
Household is middle income or lower (2)	0.033	1										
Mother had no formal education (3)	-0.007	0.037	1									
Amount paid for water (GH Cedis) (4)	-0.118	-0.190*	-0.081	1								
Household size (5)	-0.349**	-0.061	0.137	0.225**	1							
Total time taken to walk, get water and back (Minutes) (6)	-0.094	0.051	-0.066	-0.111	-0.02	1						
Number of functional taps in household (7)	-0.047	-0.069	-0.042	0.433**	-0.069	0.152*	1					
Number of under 5 year olds (8)	-0.05	-0.018	0.117	0.036	0.294**	0	-0.061	1				
Number of water storage containers (9)	0.027	0.069	-0.052	0.058	0.059	0.022	0.056	-0.005	1			
Water service hours is 24hrs in dry season (10)	-0.255**	0.055	0.029	0.05	0.008	0.029	0.134	-0.097	0.003	1		
Length of water storage (days) (11)	-0.314**	-0.01	-0.102	-0.064	-0.06	0.048	-0.053	0.076	-0.052	-0.199**	1	
Storage vessel is above 40 liters in dry season (12)	0.105	0.004	-0.035	0.038	0.045	0.099	-0.042	0.107	0.037	-0.085	0.178**	1

Source: Author's field survey, 2013; * $p \leq 0.05$; ** $p \leq 0.01$

Table 5.3 on the other hand shows the dry season correlation matrix of the relationship between water use and the 11 hypothesized variables. Water use was negatively correlated with mother's educational level, the amount paid for water, household size, time taken for a return water collection trip, number of functional taps in the household, number of under-five year olds, water service hours and length of water storage. A positive correlation was observed between water use and household socio-economic status, number of water storage containers and the volume of the primary water storage vessel. The correlation analysis also showed that only household size, hours of water service and length of water storage had a statistically significant correlation ($p \leq 0.05$) with water use per capita.

Tables 5.4 and 5.5 show the multiple regression coefficients for wet and dry seasons respectively using the 'enter' method. In Table 5.6, the enter method showed that together, all the 11 hypothesized variables could predict only 9% (Adjusted R^2 = 0.09) of the total variation in water use per-capita, likewise the stepwise method. However, the stepwise method showed that amongst the 11 hypothesized variables, only two variables contributed significantly to the model. These variables were household size and volume of the primary water storage vessel. The wet season data therefore suggests that there are other factors that account for water use in the study households apart from the hypothesized variables.

In the dry season analysis, all 11 variables accounted for 34% (Adjusted R^2 =0.34) of the variation in water use. However, the stepwise method showed that amongst the 11 variables, four contributed significantly to the model. These variables were household size, length of water storage, hours of water service and volume of the primary water storage vessel (Tables 5.5 and 5.6).

Table 5.4 Multiple regression coefficients for all households in the wet season.

Variables (Wet season)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	97.904	21.989		4.453	.000
Household is middle income or lower	-16.359	8.123	-.157	-2.014	.046
Number of service hours is 24hrs	1.129	8.007	.011	.141	.888
Mother had no formal education	6.049	13.243	.036	.457	.648
Storage vessel is above 40 liters	29.375	10.672	.215	2.753	.007
Amount paid for water (GH₵)	.986	1.649	.048	.598	.551
Number of people making up household	-10.103	2.799	-.294	-3.609	.000
Total time taken to walk, get water and back (Minutes)	.413	1.348	.023	.306	.760
Number of functional taps in household	-29.146	15.122	-.153	-1.927	.056
Number of under 5 year olds	-.881	7.580	-.009	-.116	.908
Number of water storage containers	1.380	1.788	.060	.772	.441
Length of water storage (days)	-3.746	2.820	-.108	-1.328	.186

Source: Author's field survey, 2012; Dependent Variable: L / capita / day (Wet season), n = 165

Table 5.5 Multiple regression coefficients for all households in the dry season.

Variables (Dry season)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	52.714	10.532		5.005	.000
Household is middle income or lower	.671	3.058	.013	.219	.827
Mother had no formal education	.065	4.505	.001	.014	.989
Amount paid for water (GH₵)	-.378	.450	-.061	-.839	.402
Number of people making up household	-5.624	.964	-.385	-5.832	.000
Total time taken to walk, get water and back (Minutes)	-.517	.333	-.097	-1.552	.122
Number of functional taps in household	-.285	5.323	-.004	-.053	.957
Number of under 5 year olds	2.114	2.717	.049	.778	.438
Number of water storage containers	.321	.734	.026	.438	.662
Number of service hours is 24hrs	-15.413	3.051	-.312	-5.051	.000
Length of water storage (days)	-5.281	.763	-.433	-6.921	.000
Storage vessel is above 40 liters	27.023	9.337	.178	2.894	.004

Source: Author's field survey, 2013; Dependent Variable: L / capita / day (Dry season), n = 185

Table 5.6 Multiple regression results for determinants of water use in all surveyed households in the wet and dry seasons.

Multiple Regression method		Variables in the model	(n)	R Square	Adjusted R^2	P-value
Wet season	Enter	All 11 variables	165	0.15	0.09	0.006
	Stepwise	1. Household size.	165	0.05	0.05	0.002
		2. Household size, Storage vessel is above 40 liters.	165	0.10	0.09	0.000
Dry season	Enter	All 11 variables	185	0.38	0.34	0.000
	Stepwise	1. Household size.	185	0.12	0.11	0.000
		2. Household size, Length of water storage (days).	185	0.23	0.22	0.000
		3. Household size, Length of water storage (days), Number of water service hours is 24 hrs.	185	0.34	0.33	0.000
		4. Household size, Length of water storage (days), Number of water service hours is 24 hrs, Storage vessel is above 40 liters.	185	0.36	0.35	0.000

Source: Author's field survey 2012 and 2013 ; (n) – Number of households that had observations for all hypothesized variables.

5.4 Water Use in Piped Households

5.4.1 Socio-demographic characteristics of piped households

In order to understand the factors that determine water use, distinctions were made between piped and un-piped households. According to the International Institute of Environment and Development (IIED), 'Piped households' have piped water supplied directly to their homes whereas 'un-piped households' obtain water from sources outside the home (Thompson et al., 2001:1).

Piped water supply coverage was low 42 (11.1%) amongst the study households. Abuakwa, an urban community, had the highest proportion 19 (45%) of piped households followed by Barekese 11 (26.2%), Asuofua 10 (23.8%) and Nkawie 2 (4.8%) but households were evenly distributed across urban and peri-urban settings with 21 (50%) of piped households being urban and 21 (50%) being peri-urban.

The mean age of a mother living in a piped household was 29 years (±7 S.D) compared to 37 years for spouses. A total of 31 (74%) mothers were married and only 2 (4.8%) of mothers did not have formal education. On the other hand, 100% of all spouses of mothers living in piped households were formally educated. With respect to occupation, more than half of the mothers interviewed were self-employed 22 (52.4%), housewives 9 (21.4%) or traders 8 (19%) whereas their male counterparts were mostly drivers 18 (42.9%), self employed 9 (21.4%) or traders 4 (9.5%).

Living in single room apartments with their households was reported by 31 (74%) mothers whereas more than half 28 (66.7%) of mothers indicated that they had only one under-five year old child in their household. In terms of socio-economic status, 33 (82.5%) of piped households were above the middle income category whereas 7 (17.5%) were in the middle income category or lower. The average liters of water consumed per capita per day in the wet and dry seasons were estimated at 58.03 liters and 25.33 liters respectively. In addition, an equal proportion of piped households 12 (50%) shared and 12 (50%) privately owned latrines with a large proportion 31 (71.4%) using unimproved sanitation though the household was piped.

5.4.2 Determinants of water use in piped households

There were a total of 42 (11.1%) of piped households and 336 (88.9%) un-piped households but in the statistical analysis, there were 17 and 23 households which had observations for all the hypothesized variables in the wet and dry seasons respectively. Table 5.7 shows the correlation matrix of water use and 10 variables in the wet season. Water use showed a negative correlation with household socio-economic status, volume of primary water storage vessel, household size and time taken to make a return water collection trip (min.). A positive correlation was however found between water use and hours of water service, amount paid for water, the number of functional taps, number of under-five year olds, number of water storage containers and length of water storage (Table 5.7). The number of functional taps and number of under five year olds were the only variables that showed a statistically significant correlation with water use in the wet season.

On the other hand, Table 5.8 shows that in the dry season, factors such as household socio-economic status and mother's educational level showed a positive correlation with water use. Factors such as amount paid for water, household size, time taken to make a return water collection trip (min.) and the number of functional taps in the household were negatively correlated with water use in the dry season.

Table 5.7 Correlation matrix of the relationship between water use and 10 variables in **piped households** in the wet season.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
L / capita / day (Wet season) (1)	1										
Household is middle income or lower (2)	-0.025	1									
Number of service hours is 24hrs (3)	0.092	-0.494	1								
Volume of storage vessel above 40 liters (4)	-0.035	-0.339	-0.091	1							
Amount paid for water (GH Cedis) (5)	0.314	-0.381	0.193	0.135	1						
Household size (6)	-0.309	-0.303	0.15	0.297	-0.031	1					
Total time taken to walk, get water and back (Minutes) (7)	-0.179	0.12	-0.649	0.305**	-0.134	0.404	1				
Number of functional taps in household (8)	0.413*	0.132	-0.065	0.209	0.244	-0.436	-0.139	1			
Number of under 5 year olds (9)	0.468*	-0.119	0.203	0.139	-0.297	-0.013	-0.294	-0.182	1		
Number of water storage containers (10)	0.193	0.133	0.198	-0.406	0.315	0.346	-0.279	-0.194	0	1	
Length of water storage (days) (11)	0.043	-0.203	0.222	-0.098	0.472*	0.405	0.208	-0.07	-0.245	0.234	1

Source: Author's field survey, 2012; * $p \leq 0.05$; ** $p \leq 0.01$

Table 5.8 Correlation matrix of the relationship between water use and 10 variables in **piped households** in the dry season.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
L / capita / day (Dry season) (1)	1										
Household is middle income or lower (2)	0.359*	1									
Mother had no formal education (3)	0.254	-0.183	1								
Amount paid for water (GH Cedis) (4)	-0.377*	-0.358	-0.188	1							
Household size (5)	-0.359*	-0.275	-0.213	0.794**	1						
Total time taken to walk, get water and back (Minutes) (6)	-0.123	-0.138	-0.216	-0.28	-0.069	1					
Number of functional taps in household (7)	-0.165	0.026	0.322	0.455*	0.247	-0.405	1				
Number of under 5 year olds (8)	-0.246	-0.273	-0.247	0.238	0.497	0.311	-0.054	1			
Number of water storage containers (9)	-0.182	0.092	0.178	0.143	0.049	-0.141	-0.162	0.012	1		
Water service hours is 24 for Dry season (10)	-0.357*	-0.098	0.183	-0.176	-0.264	0.323	-0.026	-0.335	0.033	1	
Length of water storage (days) (11)	-0.391*	-0.09	-0.215	-0.004	-0.101	-0.179	0.045	-0.122	0.087	-0.104	1

Source: Author’s field survey, 2013; * $p \leq 0.05$; ** $p \leq 0.01$

Statistically significant correlations were found between water use and household socio-economic status, amount paid for water, household size, hours of water service and the length of water storage in the dry season.

Table 5.9 Multiple regression results for determinants of water use in piped households.

Season	**Multiple Regression method**	**Variables in model**	**(n)**	**R Square**	**Adjusted R^2**	**P-value**
Wet season	Enter	10 variables	17	0.93	0.81	0.009
Dry season	Enter	10 variables	23	0.80	0.63	0.006

Source: Author's field survey, 2012 and 2013.

Table 5.9 presents the results of the enter method of multiple regression. Due to the low number of cases with complete observations for both the wet and dry seasons a stepwise analysis could not be conducted in SPSS. The enter method alternatively shows that in the wet season, the hypothesized variables accounted for 81% of the variation in 17 cases whereas in the dry season, the hypothesized variables accounted for 63% of the variation in 23 cases. Due to the relatively small number of cases with complete observations for all the hypothesized variables in piped households for both wet (n = 17) and dry season (n = 23), the multiple regression results in Table 5.9 must be interpreted with caution.

5.5 Water Use in Un-Piped Households

5.5.1 Socio-demographic characteristics of un-piped households

There were a relatively large proportion 336 (88.9%) of un-piped households observed in the study with a total of 221 (65.8%) and 115 (34.2%) of un-piped households being urban and peri-urban respectively. Of the four study communities, the highest proportion 156 (46.4%) of un-piped households lived in Abuakwa whilst 65 (19.3%) and 60 (17.9%) lived in Nkawie and Barekese respectively with 55 (16.4%) of un-piped households living in Asuofua.

More than 80% of mothers living in un-piped households 284 (84.8%) lived in a one room apartment with an average household size of 5 members (±2 S.D.) whilst 222 (66.5%) of mothers also lived with only one under-five year old child in their household. The mean age of a mother living in an un-piped household was 31 years (±7 S.D) whereas that of their spouses was 38 years (±9 S.D).

With respect to education, 36 (10.7%) of mothers did not have any formal education compared to 18 (5.7%) of their male counterparts. Most mothers 142 (42.3%) who lived in un-piped households were traders, self employed 98 (29.2%), or housewives 33 (9.8%) whereas their male counterparts were mostly self employed 147 (43.8%), drivers 63 (19.4%), or civil servants 33 (10.2%).

The average amount paid for water per day per capita was estimated at GH₵ 1.00, with an average of 4 vessels of water collected per capita per day. It also took an average of 5 minutes to make a return water collection trip for un-piped households. In the wet and dry season, the average volume of water used per capita per day was estimated at 53.65 liters and 21.34 liters respectively. Ownership of sanitation facilities was skewed towards sharing 64 (71.9%) and private ownership 25 (28.1%) whilst majority 311 (92.6%) used unimproved sanitation facilities.

5.5.2 Determinants of water use in un-piped households

An assessment of the determinants of water use in un-piped households was preceded by a correlational analysis of the hypothesized factors. Factors such as household socio-economic status, mother's educational level, household size, number of functional taps, number of under-five year olds and number of water storage containers were negatively correlated with water use. However factors such as hours of water service, volume of primary water storage vessel, amount paid for water and the length of water storage showed a positive correlation with water use in un-piped households (Table 5.10). Amongst the hypothesized variables, only socio-economic status, volume of the primary water storage vessel and household size had a statistically significant correlation with water use.

In Table 5.11, the dry season correlation matrix for un-piped households is presented. Nine factors namely household socio-economic status, mother's educational level, amount paid for water, household size, time taken to make a return water collection trip, number of functional taps, number of under-five year olds, hours of water service and length of water storage showed a negative correlation with water use. Only two factors showed a positive correlation in the dry season namely number of water storage containers and volume of the primary water storage vessel. Furthermore, three variables showed a statistically significant correlation and they were household size, hours of water service, and length of water storage (Table 5.11). A comparison of the correlation matrices for both wet and dry seasons reveals some similarities.

Table 5.10 Correlation matrix of the relationship between water use and 11 variables in **un-piped households** in the wet season.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
L / capita / day (Wet season) (1)	1											
Household is middle income or lower (2)	-0.194*	1										
Number of service hours is 24hrs (3)	0.069	-0.058	1									
Mother had no formal education (4)	-0.072	0.167*	-0.131	1								
Volume of storage vessel above 40 liters	0.222**	-0.131	0.014	-0.104	1							
Amount paid for water (GH Cedis) (6)	0.12	-0.100	-0.046	-0.017	0.051	1						
Household size (7)	-0.270**	0.026	-0.118	0.193*	0.066	-0.072	1					
Total time taken to walk, get water and back (Minutes) (8)	0.000	-0.073	0.069	-0.042	-0.003	-0.098	0.086	1				
Number of functional taps in household (9)	-0.101	-0.105	0.123	-0.074	-0.08	-0.032	-0.084	-0.052	1			
Number of under 5 year olds (10)	-0.123	0.12	-0.082	0.035	-0.171*	-0.06	0.208**	0.004	-0.009	1		
Number of water storage containers (11)	-0.025	0.099	-0.117	-0.011	-0.066	-0.028	0.074	0.117	0.106	0.022	1	
Length of water storage (days) (12)	0.023	-0.026	-0.054	-0.058	0.164*	0.091	-0.131	0.080	-0.121	-0.220**	0.152*	1

Source: Author’s field survey, 2012; * $p \leq 0.05$; ** $p \leq 0.01$

Table 5.11 Correlation matrix of the relationship between liters of water use and 11 variables in **un-piped households** in the **dry season.**

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
L / capita / day (Dry season) (1)	1											
Household is middle income or lower (2)	-0.006	1										
Dummy Mother had no formal education (3)	-0.037	0.054	1									
Amount paid for water (GH Cedis) (4)	-0.058	-0.134	-0.042	1								
Household size (5)	-0.349**	-0.035	0.193**	-0.118	1							
Total time taken to walk, get water and back (Minutes) (6)	-0.089	0.070	-0.051	-0.069	-0.014	1						
Number of functional taps in household (7)	-0.039	-0.037	-0.107	0.167*	-0.154*	0.343**	1					
Number of under 5 year olds (8)	-0.026	0.011	0.154*	-0.082	0.268	-0.034	-0.084	1				
Number of water storage containers (9)	0.048	0.078	-0.069	-0.029	0.069	0.041	0.066	-0.008	1			
Number of service hours is 24hrs in dry season (10)	-0.250**	0.092	0.021	0.081	0.068	0.000	0.113	-0.076	-0.013	1		
Volume of water storage vessel above 40 liters (11)	0.111	0.012	-0.033	0.026	0.057	0.106	-0.094	0.111	0.033	-0.101	1	
Length of water storage (days) (12)	-0.306**	-0.017	-0.099	-0.039	-0.067	0.067	-0.020	0.096	-0.053	-0.193**	0.194**	1

Source: Author’s field survey, 2013; * $p \leq 0.05$; ** $p \leq 0.01$

The correlation data presented in Tables 5.10 and 5.11 suggest that factors such as household socio-economic status, mother's educational level, household size and the number of under-five year olds have a negative correlation with water use. In other words, in both wet and dry seasons, the aforementioned factors exhibit an inverse relationship with water use. For example as the household size increases, there is likely to be a reduction in the amount of water collected per-capita in un-piped households.

With respect to assessing the determinants of water use in un-piped households in the Wet season, the hypothesized variables together accounted for 12% of the variation in water use whereas in the dry season, the hypothesized variables together accounted for 33% of the variation (Table 5.14). This result therefore suggests that together, the hypothesized variables could not provide a good model for the prediction of water use in the wet season. Further analysis using the stepwise method showed that amongst the hypothesized variables in the wet season, only household socio-economic status, household size and the volume of the primary water storage vessel contributed significantly to the model (Tables 5.12 and 5.14).

Compared to the wet season, the hypothesized variables in the dry season presented a relatively better model for the prediction of water use (Adjusted R^2 = 0.33). Factors (variables) such as volume of the primary water storage vessel, hours of water service, length of water storage and household size accounted for 33% of the variation in water use. An observation worth noting is the fact that household size and volume of the primary water storage vessel manifest themselves as significant predictors of water use for un-piped households in both wet and dry seasons (Tables 5.13 and 5.14)

Table 5.12 Multiple regression coefficients for un-piped households in the Wet season.

Variables (Wet season)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	101.168	23.212		4.358	.000
Household is middle income or lower	-18.697	8.743	-.173	-2.138	.034
Number of service hours is 24hrs	4.893	8.561	.046	.572	.569
Mother had no formal education	5.285	13.541	.032	.390	.697
Volume of storage vessel above 40 liters	30.799	11.201	.223	2.750	.007
Amount paid for water (GH₵)	2.816	2.868	.077	.982	.328
Number of people making up household	-10.587	2.917	-.302	-3.630	.000
Total time taken to walk, get water and back (Minutes)	.196	1.429	.011	.137	.891
Number of functional taps in household	-39.198	21.783	-.145	-1.800	.074
Number of under 5 year olds	-1.704	8.047	-.017	-.212	.833
Number of water storage containers	1.550	1.909	.066	.812	.418
Length of water storage (days)	-3.420	3.074	-.093	-1.112	.268

Source: Author's field survey, 2012; Dependent Variable: L / capita / day (Wet season), n = 148

Table 5.13 Multiple regression coefficients for un-piped households in the Dry season.

Variables (Dry season)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	53.070	10.814		4.908	.000
Household is middle income or lower	-.868	3.272	-.018	-.265	.791
Mother had no formal education	-.353	4.795	-.005	-.074	.941
Amount paid for water (GH₵)	-1.627	1.042	-.105	-1.562	.120
Number of people making up household	-6.271	1.075	-.407	-5.834	.000
Total time taken to walk, get water and back (Minutes)	-.466	.372	-.088	-1.252	.213
Number of functional taps in household	-1.189	7.051	-.012	-.169	.866
Number of under 5 year olds	2.969	2.864	.071	1.036	.302
Number of water storage containers	.547	.776	.046	.705	.482
Number of service hours is 24hrs dry season	-13.103	3.296	-.267	-3.975	.000
Volume of water storage vessel above 40 liters	27.051	9.541	.191	2.835	.005
Length of water storage (days)	-5.057	.806	-.426	-6.277	.000

Source: Author's field survey, 2013; Dependent Variable: L / capita / day (Dry season), n = 162

Table 5.14 Multiple regression results for determinants of water use in **un-piped households.**

Multiple Regression method		Variables in model	(n)	R Square	Adjusted R^2	P-value
Wet season	Enter	All 11 variables	148	0.18	0.12	0.002
	Stepwise	1. Household size	148	0.07	0.06	0.001
		2. Volume of storage vessel, Household size.	148	0.13	0.11	0.000
		3. Household is middle income or lower, Volume of storage vessel, Household size	148	0.15	0.13	0.000
Dry season	Enter	All 11 variables	162	0.37	0.33	0.000
	Stepwise	1. Household size	162	0.12	0.11	0.000
		2. Length of water storage (days), Household size.	162	0.23	0.22	0.000
		3. Number of service hours is 24hrs, Length of water storage (days), Household size.	162	0.31	0.30	0.000
		4. Volume of water storage vessel is above 40 liters, number of service hours is 24hrs, length of water storage (days), Household size.	162	0.35	0.33	0.000

Source: Author’s field survey, 2012 and 2013

5.6 Water Use in Urban Households

5.6.1 Socio-demographic characteristics of urban households

An assessment of selected socio-demographic characteristics of urban households shows that between the two urban study communities (n = 242), the highest proportion of urban residents 175 (72.3%) were located in Abuakwa followed by 67 (27.7%) located in Nkawie. Married respondents constituted 207 (85.5%) of the urban study population whilst the mean household size was 5 members (± 2 S.D). Also there were 155 (64.6%) of urban households with only one under five year old child living in it with 203 (84.2%) living in single room apartments.

The mean age of mothers in urban households was 31 years (± 6 S.D) compared to 39 years (± 9 S.D) for their male counterparts. Whereas majority of mothers 104 (43%) were involved in trading, 76 (31.4%) were self employed or housewives 25 (10.3%), 98 (40.5%) of their male counterparts were self employed, drivers 48 (19.8%) or civil servants 23 (9.5%). With respect to education, more mothers in urban households 24 (10%) did not have formal education compared to 13 (5.8%) of their male counterparts. Though 224 (92.6%) of urban households used improved sources, only 21 (8.7%) were piped with water. The average amount paid for water per capita per day was estimated at GH₵ 2.00 and it took an average of 6 minutes to make a return water collection trip for an urban household. In the wet and dry seasons, the average volume of water consumed per capita per day was estimated at 61.24 and 21.17 liters respectively. With respect to sanitation, majority 222 (91.7%) used unimproved sanitation facilities whereas 20 (8.3%) using improved ones with a total of 20 (35%) and 37 (65%) households privately owning and sharing sanitation facilities respectively.

5.6.2 Determinants of water use in urban households

The urban setting is one that presents itself as an attractive pull for some households living in peri-urban and rural settings. The perceived advantages of relatively better opportunities in urban areas such as good schools, roads, telecommunications, water, sanitation, superior housing and relatively better jobs serve as pull factors for households seeking better opportunities in the urban areas.

Due to their higher populations, urban areas are characterized by a high demand for water services compared to rural areas. The correlations between water use and hypothesized factors in the wet and dry seasons are presented in Tables 5.15 and 5.16 respectively. In the wet season, only capacity of the volume of the primary water storage vessel, number of water storage vessels, and length of water storage showed a positive correlation with water use. Factors such as household socio-economic status, mother's educational level, amount paid for water, household size, number of functional taps and the number of under-five year olds showed a negative correlation with water use. Furthermore, only two factors; volume of the primary water storage vessel, and number of under-five year olds showed a statistically significant correlation with water use (Tables 5.15 and 5.17). In Table 5.16, household socio-economic status, number of functional taps and volume of the primary water storage vessel showed a positive correlation with water use in the dry season. A total of six factors showed a negative correlation namely; amount paid for water, household size, time taken to make a return water collection trip, number of under-five year olds, hours of water service and length of water storage. Only two variables showed a statistically significant correlation with water use namely; household size and length of water storage

Table 5.15 Correlation matrix of the relationship between water use and 11 variables in **urban households** in the wet season.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
L / capita / day (Wet season) (1)	1											
Household is middle income or lower (2)	-0.194	1										
Number of service hours is 24hrs in wet season (3)	0.138	0.007	1									
Mother had no formal education (4)	-0.17	0.158	-0.17	1								
Volume of storage vessel is above 40 liters in wet season (5)	0.278*	-0.243*	0.342**	-0.364**	1							
Amount paid for water (GH Cedis) (6)	-0.127	-0.069	-0.111	0.251*	-0.172	1						
Household size (7)	-0.133	-0.200	-0.113	0.068	0.228	-0.082	1					
Total time taken to walk, get water and back (Minutes) (8)	-0.003	-0.115	0.054	-0.005	0.214	-0.03	0.108	1				
Number of functional taps in household (9)	-0.106	0.208	0.141	-0.064	0.072	0.221	-0.181	-0.084	1			
Number of under 5 year olds (10)	-0.206*	0.027	-0.224*	0.325**	-0.309**	0.103	0.225*	0.086	-0.138	1		
Number of water storage containers (11)	0.190	0.078	-0.068	0.152	-0.167	-0.138	0.159	-0.022	-0.042	0.041	1	
Length of water storage (days) (12)	0.006	0.017	0.145	-0.056	0.121	-0.094	-0.262*	-0.115	0.215*	-0.218*	-0.055	1

Source: Author's field survey, 2012; * $p \leq 0.05$; ** $p \leq 0.01$

Table 5.16 Correlation matrix of the relationship between water use and 11 variables in **urban households** in the dry season.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
L / capita / day (Dry season) (1)	1											
Household is middle income or lower (2)	0.037	1										
Mother had no formal education (3)	0.045	-0.046	1									
Amount paid for water (GH Cedis) (4)	-0.086	-0.162	-0.069	1								
Number of people making up household (5)	-0.348**	-0.257**	-0.046	0.519**	1							
Total time taken to walk, get water and back (Minutes) (6)	-0.093	0.059	-0.125	-0.093	-0.08	1						
Number of functional taps in household (7)	0.050	0.048	0.056	0.543**	0.053	0.280**	1					
Number of under 5 year olds (8)	-0.155	-0.126	0.288**	0.150	0.350**	0.014	-0.092	1				
Number of water storage containers (9)	0.016	-0.046	0.112	0.09	0.174*	0.054	0.099	-0.06	1			
Number of service hours per day is 24 hours in the dry season (10)	-0.171	0.154	0.031	-0.097	-0.061	0.04	0.069	-0.059	-0.009	1		
Volume of water storage vessel is above 40 liters (11)	0.124	-0.104	-0.111	0.035	0.077	0.07	0.068	0.123	-0.008	-0.168	1	
Length of water storage (days) (12)	-0.427**	-0.041	-0.041	-0.1	-0.005	0.036	-0.124	0.107	-0.041	-0.201*	0.195*	1

Source: Author's field survey, 2013; * $p \leq 0.05$; ** $p \leq 0.01$

The multiple regression coefficients for urban households in the wet and dry seasons are presented in Tables 5.17 and 5.18 respectively. Also, the multiple regression analysis of the determinants of water use in urban households is presented in Table 5.19 and it shows that in the wet season, all the hypothesized variables together accounted for only 12% of the variation in water use (Tables 5.17 and 5.19). However, the stepwise method shows that three variables (factors), volume of the primary water storage vessel, number of water storage vessels and household size, together accounted for 16% of the total variation in water use in urban households (Table 5.19).

On the other hand, the 11 hypothesized variables together accounted for 37% of the variation in water use in the dry season compared to 12% in the wet season. The stepwise method however yielded a relatively better model compared to that of the wet season. A total of 40% of the variation in water use in the dry season for urban households was accounted for by four factors namely; length of water storage, household size, hours of water service and volume of the primary water storage vessel (Tables 5.18 and 5.19).

The results of the multiple regression analysis shown in Table 5.19 therefore suggests that in urban households, the volume of the primary water storage vessel and household size are determinants that manifest themselves in both the wet and dry seasons.

Table 5.17 Multiple regression coefficients for urban households in the Wet season.

Variables (Wet season)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	90.848	36.010		2.523	.015
Household is middle income or lower	-17.007	12.423	-.172	-1.369	.176
Number of service hours is 24hrs	1.656	12.450	.017	.133	.895
Mother had no formal education	-3.440	20.058	-.023	-.172	.864
Volume of storage vessel is above 40 liters	50.526	20.706	.369	2.440	.018
Amount paid for water (GH₵)	-7.844	32.578	-.031	-.241	.811
Number of people making up household	-11.251	4.614	-.331	-2.438	.018
Total time taken to walk, get water and back (Minutes)	-1.217	1.823	-.080	-.668	.507
Number of functional taps in household	-37.757	36.777	-.131	-1.027	.309
Number of under 5 year olds	-4.091	12.303	-.044	-.332	.741
Number of water storage containers	8.727	3.450	.307	2.530	.014
Length of water storage (days)	-3.448	4.213	-.103	-.818	.417

Source: Author's field survey, 2012; Dependent Variable: L / capita / day (Wet season), n = 68

Table 5.18 Multiple regression coefficients for urban households in the Dry season.

Variables (Dry season)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	53.197	14.153		3.759	.000
Household is middle income or lower	-.875	4.280	-.018	-.204	.839
Mother had no formal education	.584	6.731	.008	.087	.931
Amount paid for water (GH)	.017	.716	.003	.024	.981
Number of people making up household	-5.935	1.590	-.416	-3.734	.000
Total time taken to walk, get water and back (Minutes)	-.505	.385	-.125	-1.311	.194
Number of functional taps in household	2.846	8.974	.039	.317	.752
Number of under 5 year olds	.282	3.674	.008	.077	.939
Number of water storage containers	1.195	1.522	.068	.786	.434
Number of service hours is 24hrs	-12.253	4.192	-.257	-2.923	.005
Volume of water storage vessel is above 40 liters	29.102	11.810	.217	2.464	.016
Length of water storage (days)	-6.060	1.037	-.511	-5.844	.000

Source: Author's field survey, 2013; Dependent Variable: L / capita / day (Dry season), n = 92

Table 5.19 Multiple regression results for determinants of water use in urban households.

Multiple Regression method		Variables in model	(n)	R Square	Adjusted R^2	P-value
Wet season	Enter	All 11 variables	68	0.27	0.12	0.06
	Stepwise	1. Volume of storage vessel is above 40 liters.	68	0.07	0.06	0.022
		2. Volume of storage vessel is above 40 liters, Number of water storage containers.	68	0.13	0.10	0.009
		3. Volume of storage vessel is above 40 liters, Number of water storage containers, Household size.	68	0.20	0.16	0.002
Dry season	Enter	All 11 variables	92	0.44	0.37	0.000
	Stepwise	1. Length of water storage (days).	92	0.18	0.17	0.000
		2. Length of water storage (days), Household size.	92	0.30	0.28	0.000
		3. Length of water storage (days), Household size, Number of service hours is 24 hrs.	92	0.38	0.36	0.000
		4. Length of water storage (days), Household size, Number of service hours is 24 hrs, Volume of water storage is above 40 liters.	92	0.42	0.40	0.000

Source: Author's field survey 2012 and 2013.

5.7 Water Use in Peri-Urban Households

5.7.1 Socio-demographic characteristics of peri-urban households

Barekese and Asuofua were communities that accounted for 71 (52.2%) and 65 (47.8%) of total peri-urban households studied. In terms of housing characteristics, majority 122 (82.4%) of peri-urban households lived in single room apartments, whilst 21 (12.4%) and 3 (2.2%) lived in two room and three room apartments respectively. Furthermore, there were a total of 95 (69.9%) of peri-urban households with one under-five year old child.

Most mothers, 120 (88.2%), were married and had a mean age of 31 years (± 7 S.D) compared to 37 years (± 8 S.D) for their male counterparts. There were more mothers without formal education 14 (10.3%) compared to 5 (3.9%) of their male counterparts and in terms of occupation, most mothers interviewed in the peri-urban study communities were traders 46 (33.8%), self employed 44 (32.4%) or housewives 17 (12.5%). On the other hand, their male counterparts were mostly self employed 58 (42.6%), drivers 33 (24.3%) or traders 14 (10.3%).

Though majority of peri-urban households 133 (97.8%) used improved primary water sources only 21(15.4%) were piped. Peri-urban study households paid an estimated average of GH₵ 0.80 per capita per day for water collection with an average of 3 water storage containers per household. In terms of water use, peri-urban household used an estimated average of 45.34 liters and 23.03 liters of water per capita in the wet and dry seasons respectively. With respect to sanitation ownership, a larger proportion of peri-urban households 39 (69.6%) shared sanitation facilities compared to 17 (30.4%) of households which privately owned sanitation facilities with a high proportion of peri-urban households 119 (87.5%) using unimproved sanitation facilities.

5.7.2 Determinants of water use in peri-urban households.

Tables 5.20 and 5.21 show the correlation matrices for peri-urban households in the wet and dry seasons respectively. In the wet season, six out of 11 variables showed a negative correlation with water use and they included household socio-economic status, hours of water service, household size, number of functional taps, number of under-five year olds and number of water storage containers. Variables such as volume of primary water storage vessel, amount paid for water, time taken for a return water collection trip and length of water storage showed a positive correlation with water use. However, amongst the hypothesized variables, only two showed a statistically significant correlation with water use and the variables were household socio-economic status and household size (Table 5.20).

In the dry season correlation analysis (Table 5.21), household socio-economic status, the number of under five year olds, number of water storage vessels, number of and volume of the primary water storage vessel showed a positive correlation, whereas mother's educational level, amount paid for water, household size, time taken for a return water collection trip, number of functional taps, hours of water service and length of water storage showed a negative correlation with water use. With respect to statistical significance, three variables; household size, hours of water service and length of water storage showed a statistically significant correlation with water use in peri-urban households in the dry season.

Table 5.20 Correlation matrix of the relationship between water use and 11 variables in **peri-urban households** in the wet season.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
L / capita / day (Wet season) (1)	1											
Household is middle income or lower (2)	-0.171*	1										
Water service is 24hrs for wet season (3)	-0.027	-0.162	1									
Mother had no formal education (4)	0.010	0.165	-0.137	1								
Volume of storage vessel is above 40 liters in Wet Season (5)	0.148	-0.085	-0.169*	0.061	1							
Amount paid for water (GH Cedis) (6)	0.121	-0.204*	0.125	-0.074	0.124	1						
Household size (7)	-0.328**	0.166	-0.193*	0.313**	-0.069	-0.146	1					
Total time taken to walk, get water and back (Minutes) (8)	0.018	-0.004	-0.028	-0.045	-0.159	-0.173*	0.137	1				
Number of functional taps in household (9)	-0.033	-0.168	0.195*	-0.114	0.003	0.246**	-0.190*	-0.13	1			
Number of under 5 year olds (10)	-0.048	0.157	0.006	-0.177	-0.079	-0.133	0.188*	-0.075	-0.017	1		
Number of water storage containers (11)	-0.073	0.116	-0.093	-0.091	-0.034	0.042	0.063	0.151	0.043	0.035	1	
Length of water storage (days) (12)	0.033	-0.101	-0.06	-0.087	0.202	0.293**	-0.063	0.199*	-0.107	-0.221*	0.236**	1

Source: Author's field survey, 2012; * $p \leq 0.05$; ** $p \leq 0.01$

Table 5.21 Correlation matrix of the relationship between water use and 11 variables in **peri-urban households** in the dry season

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
L / capita / day (Dry season) (1)	1											
Household is middle income or lower (2)	0.024	1										
Mother had no formal education (3)	-0.055	0.119	1									
Amount paid for water (GH Cedis) (4)	-0.162	-0.232*	-0.1	1								
Household size (5)	-0.344**	0.135	0.319**	-0.148	1							
Total time taken to walk, get water and back (Minutes) (6)	-0.099	0.063	0.047	-0.176	0.058	1						
Number of functional taps in household (7)	-0.137	-0.184*	-0.141	0.299**	-0.189**	-0.089	1					
Number of under 5 year olds (8)	0.094	0.133	-0.107	-0.164	0.208**	-0.099	-0.022	1				
Number of water storage containers (9)	0.018	0.125	-0.147	0.046	0.033	0.062	0.037	0.076	1			
Water service hours is 24hrs in dry season (10)	-0.334**	-0.041	0.027	0.243**	0.076	0.013	0.199*	-0.151	0.008	1		
Volume of storage vessel is above 40 liters (11)	0.081	0.129	0.057	0.042	0.017	0.205*	-0.175*	0.093	0.062	0.014	1	
Length of water storage (days) (12)	-0.212*	0.018	-0.162	-0.019	-0.113	0.091	0.016	0.043	-0.066	-0.196*	0.16	1

Source: Author's field survey, 2013; * $p \leq 0.05$; ** $p \leq 0.01$

The wet season analysis of the determinants (Tables 5.22 and 5.24) showed that all the 11 hypothesized variables together could not provide a satisfactory model that determines water use (Adjusted R^2 = 0.08). Household size, was the only statistically significant variable that contributed only 9% of total variation in water use.

On the other hand, in the dry season, a relatively better model was provided when all 11 variables were assessed together using the 'enter' method (Adjusted R^2 = 0.29). This means that the enter method yielded a model that was able to predict about 30% of the variation in water use. The stepwise multiple regression method however showed that out of the 11 variables, only 3 contributed significantly to 29% of the variation in water use in the dry season and they include household size, hours of water service and length of water storage (Tables 5.23 and 5.24).

Table 5.22 Multiple regression coefficients for peri-urban households in the Wet season.

Variables (Wet season)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	101.649	29.338		3.465	.001
Household is middle income or lower	-15.579	11.152	-.147	-1.397	.166
Water service is 24hrs	-8.894	10.958	-.085	-.812	.419
Mother had no formal education	27.406	19.819	.152	1.383	.170
Volume of storage vessel is above 40 liters	14.732	14.032	.110	1.050	.297
Amount paid for water (GH₵)	2.020	1.791	.125	1.128	.262
Number of people making up household	-13.727	3.783	-.402	-3.629	.000
Total time taken to walk, get water and back (Minutes)	2.417	2.063	.125	1.172	.245
Number of functional taps in household	-19.644	17.526	-.119	-1.121	.266
Number of under 5 year olds	9.341	10.404	.097	.898	.372
Number of water storage containers	-.581	2.183	-.028	-.266	.791
Length of water storage (days)	-2.389	4.061	-.068	-.588	.558

Source: Author’s field survey, 2012; Dependent Variable: L / capita / day (Wet season), n = 97

Table 5.23 Multiple regression coefficients for peri-urban households in the Dry season.

Variables (Dry season)	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	54.011	17.411		3.102	.003
Household is middle income or lower	-.172	4.758	-.003	-.036	.971
Mother had no formal education	1.234	7.352	.016	.168	.867
Amount paid for water (GH₵)	-1.016	.747	-.135	-1.360	.178
Number of people making up household	-6.308	1.479	-.420	-4.264	.000
Total time taken to walk, get water and back (Minutes)	-.861	.866	-.092	-.993	.323
Number of functional taps in household	-7.083	7.604	-.090	-.932	.354
Number of under 5 year olds	5.494	5.025	.105	1.093	.278
Number of water storage containers	.137	.936	.013	.146	.884
Service hours is 24hrs	-15.374	4.832	-.303	-3.182	.002
Volume of storage vessel is above 40 liters	25.019	16.480	.144	1.518	.133
Length of water storage (days)	-4.200	1.162	-.336	-3.613	.001

Source: Author’s field survey, 2013; Dependent Variable: L / capita / day (Dry season), n = 93

Table 5.24 Multiple regression results for determinants of water use in peri-urban households.

Multiple Regression method		Variables in model	(n)	R Square	Adjusted R^2	P-value
Wet season	Enter	All 11 variables	97	0.19	0.08	0.057
	Stepwise	1. Number of people making up the household	97	0.10	0.09	0.001
Dry season	Enter	All 11 variables	93	0.38	0.29	0.000
	Stepwise	1. Household size.	93	0.11	0.10	0.001
		2. Household size, Service hours is 24hrs.	93	0.21	0.19	0.000
		3. Household size, Service hours is 24hrs, Length of water storage (days).	93	0.31	0.29	0.000

Source: Author's field survey 2012 and 2013.

5.8 Nature of Relationships Between Per-Capita Water Use and Hypothesized Factors

In Table 5.25, a summary table of the results of the correlational analysis between water use and 11 hypothesized variables (factors) is presented. Specifically Table 5.25 shows how the relationship between water use and the 11 factors were distributed across 6 settings.

Table 5.25 Summary table of the results of the correlational analysis between water use and 11 selected variables.

Variables	Settings									
	Piped		**Un-piped**		**Urban**		**Peri-urban**		**Total wet season**	**Total dry season**
	W	**D**	**W**	**D**	**W**	**D**	**W**	**D**		
Household is middle income or lower	−	+	−	−	−	+	−	+	−	+
Mother had no formal education	*	+	−	−	−	+	+	−	−	−
Amount paid for water (GH Cedis)	+	−	+	−	−	−	+	−	+	−
Household size	−	−	−	−	−	−	−	−	−	−
Total time taken to walk, get water and back (Minutes)	−	−	+	−	−	−	+	−	+	−
Number of functional taps	+	−	−	−	−	+	−	−	−	−
Number of under 5 year olds	+	−	−	−	−	−	−	+	−	−
Number of water storage containers	+	−	−	+	+	+	−	+	−	+
Hours of water service is 24hrs	+	−	+	−	+	−	−	−	+	−
Storage vessel is above 40 liters	−	*	+	+	+	+	+	+	+	+
Length of water storage (days)	+	−	+	−	+	−	+	−	+	−

Source: Author's field survey, 2012 and 2013; W- wet season; D – dry season ; * - Variable was excluded by SPSS.

The 6 settings were piped, un-piped, urban, peri-urban, wet and dry seasons and they were chosen in order to facilitate a broader appreciation and comparison of similarities and differences across time and space.

A key distinguishing feature in Table 5.25 is that household size was the only variable that was negatively correlated with water use per capita across all the selected settings. It therefore suggests that in households where the household size was large, water use per capita was low whereas water use per capita was higher in households which had lower household sizes. The inverse relationship between per capita water use and household size has been supported by studies such as, Martin (1999), Arouna and Dabbert (2009) and Keshavarzi et al., (2006). In all wet season surveys, household socio-economic status was negatively correlated with water use (Table 5.25).

The number of functional taps was positively correlated with water use in two exceptional settings namely in piped households in the wet season and in urban households in the dry season. Apart from the two mentioned settings, in all other settings, the number of functional taps manifested a negative correlation with water use (Table 5.25). The result suggests that per capita water use increased in households where the number of functional taps was smaller.

With respect to the size of the primary water storage vessel, a consistent pattern emerged. Apart from a negative correlation with water use in the wet season in piped households, the size of the primary water storage vessel showed a positive relationship with water use per capita across the selected settings. The data therefore suggests that the more households used primary water storage containers that were 40 liters and above, the higher the water use per capita was. This result may have been partially due to the desire of households to fill their storage vessels to the brim as an insurance for lengthy water storage and lengthy times of water usage as alluded to by some participants in FGDs.

Duration of water service was negatively correlated with per capita water use in peri-urban households during the wet and dry season only. In all the other settings, duration of water service was positively correlated with per-capita water use in the wet season and negatively correlated in the dry season. This result suggests that in the wet season, as duration of service increased, it may have offered the opportunity for the household to have collected more water thereby increasing per capita water use. In an FGD in Nkawie duration of service was deemed as very important to mothers. When asked the question 'If more water points are provided will you use more water?' a mother indicated that:

> *'It is not a matter of we getting more water and we using more water but that we get the water early to be able to do what we have to do'*.

It was learnt from the mothers in the FGD that because water collection activity was a household chore that 'took time' in addition to other competing interest, it was imperative that the duration of water service increased to afford the collection of water at any time of the day.

The length of water storage in days also showed a consistent pattern across all the selected settings. The number of days of storing water was positively correlated with water use per capita across the wet season whereas a negative correlation was observed. This result therefore suggests that an increase in water use per capita resulted when there was an increase in the number of days of water storage in the wet season. On the other hand, in the dry season, a decrease in the number of days of water storage resulted in an increase in water use per capita.

In general, the models that were derived to predict per capita water use had low predictive power and that could have been due to misspecification errors. The low predictive power could also reflects the fact that other factors apart from the hypothesized ones could have accounted for per capita domestic water use. According to Fan et al., (2013), the factors that affect domestic water use in the household are often complex and attempts to study the determinants' effect on water consumption may more often yield modest R^2 values up to 0.40. For example studies by Syme et al., (2004) in Perth Australia as well as Corral-Verdugo et al., (2002) in Mexico yielded R^2 values of 0.22 and 0.13 respectively. Also, Fan et al., (2013), in their China Wei River Basin study reported an R^2 value of 0.37. Therefore the observations of this study may be a reflection of the complex nature of water use factors in the domestic environment in general and households with children under five years in particular.

5.9 Per-Capita Water Use and its Relationship with the Number of Under-Five Year Olds in the Household

A positive relationship between the number of under-five year olds and water use was observed in two settings; in piped households in the wet season and in peri-urban households in the dry season (Table 5.25). The data suggests that in these settings, the volume of water used per capita increased when there was an increase in the number of under-five year olds. However, apart from the settings identified, the number of under-five year olds showed a negative correlation with water use per capita in all other settings (Table 5.25). The negative correlation suggests that an increase in the number of under five year olds, was followed with a decrease in water use per capita. In general, it is noted that families with children or teenagers can be expected to use more water (Corbella and Pujol, 2009; Krantz, 2005). However a distinction in the age categories of children must be made. The finding that the number of children below 5 years was not a determinant of water use could be explained in part by the fact that most water use decisions of under-five year old children may have been made by the mother or an older person in the household. However, from the FGDs, it was realized that 'children' from 6 – 18 years were given relatively increased freedom to make water use decisions compared to their counterparts who were 5 years and below. Under-five year old children were perceived by mothers in the FGD discussions as less capable of making 'appropriate' water use decisions. Therefore the amount of water that under-five year old children could use for bathing and other domestic activities was generally decided by the mother.

In terms of statistical significance, a statistically significant correlation was found between the number of under-five year old children and water use per capita in urban households in the wet season and in piped households in the wet season only. No statistically significant correlations were found in the dry season analysis with respect to the relationship between water use per capita and the number of under-five year old children.

An analysis of the determinants of water use in all study households, piped households, un-piped households, urban and peri-urban households is presented in Tables 5.6, 5.9, 5.14, 5.19 and 5.24 respectively. However in all the multiple regression analysis carried out to identify the determinants of water use, the number of under-five year old children failed to reach statistical significance of $p \leq 0.05$ and did not manifest as a determinant in any of the models derived to predict water use in any of the selected spatial contexts. Therefore this study failed to reject the hypothesis which states that 'H_0: The number of under-five year old children is not a statistically significant determinant of water use'. Though some mothers claimed in FGDs that they used more water when they had more under-five year old children due to the need to carry our laundry frequently, the data suggests that other factors such as household size, the volume of the primary water storage vessel and length of water storage were relatively stronger predictors of per-capita water use compared to number of children under-five years.

5.10 Chapter Summary.

This chapter examined the determinants of water use in piped and un-piped households, determinants of water use in urban and peri-urban households, and determinants of water use in the wet and dry seasons in general. Factors such as household size, length of water storage hours of water service and volume of the primary water storage vessel were identified as determinants of water use in the dry season. On the other hand, only household size and volume of the primary water storage vessel were identified as determinants of water use in a weak model predicting 9% of variation in water use in the wet season.

Piped water supply was low 42 (11.1%) amongst the study households. In un – piped households, volume of the primary water storage vessel, hours of water service, length of water storage and household size were identified as determinants of water use in a model that predicted 33% of variation in water use in the dry season. In the wet season, 13% of the variation in water use was explained by the combination of factors such as household socio-economic status, volume of the primary water storage vessel and household size.

In urban households, length of water storage, household size, hours of water service and volume of the primary water storage vessel together predicted 40% of the variation in water use in the dry season. In the wet season, 16% of the variation in water use was explained by the combined effect of volume of the primary water storage vessel, the number of water storage vessels and household size. In peri-urban households, household size, hours of water service and length of water storage predicted 29% of the variation in water use in the dry season whereas in the wet season, household size was the only variable identified as a determinants of water use in a model that predicted only 9% of the variation in water use. A comparison of the determinants across the selected spatial settings shows that the number of under-five year old children was not a statistically significant determinant of per-capita water use.

CHAPTER SIX

6.0 CHILDHOOD DIARRHOEA IN THE DOMESTIC ENVIRONMENT

6.1 Introduction

In the preceding chapter an analysis of the determinants of domestic water use was presented. This chapter discusses childhood diarrhoea under five broad themes; Maternal knowledge, health seeking behaviour and practices relating to childhood diarrhoea, childhood diarrhoea prevalence, risk factors associated with childhood diarrhoea in the wet and dry seasons, and the relationship between domestic water use and childhood diarrhoea.

6.2 Maternal Knowledge, Health Seeking Behaviour and Practices Relating to Childhood Diarrhoea

In Sub-Saharan Africa (SSA), though the responsibility of raising children belongs to both parents, the mother plays a vital role in the domestic environment by nurturing the newly born, cooking for the household and providing breast milk, an essential element which contains nutrients, antioxidants, hormones and antibodies by which infants develop (UNICEF/WHO, 2009). Communities vary with respect to maternal knowledge, health seeking behaviour and practices relating to childhood diarrhoea. Maternal knowledge, health seeking behaviour and practices are important due to the fact that they have significant implications for the control of childhood diarrhoea in the domestic environment.

6.2.1 Perceived knowledge of the cause of diarrhoea and its management

Mothers were asked to indicate the primary cause of childhood diarrhoea, the results of which are shown in Table 6.1. In decreasing percentage order, 'poor sanitation and hygiene' was viewed by 128 (34.4%) mothers as the primary cause of childhood diarrhoea. This was followed by poor water quality by 120 (32.3%) mothers, eating stale food 40 (10.8%), over eating 14 (3.8%), the supernatural 9 (2.4%), body contact with a person suffering from diarrhoea 3 (0.8%) and excessive fluid intake 2 (0.5%) (Table 6.1).

Table 6.1 Perceived primary cause of diarrhoea.

Primary cause of diarrhoea	**Communities (%)**				**Location (%)**		**Total (%)**
	Abuakwa	**Nkawie**	**Asuofua**	**Barekese**	**Urban**	**Peri-urban**	
The supernatural	3 (1.7)	1 (1.6)	4 (6.2)	1 (1.4)	4 (1.7)	5 (3.7)	9 (2.4)
Excessive drinking	1 (0.6)	1 (1.6)	0 (0)	0 (0)	2 (0.8)	0 (0)	2 (0.5)
Over eating	10 (5.7)	2 (3.1)	1 (1.5)	1 (1.4)	12 (5.0)	2 (1.5)	14 (3.8)
Poor water quality	60 (34.5)	13 (20.3)	32 (49.2)	15 (21.7)	73 (30.7)	47 (35.1)	120 (32.3)
Eating stale food	14 (8.0)	11 (17.2)	12 (18.5)	3 (4.3)	25 (10.5)	15 (11.2)	40 (10.8)
Body contact with sufferer	2 (1.1)	1 (1.6)	0 (0)	0 (0)	3(1.3)	0 (0)	3 (0.8)
Poor sanitation	51 (29.3)	27 (42.2)	9 (13.8)	41 (59.4)	78 (32.8)	50 (37.3)	128 (34.4)
Don't know	33 (19.0)	8 (12.5)	7 (10.8)	8 (11.6)	41 (17.2)	15 (11.2)	56 (15.1)
Total	174 (100)	64 (100)	65 (100)	69 (100)	238 (100)	134 (100)	372 (100)

Source: Author's field survey, 2012;

The data in Table 6.1 therefore suggests that about 77% of mothers had a satisfactory knowledge of the causes of childhood diarrhoea whereas 7.9% had unsatisfactory knowledge. A total of 56 (15.1%) mothers did not know the cause of childhood diarrhoea. Of this number (n = 56), majority 41 (73%) resided in urban communities whereas 15 (27%) resided in peri-urban communities. A study by Rehan et al., (2003) in India also found an unsatisfactory level of knowledge of mothers regarding the cause of diarrhoea.

As can be seen by the frequencies cross tabulated in Table 6.1, there was no statistically significant difference in the distribution of urban and peri-urban households across the perceived cause of childhood diarrhoea amongst mothers χ^2 (7, n = 372) = 10.31, p = 0.17. Residential location did not have any statistically sigignificant influence on the perceived cause of childhood diarrhoea.

According to the International Epidemiological Association, health education refers to learning resources and teaching programmes concerned with health – its protection and promotion (IEA, 2008). Health education about the causes, prevention and management of childhood diarrhoea is a vital tool which mothers use to secure the health of children. In the context of this study, five primary means of health education were identified as the sources from which mothers in the study were educated on diarrhoea related issues. These were through radio, television, the mid-wife, hospital staff such as nurses and doctors, and a formally organized briefing session in the community (Table 6.2). The most frequent means by which mothers received education about the causes, prevention and management of childhood diarrhoea was the television 96 (48.7%). This was followed by ‘a formally organized briefing session' from which 60 (30.5%) mothers indicated that they received education on diarrhoea at the health facility during weighing sessions.

Table 6.2 Primary means of receiving diarrhoea related information.

Primary means	**Communities (%)**				**Location (%)**		**Total**
	Abuakwa	**Nkawie**	**Asuofua**	**Barekese**	**Urban**	**Peri-urban**	
Radio	11 (13.8)	3 (7.1)	3 (9.1)	6 (14.3)	14 (11.5)	9 (12.0)	23 (11.7)
Television	35 (43.8)	21 (50.0)	17 (51.5)	23 (54.8)	56 (45.9)	40 (53.3)	96 (48.7)
Midwife	10 (12.5)	1 (2.4)	1 (3.0)	1 (2.4)	11 (9.0)	2 (2.7)	13 (6.6)
A formally organized briefing session	22 (27.5)	14 (33.3)	12 (36.4)	12 (28.6)	36 (29.5)	24 (32.0)	60 (30.5)
Hospital staff	1 (1.2)	3 (7.1)	0 (0)	0 (0)	4 (33.3)	0 (0)	4 (2.0)
Can't remember	1 (1.2)	0 (0)	0 (0)	0 (0)	1 (0.8)	0 (0)	1 (0.5)
Total	80 (100)	42 (100)	33 (100)	42 (100)	122 (100)	75 (100)	197 (100)

Source: Author's field survey, 2012.

In a FGD discussion in Asuofua, when asked about diarrhoea education at weighing sessions, a 32 year old mother indicated that;

> '*When we go for weighing, we are informed about the need to wash our hands by the nurses. They (nurses) also teach us how to prepare the ORS solution using the procedures which have been prescribed on the weighing card.*'

Thus the preceding quote suggests that at the weighing sessions, attention was given to the management of diarrhoea episodes whereas the causes and mechanisms of disease transmission in the domestic environment were minimally discussed. When asked about the effectiveness of the educational messages given during the weighing sessions, some mothers were of the view that it was not effective due to the fact that in some cases, when the mothers were being educated at the weighing sessions, other mothers would be conversing with their colleagues, attending to the needs of their babies or concentrating on activities taking place in the surrounding environment. Others were of the view that in some cases discussants at briefing sessions concentrated mostly on malaria than other diseases such as diarrhoea.

The radio, midwife, and hospital staff were comparatively minimal means by which 23 (11.7%), 13 (6.6%) and 4 (2.0%) mothers received health education on diarrhoea (Table 6.2). A study in India suggested that mothers' exposure to electronic mass media increased awareness and use of ORT (Rao et al., 1998). However in this study, formally organized briefing sessions together with the television constituted the primary means for approximately 80% of the study population (Table 6.2). A chi square test of independence showed χ^2 (7, n = 197) = 6.54, p = 0.25, indicating that there was no statistically significant difference between urban and peri-urban households with respect to the primary means of education on diarrhoea for mothers.

6.2.2 Health seeking behaviour of mothers during childhood diarrhoea episodes

Mothers were asked to indicate the most important symptom that motivated them to seek immediate medical attention for the under-five year old child in the household (index child). About 43% of mothers 114 (42.5%) sought immediate medical attention only when their under-five year old children got sicker (Table 6.3).

However, with respect to spatial distribution, more mothers living in urban households 95 (66%) sought immediate medical attention when their child's health condition became worse than those living in peri-urban households 49 (34%). This finding is similar to that of Buor (2004) who found a higher health facility utilization rate for urban districts compared to their rural counterparts in Ghana. The finding also suggests that in some cases mothers waited till the child's illness got worse before seeking medical attention and this is consistent with Adhikari et al., (2006) and Sreeramareddy et al., (2006) both of whom found that mothers sought health care only when their health situation or that of their children got worse.

Table 6.3 Symptoms that motivate a mother to seek immediate medical attention for her child who develops diarrhoea.

Symptoms	**Communities (%)**				**Location (%)**		**Total (%)**
	Abuakwa	**Nkawie**	**Asuofua**	**Barekese**	**Urban**	**Peri-urban**	
Child not able to drink or breast feed	14 (8.4)	6 (10.9)	10 (17.9)	4 (6.6)	20 (9.0)	14 (12.0)	34 (10.0)
Child's health becomes worse	78 (46.7)	17 (30.9)	14 (25.0)	35 (57.4)	95 (42.8)	49 (41.9)	144 (42.5)
Child develops fever	62 (37.1)	20 (36.4)	25 (44.6)	16 (26.2)	82 (36.9)	41 (35.0)	123 (36.3)
Child has fast breathing	6 (3.6)	7 (12.7)	5 (8.9)	4 (6.6)	13 (5.9)	9 (7.7)	22 (6.5)
Child has blood in stool	7 (4.2)	5 (9.1)	2 (3.6)	0 (0)	12 (5.4)	2 (1.7)	14 (4.1)
Child is drinking poorly	0 (0)	0 (0)	0 (0)	2 (3.3)	0 (0)	2 (1.7)	2 (0.6)
Total	167 (100)	55 (100)	56 (100)	61 (100)	222 (100)	117 (100)	339 (100)

Source: Author's field survey, 2012;

Furthermore , a total of 123 (36.3%) of mothers sought immediate medical attention when the child developed fever whereas 34 (10%), 22 (6.5%) and 14 (4.1%) mothers sought immediate medical attention when their under-five year old child was not able to drink or breast feed, developed fast breathing, or had blood in the stool respectively. The least cause for seeking immediate medical attention was when the child was drinking poorly 2 (0.6%). Chi-square analysis χ^2 (5, n = 339) = 7.48, p = 0.18 indicates that there was no statistically significant difference in the distribution of urban and peri-urban households across the symptoms that will motivate a mother to seek immediate medical attention for her under-five year old child who develops diarrhoea.

Table 6.4. First thing a mother does when her child experiences a diarrhoea episode.

1st thing done when child experiences diarrhoea	**Communities (%)**				**Location (%)**		**Total (%)**
	Abuakwa	**Nkawie**	**Asuofua**	**Barekese**	**Urban**	**Peri-urban**	
Seek medical attention	124 (72.1)	52 (81.2)	61 (93.8)	51 (75.0)	176 (74.6)	112 (84.2)	288 (78.0)
Call a friend	0 (0)	0 (0)	0 (0)	1 (1.5)	0 (0)	1 (1.8)	1 (0.3)
Treat/manage the illness at home	45 (26.2)	6 (9.4)	4 (6.2)	16 (23.5)	51 (21.6)	20 (15.0)	71 (19.2)
others	2 (1.2)	6 (9.4)	0 (0)	0 (0)	8 (3.4)	0 (0)	8 (2.2)
Can’t tell	1 (0.6)	0 (0)	0 (0)	0 (0)	1 (0.4)	0 (0)	1 (0.3)
Total	172 (100)	64 (100)	65 (100)	68 (100)	236 (100)	133 (100)	369 (100)

Source: Author’s field survey, 2012;

When their children experienced diarrhoea episodes, a large proportion of mothers 288 (78.0%) resorted to seeking medical attention first without prior home management whereas 71 (19.2%) practised exclusive treatment in the home (Table

6.4). This corroborates the assertion by Strina et al., (2005) that in some cases, diarrhoea episodes are not reported to hospitals because care starts and ends at the household level. In this study, calling a friend 1 (0.3%) and the adoption of other measures 8 (2.2%) such as asking other household members to manage the diarrhoea episode was minimal. A possible explanation which was drawn from FGD is that mothers assume full responsibility for seeking the health care of their under- five year children. Others held the view that the time of the day and severity of the episode guided their decision as to when to seek medical attention for their children.

With respect to the promptness of seeking medical attention, most mothers living in peri-urban households 112 (84.2%) sought immediate medical attention compared to their urban counterparts 176 (74.6). On the other hand, a larger proportion of mothers in urban households 51 (21.6%) treated the episode exclusively at home compared to mothers in peri-urban areas 20 (15.0%). An examination of the study communities shows that Asuofua had the highest proportion 61 (93.8%) of mothers seeking medical attention with Abuakwa having the least proportion 124 (72.1%) and with respect to exclusive management of the episode at home, Abuakwa and Asuofua had the highest 45 (26.2%) and least 4 (6.2%) proportions respectively.

Health care refers to services provided to individuals or communities by agents of the health services or professions to promote, maintain, monitor or restore health (IEA, 2008). In this study the agents of health care were categorized into three broad areas; public sector, private sector and other sources. In Table 6.5, the distribution of the primary health care facility regularly attended by members of the household is presented and it shows that most households 273 (76.0%) used the government hospital as the primary means of seeking health care. This is partially due to the presence of the government hospital in the district as well as government health centers located in all the study communities as well as the use of NHIS at the hospitals. The second most dominant facility patronized by households was the private hospital or clinic used by 38 (10.6%) of households. However, the use of private medical facilities was skewed towards urban households. In other words, with respect to private hospitals/clinics, more urban households 30 (13.1%) used such facilities than peri-urban households 8 (6.2%).

Table 6.5 The primary health care facility visited by members of the household during a diarrhoea episode by residential location.

Primary facility used	**Communities (%)**				**Location (%)**		**Total (%)**
	Abuakwa	**Nkawie**	**Asuofua**	**Barekese**	**Urban**	**Peri-urban**	
Public sector							
Government hospital	113 (67.7)	52 (83.9)	49 (75.4)	59 (90.8)	165 (72.1)	108 (83.1)	273 (76.0)
Government health center	10 (6.0)	1 (1.6)	9 (13.8)	3 (4.6)	11 (4.8)	12 (9.2)	23 (6.4)
Government health post	3 (1.8)	0 (0)	0 (0)	0 (0)	3 (1.3)	0 (0)	3 (0.8)
Private sector							
Private hospital/Clinic	23 (13.8)	7 (11.3)	7 (10.8)	1 (1.5)	30 (13.1)	8 (6.2)	38 (10.6)
Private pharmacy	1 (0.6)	0 (0)	0 (0)	2 (3.1)	1 (0.4)	2 (1.5)	3 (0.8)
Private mobile/outreach clinic	1 (0.6)	0 (0)	0 (0)	0 (0)	1 (0.4)	0 (0)	1 (0.3)
Other source							
Shop	16 (9.6)	1 (1.6)	0 (0)	0 (0)	17 (7.4)	0 (0)	17 (4.7)
Traditional practitioner	0 (0)	1 (1.6)	0 (0)	0 (0)	1 (0.4)	0 (0)	1 (0.3)
Total	167 (100)	62 (100)	65 (100)	65 (100)	229 (100)	130 (100)	359 (100)

Source: Author’s field survey, 2012;

A larger proportion of peri-urban households 108 (83.1%) patronized government hospitals than urban households 165 (72.1%). The use of other facilities such as shops and traditional practitioners was accounted for by 17 (4.7%) and 1 (0.3%) of households respectively.

The survey results therefore suggest that households in which children under-five years lived, used public sector health facilities than private ones. Chi-square analysis showed χ^2 (7, n = 359) = 21.33, p = 0.00 which indicates that there was a statistically significant difference in the distribution of urban and peri-urban households across the primary facility used by the household for health care. There was a significant reletionship which suggests that the primary facility used by members of the household during a diarrhoea episode was dependent on its residential location. During diarrhoea episodes, peri-uban households were more likely to use the government hospital than their urban counterparts, 83.1% and 72.1% respectively.

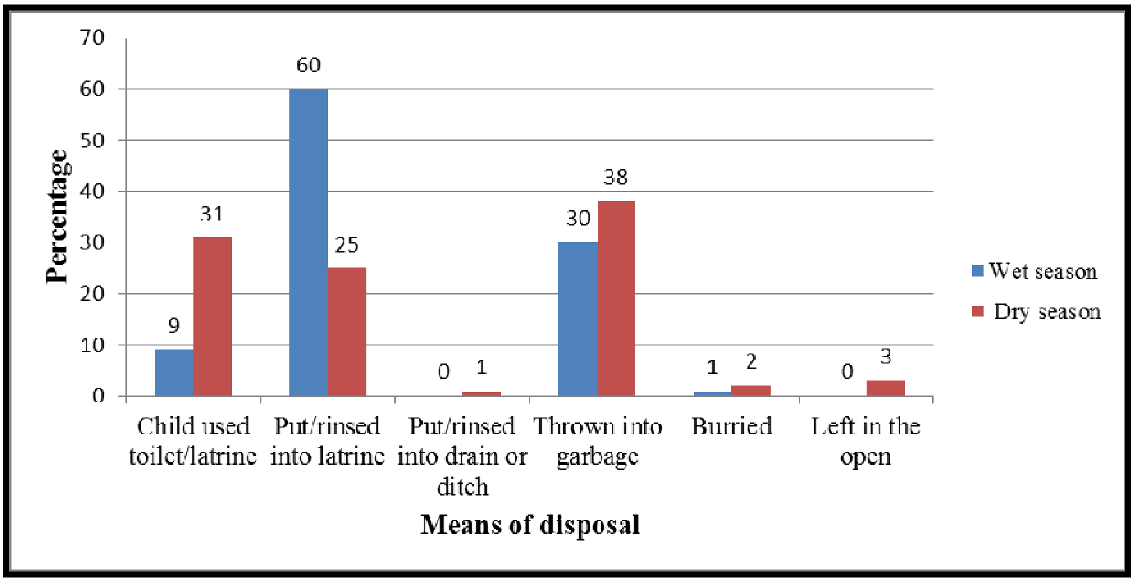
6.2.3 Practices relating to childhood diarrhoea transmission

6.2.3.1 Stool disposal for index children

The stools of children have a higher concentration of disease causing organisms than that of adults and always need to be adequately disposed of (UNICEF/WHO, 2009). Hence mothers were asked to indicate the primary method by which the stools of the index child, the child selected for study, were disposed as shown in Fig.6.1. Across all the study households (n = 307), mothers employed varied methods of stool disposal at varied times. No one method was used exclusively in the seasons. However amongst the methods employed in stool disposal for index children, the most frequently employed method was assessed. The use of a latrine or toilet, disposal into a latrine or toilet and burying of children's faeces were considered safe methods whereas other methods such as rinsing into ditch, throwing directly in garbage were unsafe according to WHO and UNICEF definitions of safe stool disposal (WHO/UNICEF, 2006:15).

The most dominant method employed by mothers was 'putting/rinsing into latrine' 189 (59.8%) and 'wrapping and throwing into garbage' 117 (38.1%) in the wet and dry seasons respectively. FGDs revealed that in some cases, mothers allowed their children to defecate into a chamber pot and then rinsed the contents into a latrine. If the child was perceived by his/her mother to be too young or not well putty trained, the mother would provide diapers into which the child defecates and is later disposed.

Fig. 6.1 Primary means of disposal of the stools of index children in the home.



Source: Author's field survey, 2012 and 2013.

In the wet season, 94 (30%) mothers threw their children's faeces directly into the garbage bin whereas 28 (9%) allowed their children to use latrines. Few mothers 1 (0.3%) left their children's stools in the open. On the other hand, in the dry season, 95

(31%) aided their children to use latrines, 77 (25%) put/rinsed stools into latrines, 10 (3%) left stools in the open, 6 (2.0%) buried, whereas 2 (0.7%) put/rinsed into drain or ditch (Fig.6.1).

In an FGD in Asuofua, mothers were asked to describe what they regularly did when their index children defecated. A 34 year old house wife said that;

> *'When my child defecates, I take off the clothes and the "pampers" and use water to bathe the child in a basin. Thereafter, I put new "pampers" on the child and throw the waste water on the streets'.*

A 28 year old housewife also said that;

> *'Some mothers are in the habit of placing the faecally soiled 'pampers' on the floor of the home rather than throwing it away especially when the household has not got a garbage bin'.*

The preceding quotes suggest that feaecally contaminated water and 'pampers' are not disposed safely. Unsafe disposal may serve as an avenue for the attraction for flies, contamination of hands or feet and possible onward transmission of diarrhoeal pathogens into the domestic domain.

Although there was evidence of unsafe disposal of children stools, in both wet 311 (98.4%) and dry seasons 289 (94.1%), majority of mothers safely disposed of the stools of their index children. Approximately 1.6% and 5.8% of households practised unsafe stool disposal in the wet and dry seasons respectively. There was a statistically significant difference in the distribution of households in the wet and dry seasons across the method of disposal of stools of index children; χ^2 (5, n = 623) = 95.81, p = 0.00. The method of stool disposal was not independent of the season but rather dependent on the season. A peculiar phenomenon that was directly observed in Nkawie was the practice of open defecation by 'children' less than 10 years. There was evidence of segregation in the use of public toilet facilities between 'adults' and 'children'. In an informal conversation to ascertain the reason for the practice, a Water Sanitation and Hygiene (WASH) committee member in Nkawie indicated that:

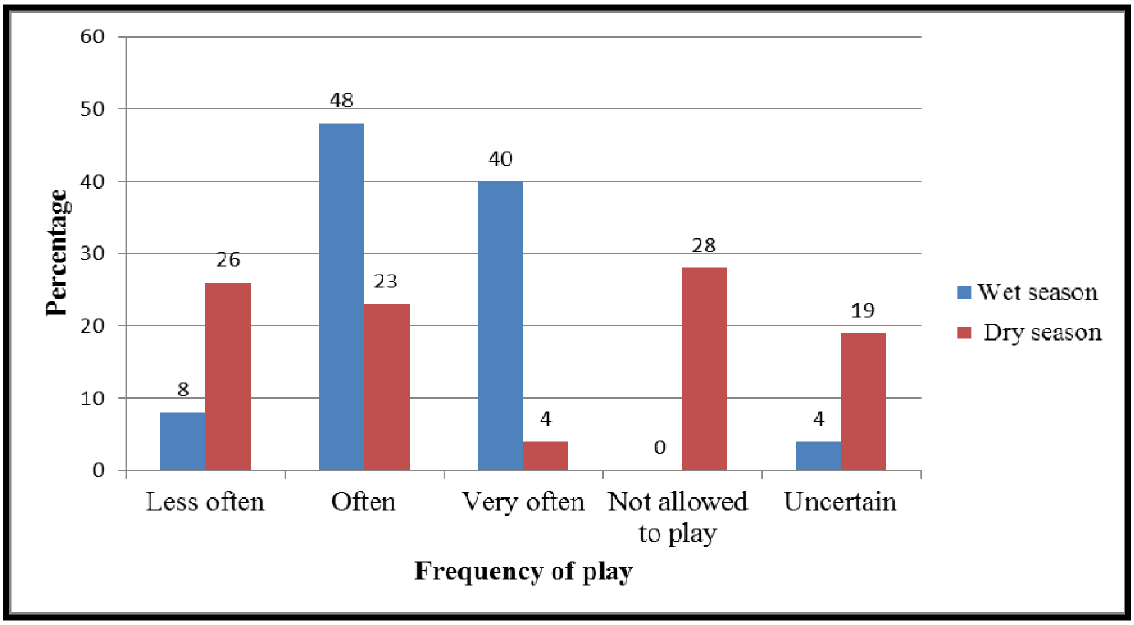
> "*There is no latrine for children. Children are not allowed to be on the same latrine with the adults due to the small capacity of the latrine. The children defecate in the open field or near the abandoned latrine*".

Also through FGDs, some mothers were of the view that they did not allow their children to use the public latrines because they were not safe to use especially at night. The implication is that when child open defecation is the norm, their feet could be soiled with faecal mater en route to or from the point of defecation and transported to the domestic environment. Secondly, flies could settle on the faecal matter and also transport faecal pathogens to the home.

6.2.3.2 Index child's play on the bare ground with soil in the home

Children, especially those below the age of five years, are deemed to be unfamiliar with their environments and the hazards contained therein and yet due to their curiosity they sometimes resort to playing in contaminated environments. Research evidence suggests that chicken and soil contaminated with faeces serve as potential pathways to faeco-oral transmission for children under-five years who play on the bare ground with soil (Ngure et al., 2013; Marquis et al., 1990). Due to their lower immune system levels and the possibility of transmission of faecal pathogens through faecal matter which are introduced into the domestic environment by feaecally soiled human feet, foot ware, animal feet or flies, the frequency of play on the bare ground by index children was assessed. In Fig.6.2, children played 'often' on the floor as reported by 183 (48.5%) mothers in the wet season. In addition, 30 (8.0%) and 150 (39.8%) of index children played in the floor 'less often' and 'very often' respectively.

Fig.6.2. Distribution of frequency of the index child's play on the bare ground with soil in the home.



Source: Author's field survey, 2012 and 2013

With respect to urban and peri-urban differences, it was observed that more mothers in urban households 133 (55.2%) allowed their index children to play 'often' on the ground compared to 50 (36.8%) of mothers in peri-urban households. Compared to urban households, a larger proportion of peri-urban households 75 (55.1%) allowed their index children to play 'very often' on the compound floor unaided.

On the other hand, in the dry season, the repeat household visit showed that a larger proportion of mothers 100 (27.6%) did not allow their children to play on the floor, a contrast to that of the wet season where none of the mothers who were interviewed indicated that they allowed their children to play on the ground. Also 92 (25.4%), 84 (23.2%) and 16 (4.4%) of mothers allowed their children to play 'less often', 'often' and 'very often' respectively in the dry season. Chi-square analysis confirmed that there was a statistically significant difference in the distribution of households in the wet and dry seasons across the frequency of the index child's play on the bare ground with soil; χ^2 (4, n = 739) = 313.54, p = 0.00.

In the context of this study, focus group discussions in Nkawie and Asuofua revealed that over 90% of mothers who participated in both FGDs, were of the view that children, especially the male under-five year old child was more curious of his environment and also played on the floor often than their female counterparts. Other views also pointed to the possibility of faecal-oral contamination as the child plays on the ground. A 35 year old trader in Asuofua indicated in the FGD that;

> *'One day, I saw my child drawing close and picking a chicken's dropping with his hands. I had to stop what I was doing and rush immediately to pick the child as it attempted to put the dropping in its mouth. I perceived that the child was ignorant and that was why he behaved the way he did'*

Thus the preceding quote suggest that in some cases some mothers placed or allowed their children to play on the bare ground with soil and mothers could have been oblivious to health hazards that their children were exposed to when they attend to other activities.

6.3 Mothers' Management of Childhood Diarrhoea in the Home

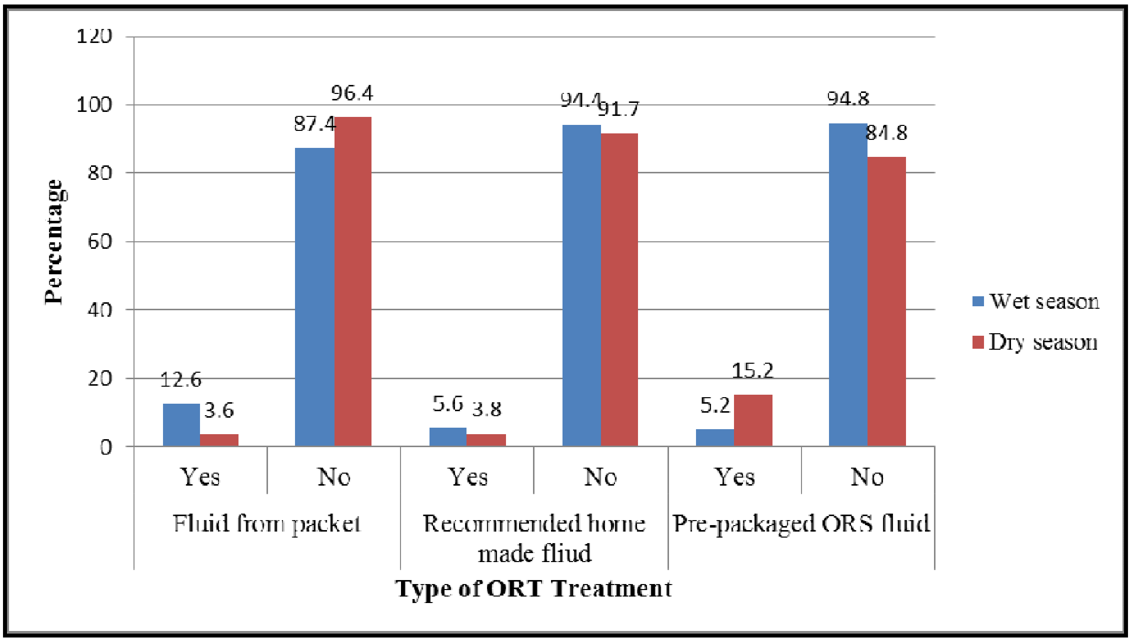
6.3.1 Oral Rehydration Therapy (ORT)

Dehydration is known to be a major outcome of diarrhoea in children and internal fluid replacement for a child who is experiencing a diarrhoea episode is essential to avoid death (UNICEF, 2012). Oral Rehydration Therapy (ORT) refers to the administration of fluid by mouth to prevent or correct the dehydration that is a consequence of diarrhoea (WHO, 1985:5). Oral Rehydration Therapy (ORT) serves as a primary means by which lost body fluids could be replaced in order to curtail dehydration (UNICEF/WHO, 2009).

With respect to the management of diarrhoea, UNICEF and WHO recommends that body fluid replacement should begin in the home and should be administered by the care giver using Oral Rehydration Salts (ORS) which is recognized as the 'gold standard' of oral rehydration therapy (ORT) (UNICEF/WHO, 2009:15). In this study, three types of oral rehydration therapy were identified amongst mothers (Fig.6.3). In households where mothers prepared an ORS solution by using a packet of ORS in powdered form and mixing with water to the recommended level, it was classified as 'Fluid from packet' following after UNICEF/WHO (2009). 'Recommended homemade fluids' are fluids that help prevent dehydration when the ORS is not available (UNICEF/WHO, 2009). They included water based foods like 'rice water' which are recommended by health professionals. 'Pre-packaged ORS fluids include

ORS fluids that have been prepared and packed for ready use. Examples of ORS in powdered form on the Ghanaian market include Hydrolyte® made by Ernest Chemists Limited and Original ORS® produced by DANNEX Limited.

Fig. 6.3 Distribution of regular use of ORT by season.



Source: Author's field survey, 2012 and 2013.

Fig. 6.3 shows the distribution of use of ORT by season and it gives an indication of low usage of ORTs in the study communities in both wet and dry seasons. In this study, regular use if ORT was defined as use of an Oral Rehydration Therapy whenever the index child experienced an episode of diarrhoea. In the wet season, majority of mothers, over 80% indicated that they did not regularly use ORT when their index children experienced as diarrhoea episode. In the wet season, only 26 (12.6%), 11 (5.6%), and 10 (5.2%) regularly used fluids from packets, recommended homemade fluids and pre-packaged ORS fluids respectively (Fig. 6.3).

Likewise in the dry season, over 80% of mothers indicated their low use of ORT. A total of 13 (3.6%), 30 (3.8%) and 55 (15.2%) used fluids from packets, recommended homemade fluids and pre-packaged ORS fluids respectively. Though over 80% of participants in FGDs held in Nkawie and Asuofua claimed that they knew how to prepare ORS solutions in the home, the data suggests that mothers' seldom used ORT treatment to manage childhood diarrhoea episodes. This result corroborates the findings of Saltzman et al. (2012) in their Ghana study in which 19% of mothers in Ejisu indicated ORS as the primary treatment for diarrhoea. Malnutrition is a contributor to the susceptibility of children to environmentally related diseases such as diarrhoea and it has also been identified as an effect of diarrhoea (UNICEF/WHO, 2009). Thus in order to reduce diarrhoeal morbidity and mortality, exclusive breastfeeding for the first six months of a child's life coupled with appropriate and adequate nutrition after six months is essential. Research evidence suggested that some mothers were not giving appropriate nutrition to their children. For example, in a personal in-depth interview at Abuakwa, a 20 year old mother said;

> *'When I gave birth, I was told at the health center by the nurses that I have to exclusively breastfeed the baby for six months but I do not value that. At present I give the child water and solid food otherwise the child will look malnourished. The breast milk alone does not satisfy the baby. I started feeding my child 'koko' at two weeks, and 'banku' in three months.'*

The preceding quote therefore suggests that in some cases, a mother's perceptions about nutrition may help to shape her decision to abide by health directives for her children or to do otherwise.

Table 6.6 shows a distribution of the health facility regularly visited during childhood diarrhoea episodes. More than half 44 (63.8%) of mothers (n = 69) attended the government health centers regularly when their children experienced diarrhoea episodes in the wet season compared to 61 (44.2%) who regularly attended in the dry season. The government health center was the most dominant facility mothers attended when there was a childhood diarrhoea episode. The second dominant facility used by mothers varied by season. The government hospital was the second dominant facility regularly used by 13 (18.8%) of mothers in the wet season whereas in the dry season, shops were the second dominant facility. The use of facilities such as government health posts, village health workers, government mobile outreach/clinics was generally low in both seasons partially due to the Ghana Health Service's (GHS) policy of concentration on the provision of primary health care through the government hospitals and health centers in the district.

Mothers' patronization of private health facilities such as private hospitals, private clinics, private physicians and private pharmacies was minimal (Table 6.6). In FGDs, some mothers attributed the phenomenon partly to the National Health Insurance Scheme (NHIS) which they use to access health care for themselves and their children. Secondly, others were of the view that they lived comparatively closer to the health centers than the government hospital which was located in Nkawie, therefore to some mothers, proximity was a contributory factor.

With respect to the consultation of traditional practitioners, a relatively lower proportion, 1 (1.14%) and 6 (4.3%) mothers resorted to the use of this option in the wet and dry seasons respectively.

6.4 Childhood Diarrhoea Prevalence

Prevalence refers to 'all people in a defined population with the disease or condition at a given point in time or over a given period of time' (Carr et al., 2007:37). The following formulae is used in calculating the prevalence rate:

$$\text{Prevalence rate} = \frac{\text{Total number of cases in a specified time period}}{\text{Total number in the defined population}} \times (10^{n})$$

Where the value of 10^{n} is usually 1 or 100 for common attributes and 1,000 or more for less common attributes (WHO, 2006:19; CDC, 2013). In this study, the 2 weeks childhood diarrhoea prevalence rate was calculated using the formulae:

$$\text{Prevalence rate} = \frac{\text{Total number of index children with disease in past 2 weeks}}{\text{Total number of index children}} \times (100)$$

The estimation of childhood diarrhoea prevalence showed that in the wet season, 24 hour prevalence was 8.2% whereas two weeks prevalence was 13%. On the other hand in the dry season, 24 hour prevalence was 3.4% whereas two weeks prevalence was 11.4%. Thus comparatively in the wet season, index children had a relatively higher prevalence of childhood diarrhoea than during the dry season survey (Table 6.6). Results of the Ghana Demographic and Health Surveys (GDHS) conducted in 2008 and 2003 indicated that the two weeks childhood diarrhoea prevalence rates were 20% and 15% respectively (GSS, 2009; GSS, 2004).

Table 6.6 Distribution of childhood diarrhoea prevalence rates by season.

Disease (Under 5 year old children)	Wet season		Dry season	
	Prevalence period	**Index children**	**Prevalence period**	**Index children**
Diarrhoea	24 Hours prior to survey	31/378 = 8.2%	24 Hours prior to survey	13/378 = 3.4%
	2 Weeks prior to survey	49/378 = 13%	2 Weeks prior to survey	43/378=11.4%

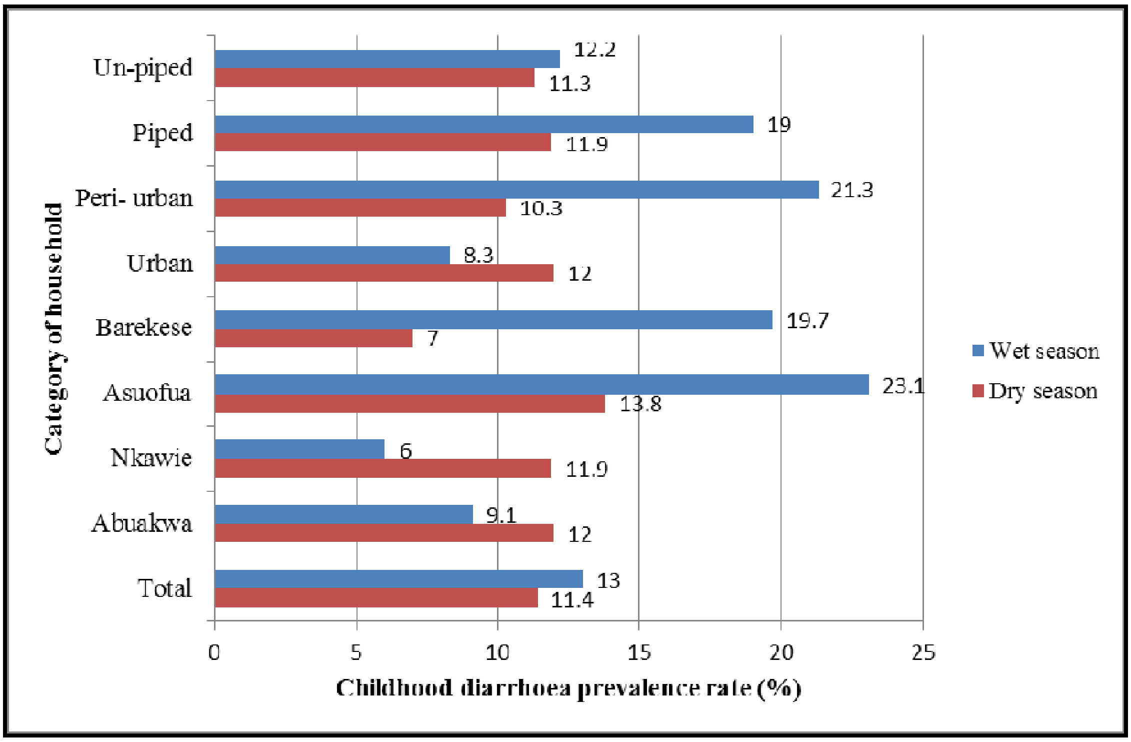
Source: Author's field survey, 2012 and 2013.

Fig.6.4 shows a seasonal distribution of childhood diarrhoea prevalence rates. Amongst the study communities, index children living in Asuofua had the highest childhood diarrhoea prevalence rates for the wet season (23.1%) and dry season (13.8%) as well. The lowest prevalence rates were however recorded in Nkawie (6%) during the wet season and Barekese (7%) during the dry season (Fig.6.4).

In the wet season, 8 out of 42 index children, living in piped households, representing 19.0% compared to 41 out of 336 index children, living in un-piped households had childhood diarrhoea two weeks prior to the survey. On the other hand, in the dry season, 5 out of 42 index children living in piped households representing 11.9% and 38 out of 298 index children living in un-piped households representing 11.3% also had diarrhoea.

With respect to urban and peri-urban household categories, 20 out of 242 index children living in urban households representing 8.3% and 29 out of 136 index children living in peri-urban households representing 21.3% had childhood diarrhoea in the wet season. On the other hand in the dry season, prevalence rates were higher for index children living in urban households than those living in peri-urban ones. A total of 29 out of 242 index children living in urban households representing 12% and 14 out of 136 index children living in peri-urban households representing 10.3% had childhood diarrhoea.

Fig.6.4 Seasonal distribution of childhood diarrhoea prevalence rates by household category.



Source: Author's field survey, 2012 and 2013.

An element of crucial public health importance is an analysis of childhood diarrhoea prevalence in relation to selected socio-demographic and domestic domain characteristics by which exposure to diarrhoeal disease pathogens may occur. The estimation of prevalence rates is helpful for assessing the need for preventive action by public health practitioners and health stake holders in the Atwima Nwabiagya District (WHO, 2006). The selected socio-demographic characteristics include household size, number of rooms, estimated household wealth, age of the mother and educational status of the mother.

6.4.1 Socio-demographic characteristics and childhood diarrhoea prevalence

The data analysis showed that in general childhood diarrhoea prevalence was higher in the wet season compared to the dry. With respect to household size, a pattern was observed. In both wet and dry seasons, childhood diarrhoea prevalence increased with an increase in household size. In other words, household size appeared to be positively related with childhood diarrhoea prevalence rates. Four member households had the highest rates compared to two member households. This finding suggests that relatively smaller sized households may be related with a lower prevalence of childhood diarrhoea (Table 6.7).

The number of room occupied by the household appeared to follow a trend. Childhood diarrhoea rates were higher in households which lived in one room apartments compared to those that lived in two and three. This finding may have resulted from possible crowding conditions in the dwelling (Table 6.7).

Households which were rated above high income also had lower rates compared to their counterparts who were lower in terms of estimated household wealth. An inference could be made that higher wealth status was negatively related with childhood diarrhoea prevalence. The higher the household wealth, the lower the childhood diarrhoea rates. This inverse relationship could have been a reflection of the fact that in general, wealthier households tend to have relatively better living conditions and relatively better access to health care compared to poor households.

With respect to the mother's age, no clear pattern emerged. Unexpectedly, it was observed that prevalence rates among children whose mothers were older than 35 years had the highest prevalence rates in the wet season and least rates in the dry.

Table 6.7 Distribution of socio-demographic characteristics and childhood diarrhoea prevalence.

Socio-demographic characteristics	N Wet season	Two weeks childhood diarrhoea prevalence (%) Wet season	N Dry season	Two weeks childhood diarrhoea prevalence (%) Dry season
Household size				
2	0	0/10 = 0.0 %	0	0/10 = 0.0 %
3	6	6/71 = 8.5 %	8	8/71 = 11.3 %
4	18	18/109 = 16.5 %	13	13/109 = 11.9 %
5 and above	25	25/186 = 13.4 %	22	22/186 = 11.8 %
Number of rooms				
1	42	42/315 = 13.3 %	38	38/315 = 12.1 %
2	6	6/51 = 11.8 %	4	4/51 = 7.8 %
3 and above	0	0/11 = 0.0 %	1	1/ 11 = 9.1 %
Household estimated wealth was above 'High middle income'				
Yes	27	27/238 = 11.3 %	24	24/238 = 10.1 %
No	22	22/132 = 16.7 %	19	19/132 = 14.4 %
Mother's age was 35 years and below				
Yes	36	36/292 = 12.3 %	38	38/292 = 13.0 %
No	12	12/84 = 14.3 %	4	4/84 = 4.8 %
Mother had no formal education				
Yes	43	43/339 = 12.7 %	34	34/339 = 10.0 %
No	6	6/38 = 15.8 %	9	9/38 = 23.7 %

Source: Author's field survey, 2012 and 2013.

The mother's educational level appeared to be positively related childhood diarrhoea prevalence rates (Table 6.7). In both seasons, the survey data suggested that mothers with no formal education had children with lower childhood diarrhoea rates compared to those who had some form of education.

Childhood diarrhoea prevalence may not only be situated using socio-demographic context but using domestic domain characteristics as well. The domestic domain characteristics of interest include the type and use of sanitation facilities, hand washing at critical times such as after using the toilet, before feeding and cleaning the bottom of children, use of primary water sources, amount of water collected daily, method of disposal of index child's stools and frequency of play on the bare floor.

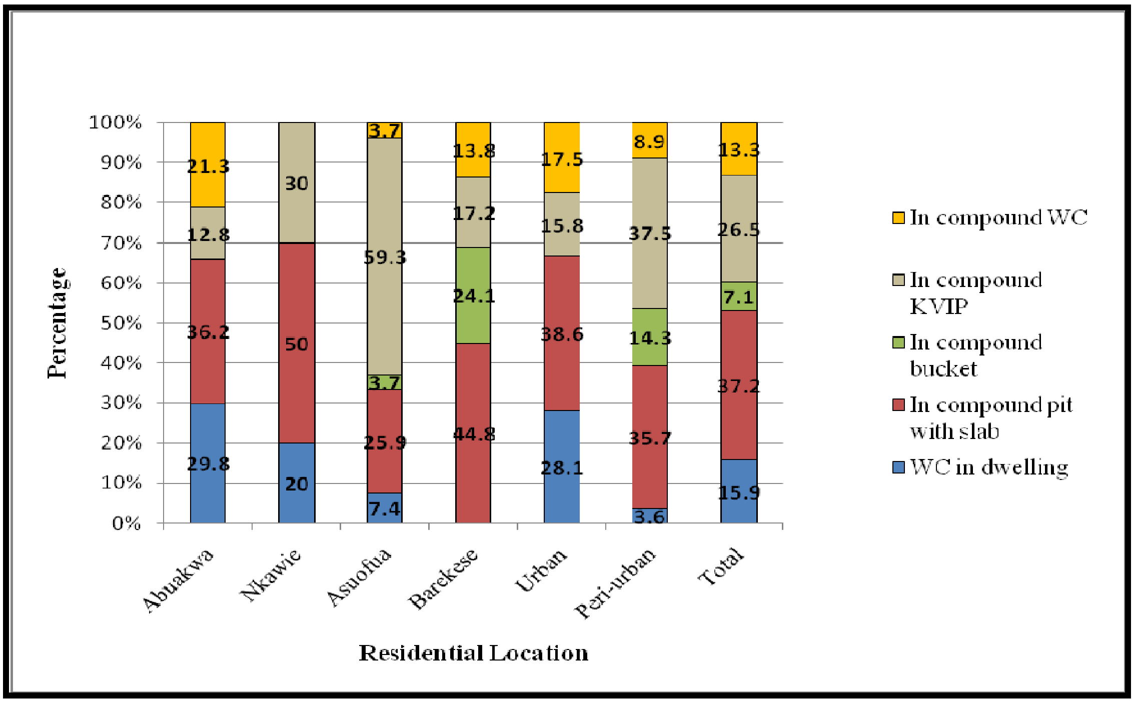
6.4.2 Childhood diarrhoea prevalence and use of sanitation facilities

Adequate sanitation ensures that human excreta are removed from human contact and appropriate hygiene practice on the other hand ensures that an individual and his or her surroundings are kept clean (Scott et al., 2007). Together, adequate sanitation and appropriate hygiene practices ensure that contaminants within the household environment do not get transmitted to an individual via the faecal-oral transmission route. Due to their implications for securing the health of members of the household, especially children below the age of 5 years, selected sanitation and hygiene characteristics of households with children under five years were examined.

Data on access to latrines was available for 357 households whereas 21 households did not provide any information on latrine possession. With reference to latrine possession in households, the study showed that a total of 113 (32%) households regularly used latrines that were located within their dwellings or on the compound of their homes (operationally defined as immediate access) whereas 244

(68%) used shared public toilet facilities that were located off their home premises (operationally defined as remote access). Of the total number of households which had access to latrines (n=113), 37 (32.7%) indicated that their households owned the latrines whilst 76 (67.3%) indicated that they were shared. Fig.6.5 shows a distribution of the type of latrine used by residential location.

Fig. 6.5 Type of sanitation facility used by households with 'immediate access'.



Source: Author's field survey, 2012.

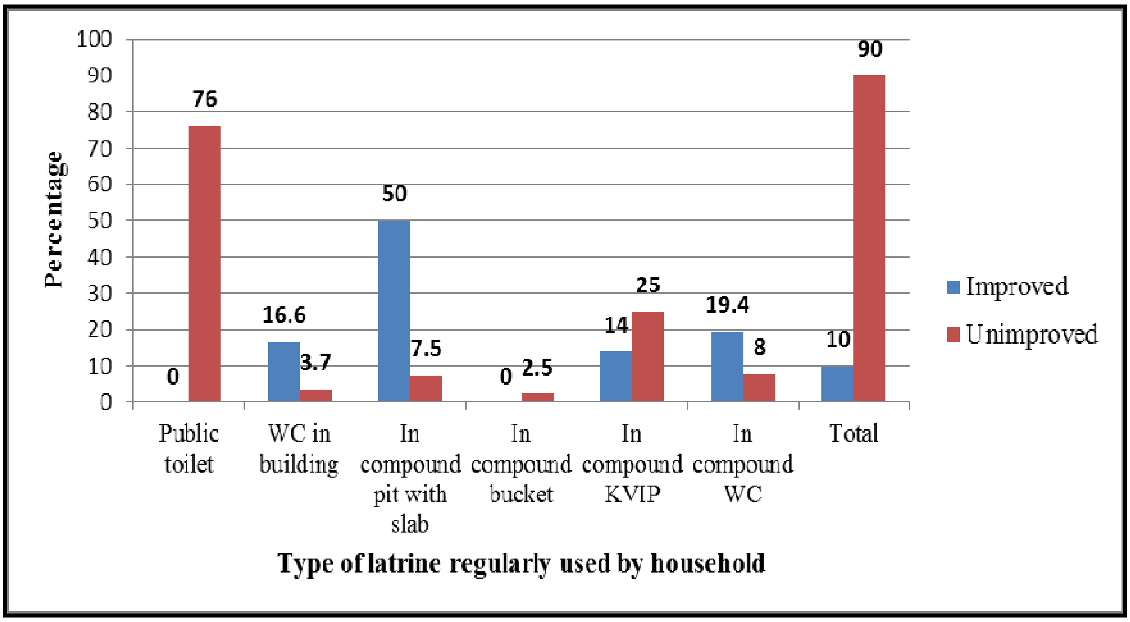
The most dominant facility used by households which had 'immediate access' to latrines (n=113) was the 'in compound pit with slab' 42 (37.2%). This was followed by the 'in compound KVIP' 30 (26.5%), the 'WC in dwelling' 18 (15.9%) and 'in compound WC' 15 (13.3%). Though there is a ban on the use of bucket/pan latrines in Ghana, 8 (7.1%) households used it. In Fig.6.5, an examination of the facilities used by households in the study communities shows that a large proportion of residents living in Asuofua (59.3%) used the 'in compound KVIP'. This is partly due to the use of houses that were built to resettle households in the Asuofua township during the construction of the Barekese dam in the 1970s. The ‘in compound pit with slab’ was predominantly used in Nkawie (50%) whereas that of the ‘ in compound bucket was used in Barekese (24.1%). Most households (29.8%) which used WCs in dwellings were resident in Abuakwa, an urban community. Thus there was a sharp contrast in the use of WCs between urban (28.1%) and peri-urban households (3.6%) (Fig.6.5).

The JMP distinguishes between the use of unimproved sanitation and improved sanitation. Unimproved sanitation includes open defecation, the use of unimproved sanitation facilities and the use of shared public sanitation facilities (WHO/UNICEF, 2013:12). According to the JMP, open defecation is practised when human faeces are disposed of in fields, forests, bushes, open bodies of water, beaches or other open spaces or disposed of with solid waste. Unimproved sanitation facilities are ones that do not ensure hygienic separation of human excreta from human contact and they include pit latrines without a slab or platform, hanging latrines and bucket latrines. Shared sanitation facilities are acceptable types that are shared between two or more households. Thus when reference is made to unimproved sanitation, it encompasses all facilities that are shared or public (WHO/UNICEF, 2013:12).

Improved sanitation facilities are defined by the JMP as facilities that are likely to ensure hygienic separation of human excreta from human contact. They include flush/pour flush to piped sewer system, septic tank or pit latrines. Other improved sanitation were ventilated improved pit (VIP) latrine, pit latrine with slab and composting toilet (WHO/UNICEF, 2013:12). Fig 6.6 shows a distribution of all the study households by their use of improved and unimproved sanitation facilities respectively. With reference to unimproved sanitation facilities regularly used by the study households (n=321), the ‘public toilet’ ranked highest in terms of use by 244

(76%) households. This was followed by ‘in compound KVIP’ 25 (7.8%), ‘in compound pit with slab’ 24 (7.5%), ‘WC in dwelling’ 12 (3.7%) and the ‘in compound WC and ‘in compound bucket’ both having 8 (2.5%) households. On the other hand, improved facility usage was smaller compared to unimproved facility usage. This is because as per the JMP definitions of improved and unimproved sanitation facilities, 36 (10%) of the study households (n = 357) used improved sanitation facilities whereas 321 (90%) used unimproved sanitation facilities. The improved facility used by most households was the ‘ in compound pit with slab’ 18 (50%) followed by ‘in compound WC’ 7 (19.4%), WC in dwelling 6 (16.6%) and the in compound KVIP 5 (14%) (Fig. 6.6).

Fig. 6.6 Distribution of latrine type by JMP definition.



Source: Author’s field survey, 2012.

Childhood diarrhoea prevalence rates were estimated with respect to the type of sanitation facilities used by the mother, and the mothers’ reported frequency of washing hands after critical periods. These were chosen based on the perceived likelihood of regular contact with faecal matter in the domestic environment. Studies by Daniels et al., (1990) and Traore et al., (1994) have shown a relationship between the use of sanitation facilities and prevalence of diarrhoea. Therefore this study assessed the relationship between sanitation facility usage and two weeks diarrhoea prevalence as shown in Table 6.8.

Table 6.8 Distribution of sanitation facility by prevalence of diarrhoea in households

Type of toilet facility	**N (Wet)**	**Childhood Diarrhoea prevalence (Wet Season)**	**N (Dry)**	**Childhood Diarrhoea prevalence (Dry Season)**
In compound bucket	1	1/8 = 12.5%	0	0/8 = 0%
WC in dwelling	2	2/18 = 11.1%	1	1/18 = 5.6%
Public toilet	31	31/244 = 12.7%	29	29/244 = 11.9%
In compound KVIP	4	4/30 = 13.3%	5	5/30 = 16.7%
In compound pit with slab	6	6/42 = 14.2%	4	4/42 = 9.5%
In compound WC	4	4/15 = 26.7%	3	3/15 = 20%
Total	48	48/357 = 13.4%	42	42/357 = 11.7%

Source: Author's field survey, 2012 and 2013.

From Table 6.8, in the wet season, index children who lived in households where the 'in compound water closet (WC)' was used, had the highest prevalence rate (26.7%). Also children who lived in households which used the 'in compound pit with slab' and 'in compound KVIP' had 14.2% and 13.3% childhood diarrhoea prevalence rates respectively. Children who lived in households that used public toilets also had 12.7% prevalence rate whilst ones that lived in households that used the 'in compound bucket' had a 12.5% prevalence rate. The lowest rate (11.1%) was recorded for index children who lived in households which had WCs in their dwellings. In the dry season however, the highest and lowest childhood diarrhoea rates were recorded for children who lived in households that used 'in compound WC' (20.0%) and 'in compound bucket' 0 (0%) respectively. Furthermore, diarrhoea prevalence rates for children who lived in households which used sanitation facilities such as the 'in compound KVIP' (16.7%), public toilets (11.9%), 'in compound pit with slab' (9.5%) and WCs in their dwellings (5.6%) were also recorded.

Comparatively, in both wet and dry seasons, the highest childhood diarrhoea prevalence rates were recorded for children who lived in households that used the 'in compound WC'. This suggests the use of 'in compound WC' may be serving as a transmission route for pathogen transmission in the domestic environment. Children who lived in households which used improved sanitation facilities in both the wet and dry seasons had comparatively lower childhood diarrhoea rates (Table 6.8).

6.4.3 Childhood diarrhoea prevalence and mothers' reported hand washing practice

The washing of hands with water and soap has been noted to be associated with the health of household members by studies such as Curtis and Cairncross (2003). The omission of hand washing at critical periods can contribute to faecal-oral transmission of diarrhoeal pathogens in the domestic environment (Ejemot et al., 2007). Mothers reported how often they washed their hands at three critical periods; after defecation, before feeding children and after cleaning the bottom of their children (Table 6.9). Childhood diarrhoea was most prevalent (36%) for children whose mothers reported that they did not wash their hands with water and soap after defecation than for children whose mothers reported that they washed their hands less often (16.7%), often (9.4%) and very often (10.7%). Similar to the wet season, childhood diarrhoea prevalence was most prevalent (18.1%) for children whose mothers reported that they did not wash their hands after defecation. Children who lived in households where mothers' claimed to wash their hands ‘less often’, ‘often’ and ‘very often’ recorded 10%, 10.6% and 10.7% diarrhoea prevalence rates respectively (Table 6.9).

Table 6.9 Distribution of reported frequency of washing hands with soap by childhood diarrhoea prevalence rate.

Critical period	**N Wet Season**	**2 weeks childhood diarrhoea prevalence (Wet Season)**	**N Dry Season**	**2 weeks childhood diarrhoea prevalence (Dry Season)**
After using the toilet				
No washing with soap	8	8/22 = 36%	4	4/22 = 18.1%
Less often	15	15/90 = 16.7%	9	9/90 = 10%
Often	23	23/244 = 9.4%	26	26/244 = 10.6%
Very often	3	3/28 = 10.7%	3	3/28 = 10.7%
Uncertain	14	0/14 = 0%	1	1/14 = 7.1%
Total	49	49/378 = 12.9%	43	43/378 = 11.4%
Before feeding children				
No washing with soap	11	11/96 = 11.4%	13	13/96 = 13.5%
Less often	13	13/64 = 20.3%	9	9/64 = 14%
Often	23	23/188 = 12.2%	20	20/188 = 10.6
Very often	2	2/15 = 13.3%	1	1/15 = 6.7%
Uncertain	0	0/15 = 0%	0	0/15 = 0%
Total	49	49/378 = 12.9%	43	43/378 = 11.4%
After cleaning bottom of children				
No washing with soap	9	9/52 = 17.3%	9	9/52 = 17.3%
Less often	17	17/88 = 19.3%	12	12/88 = 13.6%
Often	19	19/189 = 10.1%	21	21/189 = 11.1%
Very often	4	4/23 = 17.4%	1	1/23 = 4.3%
Uncertain	0	0/26 = 0%	0	0/26 = 0%
Total	49	49/378 = 12.9%	43	43/378 = 11.4%

Source: Author’s field survey, 2012 and 2013.

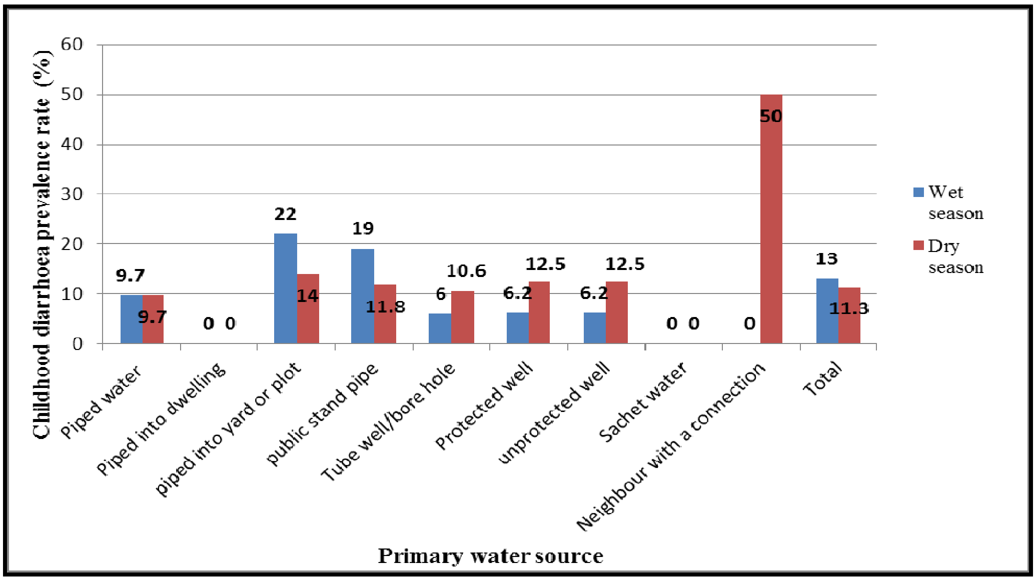
With respect to washing hands before feeding children, a similarity emerged between the wet and dry season reports by mothers. Children who lived in households where mothers washed their hands ‘less often’ before feeding their children had the highest childhood diarrhoea rates (20.3%) and (14.1%) in the wet and dry seasons respectively. Surprisingly, children whose mothers did not wash their hands before feeding them had the lowest rate (11.4%) in the wet season. This result should be interpreted with caution since childhood diarrhoea rates could have been subject to under reporting. Nevertheless, prevalence rate was lowest (6.7%) for children whose mothers washed their hands very often before feeding their children in the dry season (Table 6.9).

Children who lived in households where mothers washed their hands less often after cleaning the bottom to their children had the highest diarrhoea prevalence rates (19.3%). On the other hand, the highest rates were recorded for children who lived in households where mothers did not wash their hands after cleaning the bottom of their children in the dry season (17.3%). Chi square tests of independence also showed that there was no statistically significant difference between reported washing of hands at critical periods for the wet and dry seasons. The results therefore suggests that mothers reported hand washing behavioural patterns in the wet season did not differ statistically from that which was reported in the dry season. Also higher prevalence rates of childhood diarrhoea were recorded in households where mothers did not wash or at best washed their hands less often at critical periods. However, these results need to be interpreted with caution because reported cases of hand washing may be subject to over reporting (Danquah, 2010).

6.4.4 Childhood diarrhoea prevalence in relation to primary water sources.

With respect to childhood diarrhoea prevalence and its relationship with primary domestic water sources, 50% of households (n = 2) which relied on a neighbor with a connection reported that their index child had suffered diarrhoea in the previous two weeks in the dry season only. The graph in Fig 6.7 shows that in the wet season, approximately 20% of households who used water piped into their yard or plot and public stand piped users reported that their children experienced childhood diarrhoea two weeks prior the survey compared to approximately 12% in the dry season. Children living in households which used tube wells, protected wells and unprotected wells had higher diarrhoea prevalence (12.5%) in the dry season than in the wet season (6.2%).

Fig.6.7 Seasonal distribution of childhood diarrhoea prevalence by primary domestic water source.



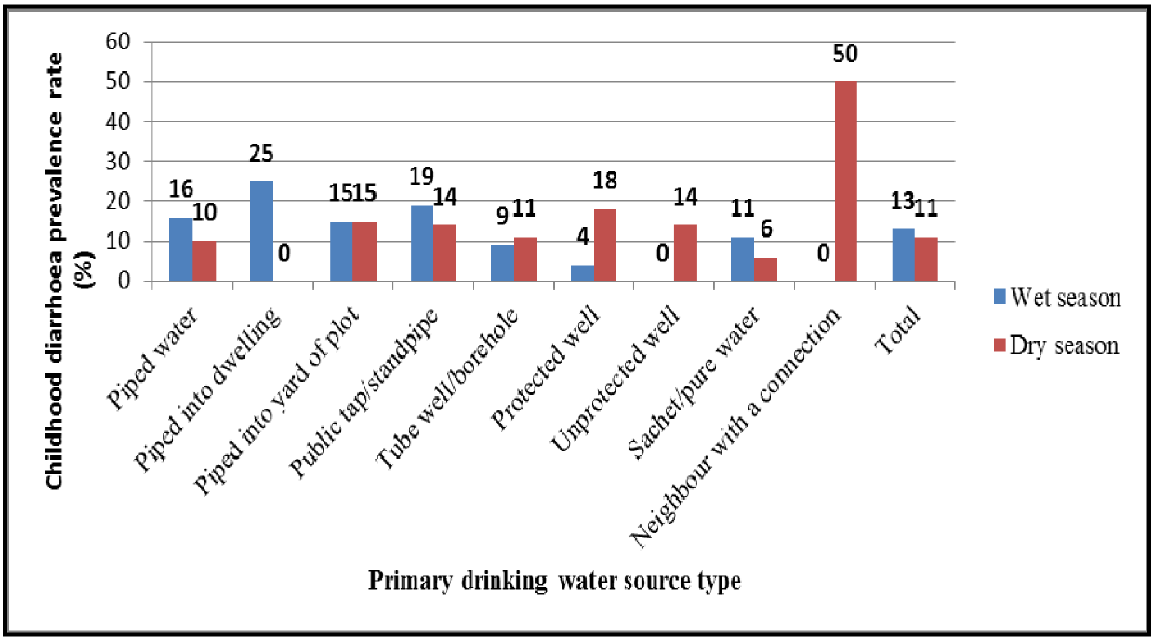
Source: Author's field survey, 2012 and 2013.

Index children living in households which used water piped into their dwellings and sachet water had the lowest childhood diarrhoea prevalence rates (0%) suggesting that households in which water was piped into their dwellings and those which used sachet water appeared to be 'safe'. Chi-square analysis showed that there was no statistically significant difference in the seasonal distribution of childhood diarrhoea prevalence across the type of domestic water source; χ^2 (8, n = 92) = 5.52, p = 0.70. In other words, there was no statistically significant relationship. Childhood diarrhoea prevalence was not dependent on the type of domestic water source.

Fig. 6.8 shows a seasonal distribution of childhood diarrhoea prevalence by primary drinking water source. The data in Fig 6.8 revealed that sachet water, an unimproved drinking water source, was the primary drinking water source used by some households in the year. Amongst households which used sachet water, childhood diarrhoea rates were higher in the wet season (11%) compared to the dry season. Unexpectedly, childhood diarrhoea for index children in households which used improved sources had relatively higher rates of childhood diarrhoea in the wet season. For example, households which had water piped into their dwelling had higher a childhood diarrhoea prevalence of 25% compared to 11% for households that relied on sachet for drinking. Also, relatively higher childhood diarrhoea prevalence rates were observed in households which used unimproved water sources in the dry season.

A comparison with domestic water sources (Fig 6.7) suggests that 'neighbour with a connection' were the least safe during the dry season. This is because prevalence rates of 50% were recorded for children who lived in households which relied on 'neighbor with a connection' in the dry season. The data suggested that neighbors were only relied on during the dry season for domestic and drinking water. This result suggests that some households relied on 'neighbour with a connection' in the dry season when perhaps water supply may have been low or stopped.

Fig. 6.8 Seasonal distribution of childhood diarrhoea prevalence by primary drinking water source.

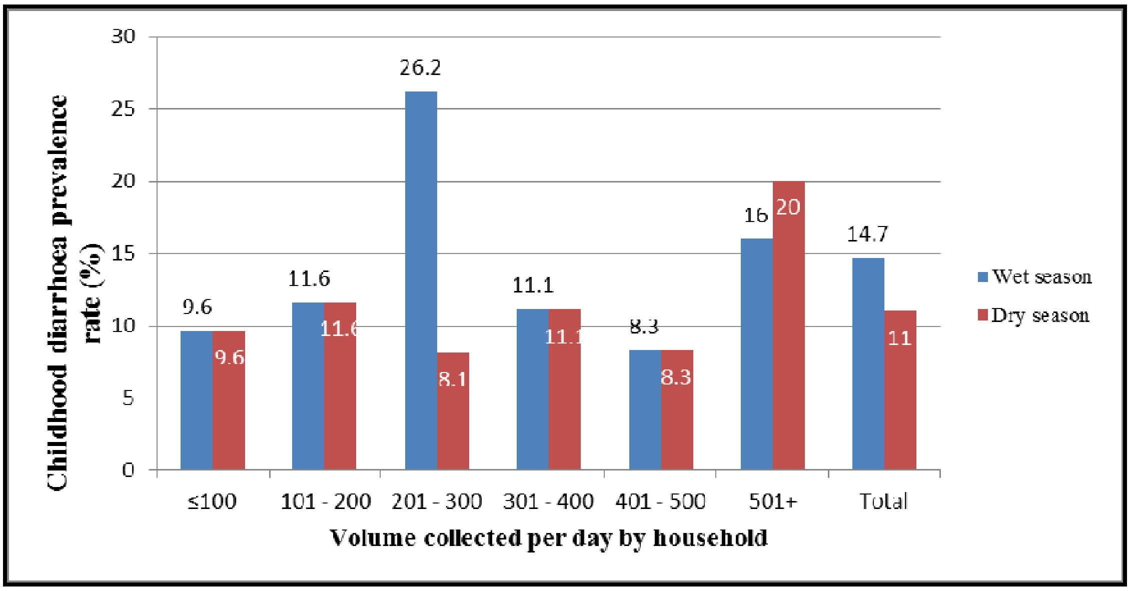


Source: Author's field survey, 2012 and 2013.

6.4.5 Childhood diarrhoea prevalence in relation to amount of water collected daily

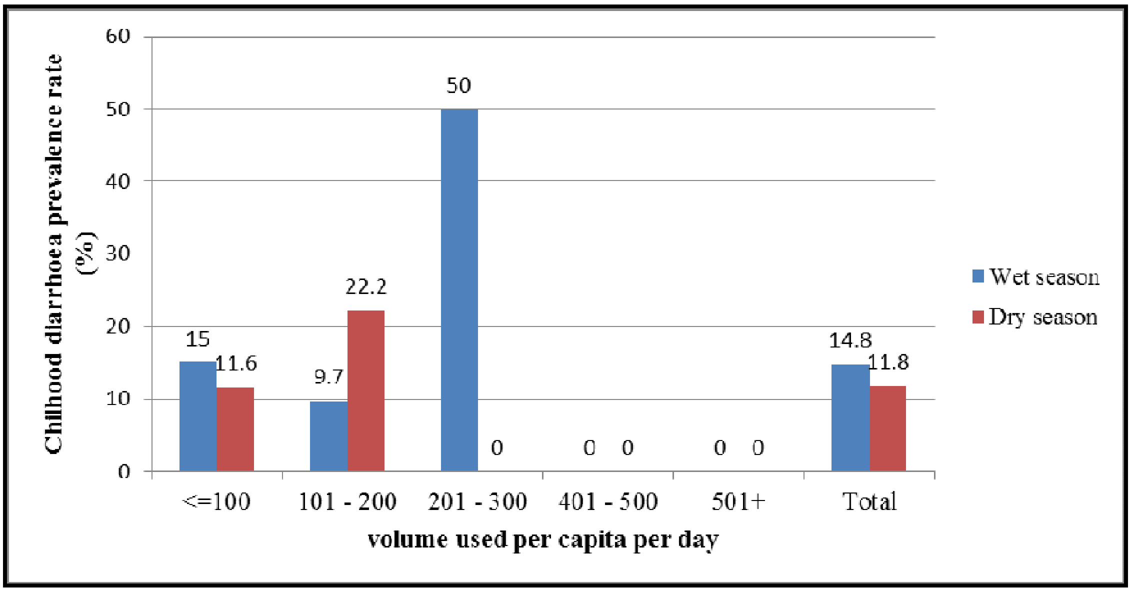
In Fig.6.9, the graph shows that in the wet season, households which collected 201 – 300 liters of water per day had the highest prevalence of childhood diarrhea (26.2%). Compared to households which collected ≤ 100 liters, households which collected 500 liters or more had relatively higher childhood diarrhoea prevalence rates. In Fig. 6.8, the seasonal distribution of childhood diarrhoea prevalence is plotted against volume of water used per capita per day. It shows that the highest childhood diarrhoea prevalence rate (50%) was recorded in the wet season for 2 out of 4 index children who lived in households (n = 4) which recorded between 201 and 300 liters per capita per day whereas in the dry season, the highest rates (22.2%) were recorded for 2 out of 9 index children living in households (n = 9) which collected between 101 – 200 liters per capita per day.

Fig. 6.9 Seasonal distribution of childhood diarrhoea prevalence by amount of water collected daily per household.



Source: Author's field survey, 2012 and 2013.

Fig. 6.10 Seasonal distribution of childhood diarrhoea prevalence by amount of water used per capita per day.



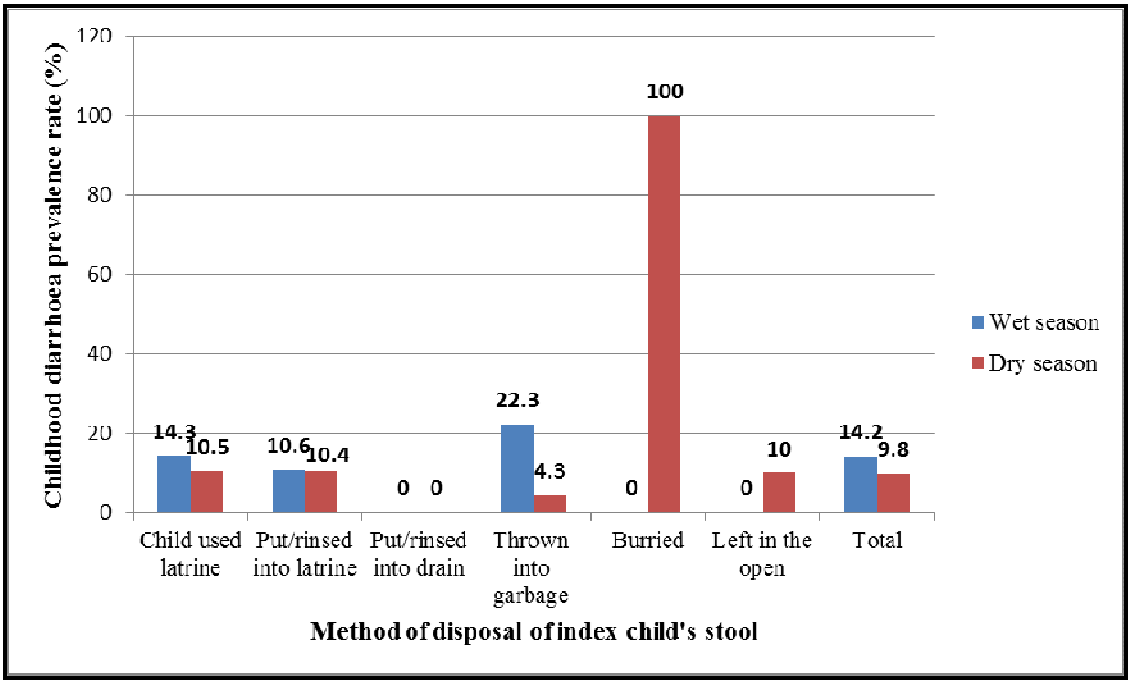
Source: Author's field survey, 2012 and 2013.

On the other hand, 34 out of 226 and 41 out of 354 index children living in households that used ≤ 100 liters per capita per day recorded childhood diarrhoea in the wet and dry seasons respectively indicating that higher prevalence rates were recorded in the wet (15%) than in the dry season (11.6%) respectively (Fig. 6.10). The result shown in Figures 6.9 and 6.10 suggests that higher volumes of water collected by the household did not correspond to lower childhood diarrhoea prevalence rates. Rather, lower volumes corresponded with lower diarrhoea rates whereas higher volumes corresponded with higher prevalence rates. This finding suggests that microbiological transmission of childhood diarrhoea may have taken place through other faeco-oral routes. Thus Jamison et al., (2006) were of the view that prevalence of diarrhoeal disease in communities which have high levels of water supply indicates that water supply alone may not curb diarrhoea.

6.4.6 Childhood diarrhoea prevalence in relation to the disposal of index child's stool

In Fig. 6.11, a seasonal distribution of childhood diarrhoea prevalence is presented with the method of disposal of index children's stools. It shows that the highest rates were recorded in the wet and dry seasons in households where index children's stools were directly thrown into the garbage (22.3%) and buried (100%) respectively. Four out of 24 representing 14.3% of index children who used the latrine and 20 out of 189 representing 10.6% of index children whose faeces were rinsed into latrine had childhood diarrhea in the wet season. Also 21 out of 94 index children representing 22.3% had childhood diarrhoea in the wet season.

Fig. 6.11 Seasonal distribution of childhood diarrhoea prevalence by method of disposal of index child's stool.



Source: Author's field survey, 2012 and 2013.

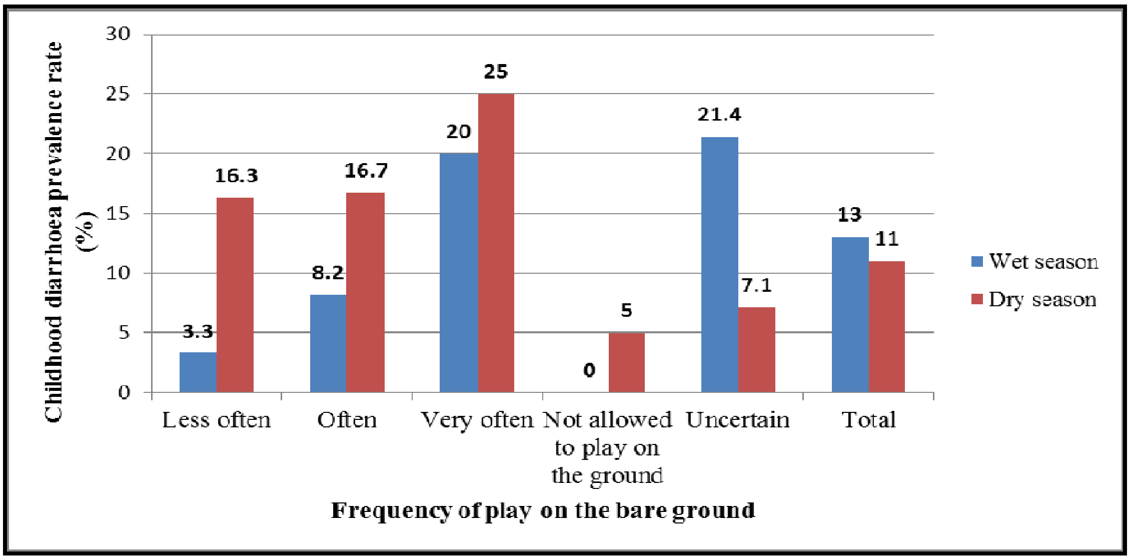
In terms of throwing faeces directly into the garbage, the outcome of 22.3% may be partially due to the attraction of flies to the faeces. Other factors which may come into play are the presence or otherwise of a garbage container and lid as well as proximity of the bin to the domestic environment. Where garbage bins are in close proximity to the domestic environment, are left uncovered and faeces are directly placed in, flies could settle on them and quickly transmit diarrhoea pathogens when they settle on food, water, utensils or the body. The lowest rates of 0% were recorded for rinsing into drains, burying and leaving in the open during the wet season. However this result does not necessarily mean that rinsing faeces into drains/ditch, burying and leaving in the open are improved means of disposal of children's stools because hygienic separation of faeces from human contact is not guaranteed (WHO/UNICEF, 2010: 12).

On the other hand, in the dry season, 10 out of 95 index children who used latrines, representing 10.5%, 8 out of 77 representing 10.4% of index children whose faeces were rinsed into a latrine and 5 out of 111 representing 4.5% of index children whose faeces were thrown directly into the garbage had childhood diarrhoea. A peculiar observation in the dry season data was that 6 out of 6 index children representing 100% of mothers who reportedly burred their faeces had childhood diarrhoea.

6.4.7 Childhood diarrhoea prevalence in relation to the index child's play on the bare ground with soil.

From Fig. 6.12 it was observed that there was a positive gradient in childhood diarrhoea prevalence rates as an index child's frequency of play on the bare ground increases. One out of 30 index children and 15 out of 92 index children played on the floor less often in the wet and dry seasons indicating prevalence rates of 3.3% and 16.3% in the wet and dry seasons respectively.

Fig. 6.12 Seasonal distribution of childhood diarrhoea prevalence by frequency of play on the bare ground.



Source: Author's field survey, 2012 and 2013.

With respect to index children who played on the bare ground 'very often', 30 out of 150 index children representing 20.0% and 4 out of 16 index children representing 25% had childhood diarrhoea in the wet and dry seasons respectively (Fig. 6.11).

Index children of mothers who claimed that they were uncertain about how frequently their children played on the floor had higher rates of diarrhoea (21.4%) in the wet season. Index children who were not allowed to play on the bare floor had the least childhood diarrhoea prevalence rates in both wet and dry seasons. The data therefore suggests that higher rates of childhood diarrhoea corresponded with playing 'very often' on the bare ground compared to index children who played 'less often' and those who did not. A possible reason for this outcome is that the bare ground serves as a repository for faecal matter from possible sources such as feaecally contaminated feet, animal droppings and buried faecal matter in the domestic environment. As the child plays on the bare ground, he/she may come into contact or ingest the feaecally contaminated dirt and contaminate his or her hands and feet.

6.5 Risk Factors Associated with Childhood Diarrhoea in the Wet Season

A risk factor refers to 'an aspect of personal habits or an environmental exposure that is associated with an increased probability of occurrence of a disease' (WHO, 2006: 32). The International Epidemiological Association also defines a risk factor as ' an attribute or exposure that is associated with an increased probability of a specified outcome such as the occurrence of disease (IEA, 2008: 218). With respect to this study, the outcome of interest was childhood diarrhoea amongst index children two weeks prior to the survey in the wet and dry seasons.

In the crude analysis of socio-demographic factors in the wet season (Table 6.10), only one variable, household residential location had a statistically significant association with childhood diarrhoea. Compared to children who lived in urban communities, children who lived in peri-urban communities were three times more likely to experience diarrhoea (OR= 3.00, 95% CI 1.62 – 5.56). In another study in Eastern Ethiopia, Mengistie et al., (2013) found that the odds of diarrhoea for children living in rural areas were 2.22 times higher than their urban counterparts which suggest that urban areas may be more associated with lower odds of diarrhoea for children. Though not statistically significant, children who lived in households where mothers had completed SHS (OR= 1.29, 95% CI 0.51 – 3.26) or lived in households which were middle income or lower (OR= 1.56, 95% CI 0.85 – 2.87) had higher odds of childhood diarrhoea.

However no statistically significant association was found between childhood diarrhoea and children who lived in households where mothers were less than 35 years (OR= 0.81, 95% CI 0.41 – 1.70), fathers who completed SHS or higher (OR= 0.79, 95% CI 0.17 – 3.55), spouses of respondents were self-employed (OR= 0.89, 95% CI 0.48 – 1.64) and households where one under-five year old child lived (OR= 0.69, 95% CI 0.37 – 1.28) (Table 6.10). In contrast, studies in Ethiopia showed that children of mothers who had no formal education and children who lived in households with two or more siblings had 1.30 times and 1.74 times higher odds of diarrhoea respectively (Mengistie et al., 2013).

Table 6.10 Socio-demographic factors associated with the prevalence of childhood diarrhoea among households in the wet season.

Socio-demographic Variables (Wet Season)	**Diarrhoea (2weeks)**		**Crude OR (95% CI)**	***p***
	Yes (%)	**No (%)**		
HH numbers 5 or more				
Yes	25 (13)	161 (87)	1.07 (0.58 – 1.95)	0.81
No	24 (13)	166 (87)	1	
Respondents age is ≤ 35				
Yes	36 (12)	256 (88)	0.81 (0.41 – 1.70)	0.63
No	12 (14)	72 (86)	1	
Mother completed SHS or higher				
Yes	6 (16)	32 (84)	1.29 (0.51 – 3.26)	0.59
No	43 (13)	296 (87)	1	
Spouse completed SHS or higher				
Yes	2 (11)	16 (89)	0.79 (0.17 – 3.55)	0.75
No	46 (14)	291 (86)	1	
Respondent is a house wife				
Yes	9 (12)	64 (88)	0.93 (0.43 – 2.01)	0.85
No	40 (14)	256 (86)	1	
Spouse is self employed				
Yes	28 (13)	189 (87)	0.89 (0.48 – 1.64)	0.72
No	21 (14)	127 (86)	1	
HH is middle income or lower				
Yes	22 (17)	110 (83)	1.56 (0.85 – 2.87)	0.15
No	27 (11)	211 (89)	1	
HH residential location				
Urban	20 (8)	222 (92)	1	
Peri-urban	29 (21)	107 (79)	3.00 (1.62 – 5.56)	0.00*
Number of under 5 children in HH				
One	29 (12)	221 (88)	0.69 (0.37 – 1.28)	0.24
Two or more	20 (16)	106 (84)	1	

Source: Author's field survey, 2012; * p ≤ 0.05.

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Table 6.11 Environmental factors associated with the prevalence of childhood diarrhoea among households in the wet season.

Environmental Variables (Wet Season)	Diarrhoea (2 weeks)		Crude OR (95% CI)	*p*
	Yes (%)	No (%)		
Latrine ownership				
Private	7 (19)	30 (81)	0.64 (0.22 – 1.87)	0.42
Shared	10 (13)	66 (87)	1	
***HH Sanitation**				
Improved	7 (19)	30 (81)	1.66 (0.68 – 4.02)	0.26
Unimproved	42 (12)	299 (88)	1	
Latrine door				
Available	11 (14)	68 (86)	1.13(0.12 – 10.11)	0.91
Not available	1 (12)	7 (88)	1	
Latrine lid				
Available	5 (14)	32 (86)	0.98 (0.28 – 3.37)	0.97
Not available	7 (14)	44 (86)	1	
Faeces seen around pit hole / slab				
Yes	5 (25)	15 (75)	2.90(0.80 – 10.43)	0.10
No	7 (10)	61 (90)	1	
Faeces seen around latrine				
Yes	5 (14)	32 (86)	0.98 (0.28 – 3.37)	0.97
No	7 (14)	44 (86)	1	
Faeces seen on latrine floor				
Yes	4 (13)	28 (87)	0.85 (0.23 – 3.10)	0.81
No	8 (14)	48 (86)	1	
Faeces seen on compound				
Yes	30 (14)	181 (86)	1.50 (0.75 – 3.00)	0.24
No	13 (10)	118 (90)	1	
Refuse disposal				
Safe	15 (10)	132 (90)	0.64 (0.33 – 1.23)	0.18
Unsafe	34 (15)	193 (85)	1	

Source: Author's field survey, 2012; * $p \leq 0.05$.

In the crude ratio analysis of environmental factors in the wet season (Table 6.11), none of the hypothesized variables (factors) showed a statistically significant association with childhood diarrhoea.

Table 6.12 Behavioural factors and the prevalence of childhood diarrhoea among households in the wet season.

Behavioural Variables (Wet Season)	Diarrhoea (2 weeks)		Crude OR (95% CI)	*p*
	Yes (%)	No (%)		
HH domestic water				
Improved	48 (13)	309 (87)	0.32(0.04 – 2.45)	0.27
Unimproved	1 (5)	20 (95)	1	
HH drinking water				
Improved	41 (14)	244 (86)	0.58(0.26 – 1.28)	0.18
Unimproved	8 (4)	82 (91)	1	
HH has 'optimal access' to domestic water				
Yes	5 (13)	33 (87)	0.85(0.31 – 2.33)	0.75
No	34 (15)	191 (85)	1	
Drinking water stored outside the dwelling				
Yes	10 (11)	85 (89)	0.73(0.34 – 1.54)	0.41
No	36 (14)	224 (86)	1	
Method of obtaining water				
Pouring	2 (17)	10 (83)	1	
Dipping with cup	41 (13)	276 (87)	0.74(0.15 – 3.51)	0.70
Storage vessel covered				
Yes	29 (14)	181 (86)	1.22(0.62 – 2.42)	0.56
No	14 (12)	107 (88)	1	
Children's stool disposal				
Safe	18 (10)	156 (90)	0.61(0.32 – 1.13)	0.11
Unsafe	31 (16)	164 (84)	1	
Child often plays on the bare ground with soil				
Yes	46 (13)	317 (83)	0.53(0.14 – 1.97)	0.34
No	3 (21)	11 (79)	1	
Mother washes hands with soap and water				
Yes	23 (11)	189 (89)	0.65(0.35 – 1.19)	0.16
No	26 (16)	140 (84)	1	

Source: Author's field survey, 2012; * $p \leq 0.05$.

Similarly, the crude ratio analysis for behavioural factors showed that none of the hypothesized variables in the wet season showed a statistically significant relationship with childhood diarrhoea. Four out of nine variables had a p-value less than 0.30. These were the use of improved domestic water sources (OR= 0.32 95% CI 0.04 – 2.45), use of improved drinking water sources (OR= 0.58, 95% CI 0.26 – 1.28), practice of safe children's stool disposal (OR= 0.61, 95% CI 0.32 – 1.13), and mother's washing of hands 'very often' after cleaning the bottom of their children (OR= 0.65, 95% CI 0.35 – 1.19) (Table 6.12).

The multivariate analysis was conducted to identify the risk factors of childhood diarrhoea during the wet season as shown in Table 6.13. In the logistic regression model 1, residential location and the number of under five year old children in the household showed statistical significance of $p \leq 0.30$ when all socio-demographic factors were assessed together. However between the two factor, residential location showed a statistically significant association ($p \leq 0.05$) with childhood diarrhoea. Model 1 suggest that children living in peri-urban households were almost three times more likely to experience diarrhoea (AOR= 2.71, 95% CI 1.44 – 5.10) compared to children who lived in urban communities. In model 2, only the type of sanitation used by the household showed statistical significance of $p \leq 0.30$ when all environmental factors were assessed together. All behavioural factors were also assessed together and only children's stool disposal satisfied the criterion for inclusion into model 3, $p \leq 0.30$.

In the final model (Table 6.13), only residential location showed a statistically significant association with childhood diarrhoea. Children who lived in peri-urban households had higher odds of diarrhoea (AOR= 3.01, 95% CI 1.61 – 5.63).

Table 6.13 Multivariate regression analysis of the factors associated with childhood diarrhoea among households in the wet season.

Risk factors (Wet Season)	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)	Final Model AOR (95% CI)
HH residential location				
Urban	1			1
Peri-urban	2.71(1.44-5.10)*			3.01(1.61- 5.63)*
Number of under 5 children in HH				
One	0.66 (0.34 - 1.26)			0.68(0.36–1.29)
Two or more	1			1
HH Sanitation				
Improved		0.49(0.20-1.22)		1.66(0.65-4.20)
Unimproved		1		1
Children's stool disposal				
Safe			0.57(0.25–1.26)	0.78(0.16–3.76)
Unsafe			1	1

Source: Author's field survey, 2012; * $p \leq 0.05$.

6.6 Risk Factors Associated with Childhood Diarrhoea in the Dry Season

In order to identify the factors associated with childhood diarrhoea in the dry season and also identify similarities and differences with factors that manifested in the wet season, dry season bi-variate and multivariate analysis were conducted. The hypothesized variables were grouped into three categories, socio-demographic, environmental and behavioural variables and assessed using the procedures described in section 6.5.

In the dry season crude ratio analysis (Table 6.14), two factors; the respondent's age and mothers' completion of SHS or better were statistically significantly associated with childhood diarrhoea. The odds of childhood diarrhoea was higher for children whose mothers' ages were 35 years or less (OR= 2.99, 95% CI 1.03 – 8.64) and also higher for children whose mothers had completed SHS (OR= 2.78, 95% CI 1.21 – 6.36). No statistically significant relationship was found between childhood diarrhoea and household size (OR= 1.08, 95% CI 0.57 – 2.03), spouse completion of SHS or better (OR= 1.48, 95% CI 0.41 – 5.35), respondent being a housewife (OR= 0.64, 95% CI 0.26 – 1.60), spouse being self employed (OR= 0.75, 95% CI 0.40 – 1.43), residential location (OR= 0.84, 95% CI 0.42 – 1.65) or the number of under-five year old children in the household (OR= 0.93, 95% CI 0.47 – 1.81). Other studies have however shown that with respect to household size, children living in larger families were more likely to have diarrhoea partly due to less attention given to children and deterioration in hygiene due to the large family size (El-Gilany and Hammad, 2005).

With respect to the bi-variate analysis of environmental factors (Table 6.15), the availability of a latrine lid and unsafe refuse disposal showed a p-value of ≤ 0.30 but only unsafe refuse disposal showed a statistically significant relationship with childhood diarrhoea.

Table 6.14 Socio-demographic factors associated with the prevalence of childhood diarrhoea among households in the dry season.

Socio-demographic Variables (dry Season)	**Diarrhoea (2weeks)**		**Crude OR (95% CI)**	***p***
	Yes (%)	**No (%)**		
HH numbers 5 or more				
Yes	22 (12)	164 (88)	1.08 (0.57 – 2.03)	0.81
No	21 (11)	169 (89)	1	
Respondents age is ≤ 35				
Yes	38 (13)	254 (87)	2.99 (1.03 – 8.64)	0.04*
No	4 (5)	80 (95)	1	
Mother completed SHS or higher				
Yes	9 (24)	29 (76)	2.78 (1.21 – 6.36)	0.01*
No	34 (10)	305 (90)	1	
Spouse completed SHS or higher				
Yes	3 (17)	15 (83)	1.48 (0.41 – 5.35)	0.54
No	40 (12)	297 (88)	1	
Respondent is a house wife				
Yes	6 (8)	67 (92)	0.64 (0.26 – 1.60)	0.34
No	37 (12)	268 (88)	1	
Spouse is self employed				
Yes	23 (11)	194 (89)	0.75 (0.40 – 1.43)	0.39
No	20 (13)	128 (87)	1	
HH is middle income or lower				
Yes	19 (14)	113 (86)	1.49 (0.78 – 2.85)	0.21
No	24 (10)	214 (90)	1	
HH residential location				
Urban	29 (12)	213 (88)	1	
Peri-urban	14 (10)	122 (90)	0.84 (0.42 – 1.65)	0.62
Number of under 5 children in HH				
One	28 (11)	222 (89)	0.93 (0.47 – 1.81)	0.83
Two or more	15 (12)	111 (88)	1	

Source: Author's field survey, 2013; * $p \leq 0.05$.

Children who lived in households where unsafe refuse disposal was practised were two times more likely to suffer diarrhoea compared to children who lived in households which practised safe stool disposal and this result is consistent with studies by Reggassa et al., (2008) and Mengistie et al., 2013.

Table 6.15 Environmental factors associated with the prevalence of childhood diarrhoea among households in the dry season.

Environmental Variables (dry Season)	**Diarrhoea (2 weeks)**		**Crude OR (95% CI)**	***p***
	Yes (%)	**No (%)**		
Latrine ownership				
Private	4 (11)	33 (89)	0.90 (0.25 – 3.14)	0.87
Shared	9 (12)	67 (88)	1	
***HH Sanitation**				
Improved	4 (11)	33 (89)	0.93 (0.31 – 2.79)	0.90
Unimproved	39 (11)	302 (89)	1	
Latrine door				
Available	11 (14)	68 (86)	1.13 (0.12 – 10.11)	0.91
Not available	1 (12)	7 (88)	1	
Latrine lid				
Available	7 (19)	30 (81)	2.14 (0.62 – 7.39)	0.22
Not available	5 (10)	46 (90)	1	
Faeces seen on compound				
Yes	20 (12)	148 (88)	1.09 (0.57 – 2.06)	0.78
No	23 (15)	186 (85)	1	
Refuse disposal				
Safe	9 (7)	124 (93)	1	
Unsafe	34 (15)	194 (85)	2.41 (1.12 – 5.20)	0.02*

Source: Author’s field survey, 2013; * $p \leq 0.05$.

Table 6.16 Behavioural factors and the prevalence of childhood diarrhoea among households in the dry season

Behavioural Variables (Dry Season)	Diarrhoea (2 weeks)		Crude OR (95% CI)	*p*
	Yes (%)	No (%)		
HH domestic water				
Improved	40 (11)	317 (89)	1	
Unimproved	3 (14)	18 (86)	1.32(0.37 – 4.68)	0.66
HH drinking water				
Improved	36 (13)	249 (87)	1	
Unimproved	7 (8)	83 (92)	0.58(0.25 – 1.36)	0.10
HH has 'optimal access' to domestic water				
Yes	2 (18)	9 (82)	1.68(0.35 – 8.07)	0.50
No	41 (12)	311 (88)	1	
Drinking water stored outside the dwelling				
Yes	13 (7)	174 (93)	0.38 (0.19 –0.77)	0.00**
No	28 (16)	146 (84)	1	
Method of obtaining water				
Pouring	1 (6)	16 (94)	0.56(0.07 – 4.40)	0.58
Dipping with cup	34 (10)	308 (90)		
Storage vessel covered				
Yes	33 (11)	255 (89)	1.48 (0.59-3.69)	0.39
No	6 (8)	69 (92)	1	
Children's stool disposal				
Safe	35 (17)	253 (83)	0.89(0.39 – 2.05)	0.80
Unsafe	8 (13)	52 (87)	1	
Child often plays on the bare ground with soil				
Yes	33 (17)	159 (83)	3.32(1.58 – 6.96)	0.00**
No	10 (6)	160 (94)	1	
Mother washes hands with soap and water often after cleaning bottom of child				
Yes	22 (10)	190 (90)	0.79(0.42 – 1.51)	0.49
No	21 (13)	145 (87)	1	

Source: Author's field survey, 2013; * $p \leq 0.05$; ** $p \leq 0.01$.

In the crude odds ratio analysis of behavioural risk factors in the dry season, two factors were statistically significantly associated with childhood diarrhoea; the storage of water on the compound of the dwelling and children often playing on the ground (Table 6.16). Children who lived in households where water was stored outside the dwelling had lower odds (OR= 0.38, 95% CI 0.19 – 0.77) of having diarrhoea compared to children who lived in households where the water was stored in the dwelling. The odds of diarrhoea was three times higher for children who often/regularly played on the floor (OR= 3.32, 95% CI 1.58 – 6.96) than for children who did not.

From Table 6.16, no statistically significant association was found between childhood diarrhoea and domestic water sources (OR= 1.32, 95% CI 0.37 – 4.68), drinking water sources (OR= 2.99, 95% CI 1.03 – 8.64), optimal access to water (OR= 1.68, 95% CI 1 0.35 – 8.07), the method of obtaining water from water storage vessels (OR= 0.56, 95% CI 0.07 – 4.40), covering of water storage vessels (OR= 1.48, 95% CI 0.59 – 3.69), children's stool disposal (OR= 0.89, 95% CI 0.39 – 2.05) and mothers washing their hands with water and soap after cleaning their children's bottom (OR= 0.79, 95% CI 0.42 – 1.51).

Multivariate logistic regression was carried out to identify the risk factors of childhood diarrhoea in the dry season, the results of which are shown in Table 6.17. In model 1, the respondent's age (AOR= 3.59, 95% CI 1.21 – 10.61), the mother'completion of SHS or better (AOR= 3.21, 95% CI 1.35 – 7.64) and the mother being a housewife (AOR= 0.54, 95% CI 0.21-1.37) showed a p-value of ≤ 0.30 during the multivariate logistic regression for socio-demographic variables. Secondly, in model 2, only the method of disposal of refuse (AOR= 0.41, 95% CI 0.19 – 0.88) showed a p-value of ≤ 0.30 during the multivariate logistic regression for environmental variables. In model 3, having optimal access to domestic water (AOR= 2.67, 95% CI 0.51 – 13.70), storage of drinking water outside the dwelling (AOR= 0.49, 95% CI 0.23 – 1.03) and children often playing on the ground (AOR= 2.46, 95% CI 1.11 – 5.44) showed a p-value of ≤ 0.30 during the multivariate logistic regression for behavioural variables.

In the final model, controlling for the effect of geographic location, four risk factors; respondent's age, mother's education, storage of water on the compound and child often playing on the ground showed a statistically significant association with childhood diarrhoea. Children who lived in households where the respondent's age was 35 years or less were three times more likely to suffer diarrhoea than children whose mother's ages were above 35 years. This result is consistent with El-Gilany and Hammad (2005) who found that the frequency of diarrhoea was significantly higher amongst children whose mothers were younger and had lower education. The finding of this study may be partially explained by two factors. First, the relatively low educational attainment of mothers in this study and secondly the result could have been a reflection of the fact that younger mothers had relatively little experience in how to manage the household environment to prevent transmission of diarrhoeal pathogens.

Table 6.17 Multivariate regression analysis of the factors associated with childhood diarrhoea among households in the dry season.

Risk factors (Dry Season)	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)	Final Model AOR (95% CI)
Respondents age is ≤ 35				
Yes	3.59 (1.21-10.61)			3.52 (1.00-10.32)*
No	1			1
Mother completed SHS or higher				
Yes	3.21 (1.35-7.64)			4.67 (1.80-12.13)*
No	1			1
Mother is a house wife				
Yes	0.54 (0.21-1.37)			0.95 (0.35-2.88)
No	1			1
Refuse Disposal				
Safe		0.41 (0.19-0.88)		0.49 (0.21 – 1.15)
Unsafe		1		1
HH has 'optimal access' to domestic water				
Yes			2.67 (0.51-13.70)	3.22 (0.56-18.28)
No			1	1
Water stored outside the dwelling				
Yes			0.49 (0.23-1.03)	0.38 (0.17-0.84)*
No			1	1
Child often plays on the bare ground with soil				
Yes			2.46 (1.11-5.44)	3.05 (1.35-6.89)*
No			1	1

Source: Author's field survey, 2013; * $p \leq 0.05$.

The odds of childhood diarrhoea was four times higher (AOR= 4.67, 95% CI 1.80 – 12.13) for children whose mothers had completed SHS or higher compared to children whose mothers had not completed SHS (Table 6.17). Also children who lived in households where domestic water was regularly stored on outside of the dwelling had lower odds of diarrhoea (AOR= 0.38, 95% CI 0.17 – 0.84) compared to children who lived in households where domestic water was regularly stored elsewhere. Children who often/regularly played on the ground were three times more likely to suffer childhood diarrhoea in the multivariate analysis (AOR= 3.05, 95% CI 1.35 – 6.89). In general the results of the multivariate analysis suggests that socio demographic and environmental factors were more at play with respect to the risk of childhood diarrhoea in the domestic environment.

6.7 The Relationship Between Domestic Water Use and Childhood Diarrhoea

In order to assess the relationship between water use and childhood diarrhoea, bi-variate and linear regression methods were employed. In order to facilitate the crude odds ratio analysis, the per capita daily water use, which was a continuous variable, was categorized according to liters per capita per day. Where a household used water between 100 liters to ≥ 300 liters per capita per day, it was considered to have optimal access and where it used less than 100 it had 'no optimal' access as defined in Table 6.18.

Table 6.18 Definition of 'optimal access' according to quantity collected.

Service Level	**Quantity collected**	**Level of health concern**
Optimal access	From 100 L / capita /day To ≥ 300 l / capita /day	All uses are adequately met and quality is readily assured.
No optimal access	< 100 l/capita/day	All uses are not adequately met.

Source: Adapted from Howard and Bartram (2003: 22) and Kennedy (2006:12).

From Table 6.19 the bi-variate logistic regression analysis showed that in both the wet and dry seasons, households with optimal access to domestic water did not show a statistically significant association with childhood diarrhoea. With a significance level set at $p \leq 0.05$, it means that there was no association between per-capita water use and household diarrhoea for both wet and dry seasons.

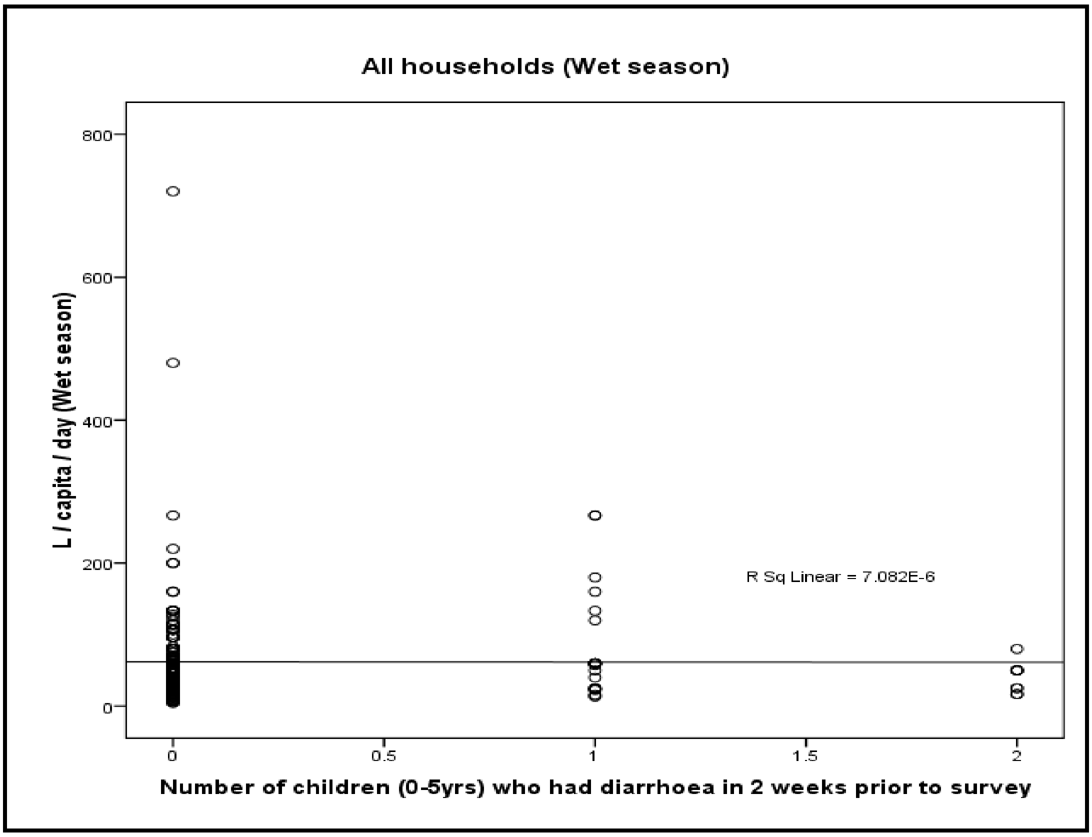
Table 6.19 Childhood Diarrhoea prevalence for households with optimal access.

Variables	**Diarrhoea (2 weeks)**		**Crude OR (95% CI)**	***p***
	Yes (%)	**No (%)**		
(Wet Season)				
HH has 'optimal access' to domestic water				
Yes	5 (13)	33 (87)	0.85(0.31 – 2.33)	0.75
No	34 (11)	191 (89)	1	
(Dry Season)				
HH has 'optimal access' to domestic water				
Yes	2 (18)	9 (82)	1.68(0.35 – 8.07)	0.50
No	41 (12)	311 (88)	1	

Source: Author's field survey, 2012 and 2013

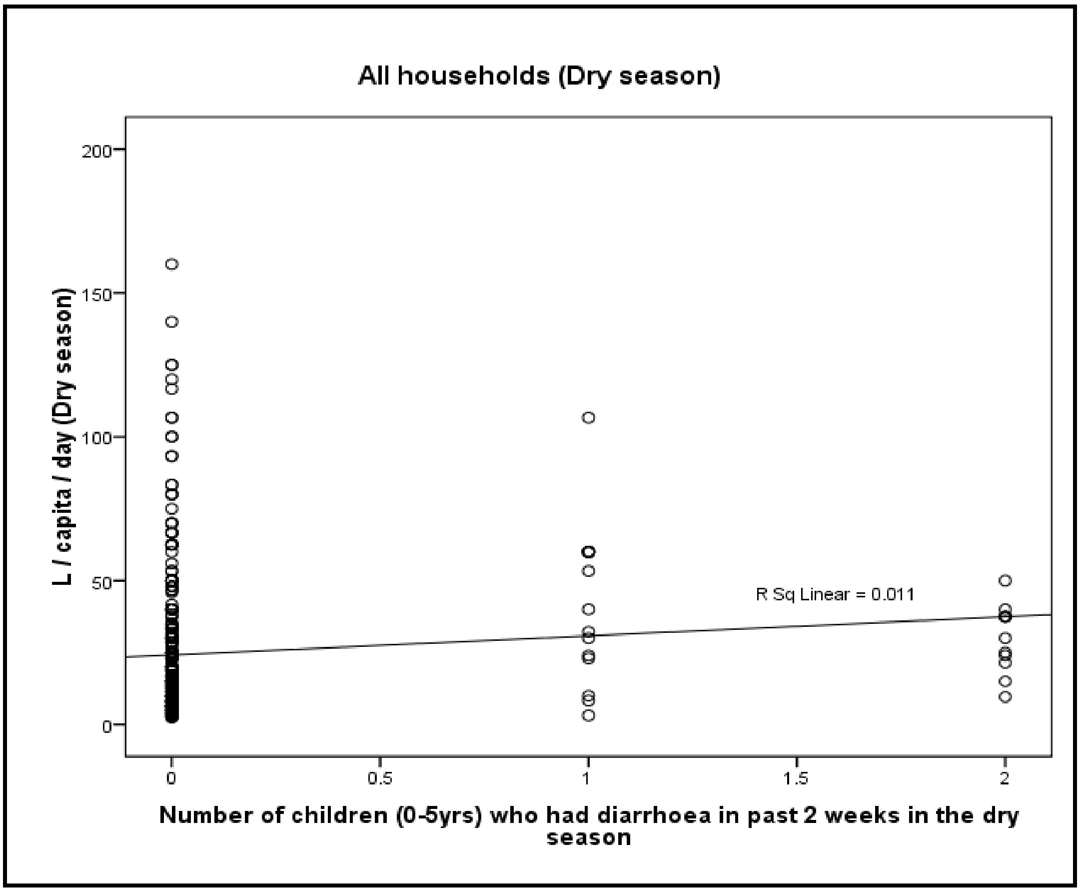
In exploring the relationship between childhood diarrhoea and domestic water use further, two variables were defined. The number of children under-five years who had diarrhoea in the previous two weeks was defined as the dependent variable whereas water use per capita per day was defined as the independent variable in SPSS. Using linear regression, the relationship between water use and childhood diarrhoea in urban, peri-urban, piped and un-piped households the wet and dry seasons was explored. The level of significance was set at 0.05 and where 'R square' was equal to zero ($R^2 = 0$), it indicated that the dependent variable was not explained by the linear model. In other words, an $R^2 = 0.00$ meant that there was no significant linear relationship between the two variables with respect to the spatial context under consideration.

Fig. 6.13 Scatter plot of the relationship between number of children with diarrhoea and daily per capita water use in the wet season.



Source: Author's field survey, 2012.

Fig. 6.14 Scatter plot of the relationship between number of children with diarrhoea and daily per capita water use in the dry season.



Source: Author's field survey, 2013.

From Fig. 6.13 and Fig. 6.14, in the wet season, the linear regression model, showed no statistically significant association between childhood diarrhoea and daily per capita water use ($p = 0.966$) and R^2 was 0.00. However in the dry season, though the linear regression model between childhood diarrhoea and daily per capita water use showed a statistically significant association ($p = 0.043$), per capita water use was able to explain only 1% of total variation in childhood diarrhoea ($R^2 = 0.01$) (Appendix VII). Therefore the hypothesis which states that 'H_0: There is no statistically significant association between per-capita water use and childhood diarrhoea in the wet and dry seasons was not rejected.

6.8 Chapter Summary

This chapter discussed maternal knowledge, health seeking behaviour and practices relating to childhood diarrhoea, household sanitation characteristics,, childhood diarrhoea prevalence as well as risk factors associated with childhood diarrhoea in the wet and dry seasons. The public toilet was the most dominant sanitation facility used by 244 (68.4%) of households (n = 357) whereas the least used was the 'in compound bucket' latrine 8 (2.2%). With respect to the JMP definitions of improved and unimproved sanitation facilities, majority of households 321 (90%) used unimproved facilities whereas 36 (10%) used improved sanitation. Most observed latrines were built with cement walls, roofed with corrugated roofing sheets and had concrete floors. With respect to waste disposal, in both wet and dry seasons, households practised unsafe refuse disposal and over 90% of households used the open ground for disposal of waste water partially due to poor drainage systems in the study communities. On the other hand, over 80% of households in both the wet and dry seasons practised safe disposal of children's stools.

Two weeks diarrhoeal prevalence was higher in the wet (17.5%) than in the dry season (7.9%) and with respect to sanitation facilities, diarrhoea prevalence was highest for households which used the WC in their dwelling in the wet season whereas ones which used the 'in compound WC' had the highest prevalence for the dry season.

A total of 77% of mothers interviewed had a satisfactory knowledge about the causes of childhood diarrhoea. However research evidence from this study showed that over 80% of mothers did not regularly use Oral Rehydration Therapy (ORT) when their children had diarrhoea episode in both seasons. There was evidence of unsafe disposal of the stools of index children and possible contamination of the home compound where waste water containing children’s faeces were disposed of in the open ground or streets. Over 90% of mothers however practised safe disposal of the faeces of index children in the wet and dry seasons.

The 24 hour prevalence rates of childhood diarrhoea were higher for index children in the wet season (8.2%) than in the dry season (3.4%) whilst the 2 weeks prevalence of childhood diarrhoea was higher in the wet season (13%) than in the dry season (11.4%). With respect to sanitation facilities, children who lived in households which used an ‘in compound WC’ had the highest childhood diarrhoea prevalence rates in the wet (26.7%) and dry (20%) seasons respectively.

Multivariate logistic regression analysis showed that in the wet season, residential location showed a statistically significant association with childhood diarrhoea in a final model of risk factors. In the dry season, respondent’s age, mother’s education, storage of water outside the dwelling and child often playing on the ground showed a statistically significant association with childhood diarrhoea. In both wet and dry season, bi-variate and multivariate logistic regression analysis showed that there was no statistically significant association between per-capita water use and childhood diarrhoea.

CHAPTER SEVEN

7.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary of the Thesis

The objective of this panel study was to explore seasonal domestic water use and its relationship with childhood diarrhoea in households which had children under-five years in the Atwima Nwabiagya District. Specifically, this study sought to characterize seasonal domestic water use behaviour, examine the determinants of domestic water use, identify risk factors of childhood diarrhoea in the domestic domain and examine the relationship between childhood diarrhoea and domestic water use in both wet and dry seasons.

Using a simple random sampling approach, a total of 378 households with children under-five years were drawn from four communities, namely Abuakwa, Nkawie, Asuofua and Barekese. Health data from the District Health Directorate of the Ghana Health Service suggested that the study communities had relatively high cases of childhood diarrhoea from 2008 – 2010. In addition, district water supply coverage was estimated as 80% in 2006 and 95% in 2009 (ANDA, 2011:31). The 378 households were visited twice; first in the wet season and second in the dry season. On each visit, mothers were interviewed using interviewer administered questionnaires and data from this source were complemented by observation schedules, in-depth interviews and focus group discussions.

With respect to the characterization of domestic water use behaviour within the household (Chapter 4), it was discussed under themes such as water sources, water collection, distance to water source, levels of service to households, the cost of domestic water and domestic water storage. There was no difference in the distribution of urban and peri-urban residents with respect to number of rooms occupied and the number of under five year olds in a household. However, there was a statistically significant difference in the distribution of urban and peri-urban households with respect to the number of years resident in the dwelling and number of under fifteen year olds. Mothers and their spouses also differed significantly with regards to occupation. With regards to water sources, there was a statistically significant difference between improved and unimproved sources and also a statistically significant difference between water sources used for domestic purposes and drinking purposes.

The primary drawer of water in the wet season was the ‘female adult’ whereas that of the dry season was the ‘female and children’. In terms of water collection the basin pan was the most prominent vessel used for water collection in both wet (59.7%) and dry (48.3%) seasons. The ‘Jerry can’ was the primary water storage vessel for households in the wet and dry seasons. The results of a paired sample *t*-test were significant; $t(255) = 10.92$, $p \leq 0.001$, indicating a large seasonal variation in mean per capita water use. Mean daily per capita water use was estimated to be 54 liters in the wet ($n = 263$) and 22 liters in the dry season ($n = 366$).

Chi-square tests showed that in the wet season and dry seasons, households were significantly distributed differently across variables such as primary drawer for the household, primary water collection vessel, number of trips per day for water collection, number of days for water collection per week, total daily volume of household water collected and period of day for water collection. In addition, households were significantly distributed differently across number of service hours per day at the water source, frequency of water storage, frequency of water transfer, place of water storage and covering of the primary water storage vessel.

The determinants of water use were assessed in piped and un-piped households, urban and peri-urban households as well as all households in the wet and dry seasons (Chapter 5). Factors such as household size, length of water storage hours of water service and volume of the primary water storage vessel were identified as determinants of water use in the dry season. On the other hand, only household size and volume of the primary water storage vessel were identified as determinants of water use in a weak model predicting 9% of variation in water use in the wet season.

Piped water supply was low 42 (11.1%) amongst the study households. In un – piped households, volume of the primary water storage vessel, hours of water service, length of water storage and household size were identified as determinants of water use in a model that predicted 33% of variation in water use in the dry season. In the wet season, 13% of the variation in water use was explained by the combination of factors such as household socio-economic status, volume of the primary water storage vessel and household size.

In urban households, length of water storage, household size, hours of water service and volume of the primary water storage vessel together predicted 40% of the variation in water use in the dry season. In the wet season, 16% of the variation in water use was explained by the combined effect of volume of the primary water storage vessel, the number of water storage vessels and household size. In peri-urban households, household size, hours of water service and length of water storage predicted 29% of the variation in water use in the dry season whereas in the wet season, household size was the only variable identified as a determinant of water use in a model that predicted only 9% of the variation in water use.

A comparison of the determinants across the selected spatial settings showed that household size manifested itself as an important factor in determining water use across time and space. Household size was also negatively correlated with water use in studies such as White et al., (1972), Sandiford et al., (1990), Thompson et al., (2001) and Keshavarzi et al., (2006).

With respect to the analysis on childhood diarrhoea (Chapter 6), it was discussed under major themes such as maternal knowledge, health seeking behaviour and practices relating to childhood diarrhoea, childhood diarrhoea prevalence, factors associated with childhood diarrhoea in the wet and dry seasons, and the relationship between domestic water use and childhood diarrhoea. A total of 77% of mothers who were interviewed had a 'satisfactory knowledge' about the causes of childhood diarrhoea. However research evidence from this study showed a low patronage of ORT by mothers when their under-five year old children experience diarrhoea episodes. Over 80% of mothers did not regularly use Oral Rehydration Therapy (ORT) when their children had a diarrhoea episode in both seasons. There was evidence of unsafe disposal of the stools of index children and possible contamination of the home compound where waste water containing children's faeces were disposed of in the open ground or streets. Over 90% of mothers however practised safe disposal of the faeces of index children in the wet and dry seasons.

The 24 hour prevalence rates of childhood diarrhoea were higher for index children in the wet season (8.2%) than in the dry season (3.4%) whilst the 2 weeks prevalence of childhood diarrhoea was higher in the wet season (13%) than in the dry season (11.4%). With respect to sanitation facilities, index children who lived in households which used an ‘in compound WC’ had the highest childhood diarrhoea prevalence rates in the wet (26.7%) and dry (20%) seasons respectively. The public toilet was the most dominant sanitation facility used by 244 (68.4%) of households (n = 357) whereas the least used was the ‘in compound bucket’ latrine 8 (2.2%). With respect to the JMP definitions of improved and unimproved sanitation facilities, majority of households 321 (90%) used unimproved facilities whereas 36 (10%) used improved sanitation. Most observed latrines were built with cement walls, roofed with corrugated roofing sheets and had concrete floors. With respect to waste disposal, in both wet and dry seasons, households practised unsafe refuse disposal and over 90% of households used the open ground for disposal of waste water partially due to poor drainage systems in the study communities. On the other hand, over 80% of households in both the wet and dry seasons practised safe disposal of children’s stools.

Childhood diarrhoea prevalence rates were relatively higher (16%) and (20%) in households which collected 500 liters or more in the wet and dry seasons respectively compared to (9.6%) in households which collected 100 liters or less per day for both wet and dry seasons. The study results therefore suggest that when an increased volume of water is supplied to household, it may not reduce childhood diarrhoea prevalence. It means then that other mechanisms of childhood diarrhoeal disease transmission such as the quality of water, hygiene and sanitation in the household may be more important.

In the multivariate analysis, only residential location showed a statistically significant association with childhood diarrhoea in the wet season. Children who lived in peri-urban households had higher odds of diarrhoea (AOR= 3.01, 95% CI 1.61 – 5.63) than their urban counterparts.

In the dry season, the mother's age (AOR= 3.52, 95% CI 1.00 – 10.32), the mother's education (AOR= 4.67, 95% CI 1.80 – 12.13), storage of water outside the dwelling (AOR= 0.38, 95% CI 0.17 – 0.84) and child often playing on the ground (AOR= 3.05, 95% CI 1.35 – 6.89) showed a statistically significant association with childhood diarrhoea. In this study, bi-variate and multivariate logistic regression analysis showed that there was no statistically significant association between per-capita water use and childhood diarrhoea in both wet and dry seasons.

7.1.1 Research Limitations

Whilst conducting this research, there were unavoidable limitations that were encountered during the design phase and data collection phase. At the design stage it was deemed worthwhile to use a longitudinal study design, given the research objectives, the time and logistical constrains. However the use of the panel approach meant that, causation of diarrhoea in the household could not be established. This study could not conclude that childhood diarrhoea was the result of per capita water consumption. That notwithstanding, the objective of identifying the risk factors of childhood diarrhoea in both wet and dry season was met. The inclusion of rural communities could have afforded a broader understanding of domestic water use and childhood diarrhoea in the district.

The results of the pilot study revealed that mothers could estimate the total amount of water collected per day but found it difficult to estimate the amount of water used in laundry, bathing, and other domestic chores. Therefore during data collection, data on amount of water used for domestic purposes such as laundry, bathing and flushing were not captured. To address the challenge of estimation of domestic water use, mothers were shown a pictorial chart of locally appropriate water containers and corresponding volumes to facilitate their recall as used by the UNHCR in its Standardized Expanded Nutrition Survey (SENS) (UNHCR, 2013). Also, the low predictive power of some of the models of domestic water use is indicative of potential misspecification errors. Productive uses of water such as sachet water production, block making, palm kennel oil extraction local beverage production and rain water collection could have potentially accounted for variation but were not included in the models.

The Research Assistants spent an average of one hour during data collection in each household and they could only observe sanitation, hygiene and environmental conditions in the household for that period. A clearer picture of conditions in the household could have been painted if observations were carried out in the afternoon and evenings but in order not to incur losses to follow-up, and given the time and logistical constraints, observations of the household were limited to the mornings. This suggests that observations could have been under-reported because most cleaning of domestic environments was done in the mornings in the study communities. Also, mothers' hand hygiene practices were self-reported and subject to possible over reporting as indicated in other studies such as Danquah, (2010). Attempts to conduct focus group discussions in Barekese proved futile due to logistical challenges hence the FGDs were conducted in three study communities other than four.

The study would have benefited from questions and observation of mother's practice of food hygiene and nipple hygiene as these were noted by the District

Director of Medical Services as possible routes of diarrhoeal pathogen transmission. Though questions on food hygiene and nipple hygiene were included in the questionnaire, it was believed that asking questions of that nature required intrusion into the private social spheres of respondents which was deemed unethical. To address this challenge, alternative proxy for measuring hygiene such as washing hands at critical times, children's stool disposal, presence of soap and previous diarrhoea history of the mother in the home were chosen as alternatives which helped to meet the research objective of identifying the risk factors of childhood diarrhoea. The microbiological quality of source and stored water of the study households could not be verified due to budgetary constraints.

7.2 Conclusions

Professor Gilbert F. White, a geographer, Professor David J. Bradley, an epidemiologist, and Dr. Anne U. White, a sociologist, conducted the land mark study of household water uses and environmental health in East Africa known as *Drawers of water (DOW I)* in 1972. Thirty years (30) later, in 2001, the International Institute for Environment and Development conducted a follow up research on the same sites to assess changes that had occurred in water uses and environmental health in the same region also known as *Drawers of water II (DOW II).* Unlike DOW I and II, this study was conducted in Ghana, West Africa and contributes to the expansion of knowledge on water use at the household level. Specifically, determinants of domestic water use in both wet and dry seasons across urban, peri-urban, piped and un-piped households were identified and this supports the comparison and contrast of information on water use in the East African and West African contexts.

This thesis has made significant contributions in the geographic study of child health at the household level. This research has helped to provide scientific evidence which serves as a basis for the designing of appropriate health interventions like maternal education which will be aimed at addressing sanitation and hygiene practices as well as mothers health seeking behaviour at the household level. This research has also provided epidemiological evidence on the risk factors that are associated with childhood diarrhoea in the wet and dry seasons which is a tool that the Atwima Nwabiagya District Health Directorate can use in order to make good choices with respect to where mitigation efforts should be targeted.

This study draws attention to seasonal variations in domestic water use behaviour as well as the determinants of domestic water use. The implication is that the stakeholders in the water sector in the Atwima Nwabiagya District such as the Ghana Water Company can adopt water management measures in the study communities knowing how the various seasonal factors outlined in this research affected water demand. Also, the results of this study has added to the body of evidence raising questions about domestic water supply and its influence on under-five diarrhoea morbidity.

This research provides evidence which is indicative of the need to extend research into other possible sources of pathogen transmission to children under-five years. For example, the micro-biological quality of source and stored water in relation to childhood diarrhoea. Another important implication is that there is the need for a review of water supply efforts aimed at improving the health of communities in the Atwima Nwabiagya District. Complementing safe, adequate water supply with maternal education on disease transmission and provision of safe and adequate sanitation is an option worth considering.

This study has demonstrated that the appropriate borrowing and application of the scientific method of enquiry from other disciplines such as Epidemiology, in geographic enquiry aids in an appreciation of factors that affect child health at the household level. For example, the use of chi-square afforded the determination of statistically significant association or differences in variables. However the use of odds ratios gave an added advantage of determining the odds of the disease occurrence as well as statistical association.

This thesis has made a contribution with respect to methodology. The research has demonstrated that the use of panel surveys in water use studies can afford the collection of data that could be compared and contrasted in time and space. The, Atwima Nwabiagya District Assembly and allied agencies like the District Health Directorate, Ghana Water Company and Community Water and Sanitation Agency, can adopt the panel survey method to assess any changes in water use or household health over time.

Based on the results of the data which were collected and analyzed from this panel study, the following conclusions are drawn:

1. There was a difference between mean daily per capita water use in the wet season and mean daily per capita water use in the dry season.

2. The number of under-five year old children was not identified as a statistically significant determinant of domestic water use in the models developed to identify the determinants of water use in both wet and dry seasons.

3. No statistically significant association was found between per-capita water use and childhood diarrhoea.

7.3 Recommendations

The recommendations are discussed in relation to the findings of this study in order to contribute to addressing domestic water use and childhood diarrhoea challenges in the Atwima Nwabiagya District.

7.3.1 Intensification of maternal education

The mother plays a key role in the life of a child. In the Ghanaian context, mothers have more contact time with children under-five years. Research evidence showed that some mothers did not practice safe disposal of children's stools, others did not practice safe water storage, whereas others did not wash their hands with soap after using the toilet. In light of the research evidence, it is recommended that the Atwima Nwabiagya District Health Directorate intensifies the education being given to mothers on the mechanisms and prevention of diarrhoeal disease transmission in the household in particular.

The ante-natal and post-natal clinics are organized on a daily basis for expectant mothers as well as nursing mothers in the health centers in the study communities. This serves as a cost effective means of reaching out with education on the mechanisms of diarrhoeal disease compared to household visits which do not guarantee physical interaction. For example, with the advent and use of diapers, nurses can educate the mothers on safe methods of children's stool disposal by using charts and practical demonstration in local languages on a daily basis as mothers attend the health centers.

It is also known that motivating behavioural change can be challenging (Scott et al., 2007). However, in the long term, an attempt to induce behavioural changes in respect of sanitation and hygiene practices in households should take into consideration nurturance, social acceptance and disgust for faeces since these have been identified as the strongest motivations for hand washing with soap amongst women (Scott et al., 2007).

7.3.2 Addressing childhood diarrhoea risk factors

Factors associated with childhood diarrhoea prevalence in households with children under-five years were identified in both wet and dry seasons. It is recommended that in the wet seasons, the district health directorate places priority in mitigating childhood diarrhoea in peri-urban households. In the dry season, it is recommended that attempts to address childhood diarrhoea should focus on educating mothers on the faecal-oral transmission of diseases and diarrhoeal disease prevention in the household. Mothers must also be discouraged from allowing their children to play with dirt on the bare ground. In addition, mothers who are less than 35 years of age should constitute the primary targets of childhood diarrhoea mitigation interventions because children who lived in households where the mother was 35 years or less were 3 times more likely to suffer diarrhoea. The health directorate of the Atwima Nwabiagya District should encourage safe storage of domestic water by incorporating the teaching of safe water storage methods to the expectant and nursing mothers who visit the health centers.

7.3.3 Provision and maintenance of adequate sanitation infrastructure

Sanitation infrastructure plays a key role in the separation of faecal matter from human contact. The ramification of unsafe handing of faecal matter in the domestic environment may be more pronounced in the health of children under-five years because they are more vulnerable to small doses of pathogens. The use of improved sanitation facilities by households is to be encouraged but this must be backed by a strong commitment of the part of private owners to adequately clean their latrines on a daily basis.

Field observations and Focus Group Discussions revealed that most public latrines in the study areas were poorly maintained and were not user friendly for the elderly. In addition, women did not use public toilets at night for fear of rape and insect bites. The building and maintenance of public latrines is capital intensive therefore the Atwima Nwabiagya District Assembly has allowed for Public-Private-Partnerships where some individuals can build and maintain latrines for public use. However, the maintenance and daily cleaning of the 'public latrines' owned by the assembly could also be sub-contracted to private companies as this will create employment for some persons in the district as well. In the designing stages, the views of stakeholders like women's groups and the elderly in the beneficiary communities must be taken into account before latrines are constructed. The District Assembly must consider facing out pit latrines and building 'public water closets' which can afford convenient use by stake holders such as women, men, the elderly, disabled persons and children.

7.3.4 Regular monitoring of domestic water service levels

The volume of water that a household uses for domestic purposes has significant implications for securing its health. As per the service level definitions proposed by Howard and Bartram (2003), 12.3% and 13.3% of households in the wet and dry seasons had less than 5 liters of water/capita/day which suggests that the households which did not have 'access' to water and found it hard to meet hygiene needs. The results from this study suggested that there was seasonal variation in domestic water use. This implies that there is the need for the Ghana Water Company Limited and the District Health Directorate to regularly monitor and ensure that per-capita domestic water consumption does not fall short of the internationally recognized minimum needed for basic consumption and hygiene needs which is 20 liters per capita per day.

In the short term, it is recommended that the Ghana Water Company Limited, Community water and Sanitation Agency (CWSA) and the District Assembly together encourage the use of water storage vessels that have a capacity of 40 liters or more, and encourage 24 hours of water service at the primary water source in households in both dry and wet seasons. These measures are intended to help increase the volume of water available per-capita per day. This must however be supported with intensive education on appropriate water storage practice in order to avoid post water collection contamination.

In the long term, it is recommended that since household size was inversely related to per-capita water use, having smaller household sizes as well as the practice of child birth spacing is to be encouraged by the District Health Directorate. Furthermore in the long term, it is recommended that the Ministry of Water Resources Works and Housing focuses on the improvement of access to water supply to on-plot or in-dwelling piped water supply service. This could be done through an extension of the township piped water supply systems and complemented with selective Public-Private-Partnership investments in rainwater harvesting.

7.3.5 Institutional capacity building and training

Institutional capacity building is very essential with respect to achieving organizational goals. Environmental health and sanitation officers play a key role in ensuring that households comply with by-laws pertaining to environmental health and sanitation. It is recommended that more environmental health officers are recruited by the district assembly, trained and posted in the study communities to intensify regular visits to households. An essential element worth considering is motivation. The recruitment should be backed by a commensurate investment in the logistics and remuneration of environmental health officers in order for them to discharge their duties without fear or favour.

Research evidence in this study has showed that some diarrhoea cases never got reported to the health centers but were rather managed in the home. This suggests that health data collected on the incidence or prevalence of diseases in the health centers may not be a true reflection of what pertains in the communities. Therefore the estimation of the distribution of environmentally related diseases in general and childhood diarrhoea in particular could be improved by the intensification of practical training of environmental health officers as well as nurses in field observation and interview techniques. As the environmental health officers and nurses visit designated households, they could collect data which can be fed into a database to study disease trends and compare them to cases reported at the health centers. It is recommended that the Ghana Health Service installs Geographic Information Systems at the district health directorate and all health centers in the district where all health data can be imputed. It is intended to afford the generation of disease maps as well as easier monitoring of diseases in time and space.

7.3.6 Review of national policies relating to child health and environmental sanitation

Given the fact that Ghana was not able to achieve the MDG target on sanitation in 2015, there is the need to revise the National Environmental Sanitation Policy to reflect the targets of the Sustainable Development Goals. Also, the National Water Policy, National Health Policy, and Child Health Policies must be revised to reflect both national developmental aspirations and the Sustainable Development Goals. Within each policy, indicators, benchmarks and implementing agencies need to be clearly outlined. In addition, implementing agencies must be given targets by which progress or retardation can be measured. Institutions responsible for monitoring and evaluation of factors must be well resourced in terms of technical expertise and funding to carry out effective monitoring. Through broad consultations, the voices of vulnerable groups in the society must be included in any intended revisions of the child health policy and policies relating to environmental sanitation.

7.3.7 Recommendations for future research

The provision of approximately 90% water coverage in the Atwima Nwabiagya District by its District Assembly is laudable. However, research evidence from this study suggests that it does not necessarily translate into lower childhood diarrhoea prevalence rates in the study households in both wet and dry seasons. Households which collected 500 liters or more water per day had higher childhood diarrhoea prevalence rates that those that collected $\leq$ 100 liters or less meaning that other transmission routes may have been responsible for childhood diarrhoea in the household. It is therefore recommended that further research is carried out into the microbiological quality of water at source and microbiological quality of stored water within the households in relation to childhood diarrhoea.

Future research could focus on factors such as food hygiene, hand washing practice, breast feeding, malnutrition, child feeding practices, nipple hygiene and mother's previous history of diarrhoea in relation to childhood diarrhoea. Future research with respect to domestic water use and its determinants may be focused on metered households in order to shed more light on cost implications as well.

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APPENDIX I

RESEARCH INSTRUMENTS

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
COLLEGE OF ARTS AND SOCIAL SCIENCES
FACULTY OF SOCIAL SCIENCES
DEPARTMENT OF GEOGRAPHY AND RURAL DEVELOPMENT
HOUSEHOLD QUESTIONNAIRE

THIS QUESTIONNAIRE IS TO BE ANSWERED BY THE FEMALE HEAD OF THE HOUSEHOLD/MOTHER

HOUSEHOLD INFORMATION PANEL		
HH1. Cluster number: ___ ___ ___	HH2. Household number: ___ ___ ___	
HH3. Interviewer name and number: Name______________________ ___ ___	SERIAL NUMBER OF QUESTIONNAIRE ( ) **GPS Location of dwelling**	
HH5 Name of Locality Wet season [ ] Dry season [ ]	**Domestic water code**	**Public water code**
HH7. Day/Month/Year of interview: ___ ___ / ___ ___ / ___ ___ __		

WE ARE FROM (***KNUST***). WE ARE WORKING ON A PROJECT CONCERNED WITH FAMILY HEALTH. I WOULD LIKE TO TALK TO YOU ABOUT THIS. THE INTERVIEW WILL TAKE ABOUT (***40***) MINUTES. ALL THE INFORMATION WE OBTAIN WILL REMAIN STRICTLY CONFIDENTIAL AND YOUR ANSWERS WILL NEVER BE IDENTIFIED. DURING THIS TIME I WOULD LIKE TO SPEAK WITH THE HOUSEHOLD HEAD AND ALL MOTHERS OR OTHERS WHO TAKE CARE OF CHILDREN IN THE HOUSEHOLD.
MAY I START NOW? *If permission is given, begin the interview.*

PLEASE TICK

A1. SOCIO – DEMOGRAPHIC BACKGROUND (Skip if dry season)

1. Estimated age (Mother)
1. Less than 15 years [ ] 2. 15-19 years [ ] 3. 20-29 years [ ] 4. 30-39 years [ ] 5. 40-49 years [ ] 6. 50-59 years [ ] 7. 60 or more years [ ]

2. Sex 1. Male [ ] 2. Female [ ]
3. Mother's educational level?
1. No formal education [ ] 2. Some primary school/JSS [ ] 3.Completed primary school/JSS [ ] 4. Some secondary School [ ] 5. Completed secondary school [ ] 6. Some university/ higher education [ ] 7. Completed university [ ]
4. How long have you lived in this household?
1. Less than one year [ ] 2. One-three years [ ] 3. Four -seven years [ ]
4. Eight-10 years [ ] 5. 11-15 years [ ] 6. 16-20 years [ ] 7. 21-25 years [ ]
8. More than 25 years [ ]
5. How many people make up your household? ……………….
6. Age of the head of the household?
1. Less than 15 years [ ] 2. 15-18 years [ ] 3. 19-25 years [ ] 4. 26-30 years [ ]
5. 31-39 years [ ] 6. 40-49 years [ ] 7. 50-59 years [ ] 8. 60 or more years [ ]
7. Occupation of father of index child ?
1. Driver [ ] 2. Teacher [ ] 3. Civil servant/gov't employee [ ]
4. Self employed [ ] 5. Professional (doc/lawyer/banker) [ ]
6. Sales woman/service worker [ ] 7.Trader [ ] 8. Artisan [ ]

9. Farmer [ ] 10. Pensioner [ ] 11. Unemployed [ ]
12. Other ………………………

8. Occupation of mother of index child?
1. House wife [ ] 2. Teacher [ ] 3. Civil servant/gov't employee [ ]
4. Self employed [ ] 5. Professional (doc/lawyer/banker) [ ]
6. Sales woman/service worker [ ] 7. Trader [ ] 8. Artisan [ ]
9. Farmer [ ] 10. Pensioner [ ] 11. Unemployed [ ]
12. Other ………………………

9. What is the father's level of schooling?
1. No formal education [ ] 2. Some primary school/JSS [ ] 3. Completed primary school/JSS [ ] 4. Some secondary School [ ] 5. Completed secondary school [ ] 6. Some university/ higher education [ ] 7. Completed university [ ]
8. Don't know

10. What is the highest educational level in the household?
1. No formal education [ ] 2. Some primary school/JSS [ ] 3. Completed primary school/JSS [ ] 4. Some secondary School [ ] 5. Completed secondary school [ ] 6. Some university/ higher education [ ] 7. Completed university [ ]
8. Don't know

11. Marital status
1. Single [ ] 2. Married [ ] 3. Living with partner [ ] 4.Widowed [ ]
5. Divorced/Separated [ ]

12. How many rooms do you and your family live in? ……………………….

13. Estimated number of years resident in dwelling?.
1. Less than one year [ ] 2.One-three years [ ] 3. Four -seven years [ ]
4. Eight-10 years [ ] 5. 11-15 years [ ] 6. 16-20 years [ ] 7. 21-25 years [ ]
8. More than 25 years [ ]

14. Do you have electricity? 1. Yes [ ] 2. No [ ]

15. Type of roof of the house
1. Thatch [ ] 2. Mud [ ] 3. Concrete or tar [ ] 4. Metal [ ] 5. Tile [ ]
6. Other ……………………………….

16. Number of under 15 year olds in household ……………………………..

17. Number of under 5 year olds in household ……………………………...

18. Status of accommodation for household
1. Owner [ ] 2. Private renting [ ] 3. Provided by employer [ ]
4. Caretaker [ ] 5. Other …………………………………

A2. DRY SEASON SOCIO – DEMOGRAPHIC BACKGROUND

1. How many people live in your household at present? ……………….
2. Number of under 15 year olds in household at present ……………………………..
3. Number of under 5 year olds in household at present ……………………………...

B. WATER SOURCE

1. At present, what are the sources of DOMESTIC water for members of your household? **Please tick.**

1. Piped water [ ]
2. Piped into dwelling [ ]
3. Piped into yard or plot [ ]
4. Public tap/standpipe [ ]
5. Tubewell/borehole [ ]
6. Protected well [ ]
7. Unprotected well [ ]
8. Protected spring [ ]
9. Unprotected spring [ ]
10. Rainwater collection [ ]
11. Tanker-truck [ ]
12 Cart with small tank/drum [ ]
13. Surface water (river, stream, dam, lake, pond, canal, irrigation channel) [ ]
14. Bottled water [ ]
15. Sachet / 'pure water' [ ]

16. Neighbour with a water source [ ]

Other (*specify*) ………………………….

2. What is the main source of DOMESTIC water for members of your household?

1. Piped water [ ]
2. Piped into dwelling [ ]
3. Piped into yard or plot [ ]
4. Public tap/standpipe [ ]
5. Tubewell/borehole [ ]
6. Protected well [ ]
7. Unprotected well [ ]
8. Protected spring [ ]
9. Unprotected spring [ ]
10. Rainwater collection [ ]
11. Tanker-truck [ ]
12. Cart with small tank/drum [ ]
13. Surface water (river, stream, dam, lake, pond, canal, irrigation channel) [ ]
14. Bottled water [ ]
15. Sachet / 'pure water' [ ]
16. Neighbour with a water source [ ]

GPS Location ………..

Other (*specify*) ………………………….

3. What is the main source of DRINKING WATER for members of your household?

1. Piped water [ ]
2. Piped into dwelling [ ]
3. Piped into yard or plot [ ]
4. Public tap/standpipe [ ]
5. Tubewell/borehole [ ]
6. Protected well [ ]
7. Unprotected well [ ]
8. Protected spring [ ]
9. Unprotected spring [ ]
10. Rainwater collection [ ]
11. Tanker-truck [ ]
12. Cart with small tank/drum [ ]
13. Surface water (river, stream, dam, lake, pond, canal, irrigation channel) [ ]
14. Bottled water [ ]
15. Sachet / 'pure water' [ ]
16. Neighbour with a water source [ ]

GPS Location ………..

Other (*specify*) ………………………….

4. Why do you choose to get water from this place mentioned in B2?

[**Please rank 1-8 with 1 being the most important reason and 8 being the least important]**

REASONS	**RANK**	**REASONS**	**RANK**
Distance		Only source	
Cost.		Only tap	
Quality		Personal/family reasons	
Reliability		Other …………………………………………	
Available			

5. Please indicate your perception of the water quality of the source mentioned in B2.

1. Unacceptable water quality [ ]
2. Favorable water quality [ ]
3. Highly favorable quality [ ]
4. No comment given by the informant or no effect [ ]

6. Please provide reasons for your answer in Q B5. …………

7. What do you use this water mentioned in QB2 for?

[**Please rank 1-8 with 1 being the most important use and 7 being the least important]**

USE	**RANK**	**USE**	**RANK**
Bathing		Animals	
Cooking		Gardening	
Drinking		Laundry	
Cleaning house		Other …………………………………………	

8. Is there a technological means to draw water from this source?

1. Technical means not available [ ]
2. Technical means are partially available [ ]
3. Technical means are available [ ]
4. Don't know [ ]

9. What kind of container do you use to collect/draw water at the source?
1. Bucket [ ] 2. Jerry can [ ] 3. Barrel/ drum [ ] 4. Clay-pot [ ]
5. sauce pan [ ] 6. Jug [ ] 7. Kettle [ ] 8. Bottles [ ]
9. No container [ ] 10. Basin pan [ ] 11. Other …………………………
10. How big is it in liters? (Ask person to show you if you are not clear)
1. Less than 5 litres [ ] 2. 5-9 litres [ ] 3. 10-14 litres [ ]
4. 15-19 litres [ ] 5. 20-24 litres [ ] 6. 25-29 litres [ ]
7. 30-34 litres [ ] 8. 35-39 litres [ ] 9. 40 or more litres [ ]
11. How many jerry cans (other vessel) of water do you collect from this source each day?
…………………………………………
12. What is the weight of the container when full?
1. 1 – 9 kg [ ] 2. 10 – 19 kg [ ] 3. 20 – 29 kg [ ] 4. 30 – 39 kg [ ]
5. Above 40 kg [ ]
13. How many days do you collect water in a week? ………………………
14. Do you pay for water from this source? 1. Yes [ ] 2. No [ ]
15. If yes? How much do you pay in GH₵ ? ……………………………………
16. How are water rates paid?
1. Block/flat rate [ ] 2. Proportional rate (according to consumption) [ ]
3. Residential rate (based on income) [ ] 4. Per bucket [ ]
5. Other ……………………………..
17. In your view, is the charge for the water appropriate? 1. Yes [ ] 2. No [ ]
18. Please give reasons for your answer in Q17.
……………………………………………………………………………………………
19. Are there times when you find no water at this source? 1. Yes [ ] 2. No [ ]
20. What coping mechanisms do you adopt during water shortage at this source?
……………………………………………………………………………………………………
……………………………………………………………………………………………
21. Please give reasons why.
……………………………………………………………………………………………………
……………………………………………………………………………………………
22. Number of households using this source?
1. One only [ ] 2. 2-5 households [ ] 3. 6-9 households [ ]
4. 10-14 households [ ] 5. 15-49 households [ ] 6. 50+ households [ ]
7. Not known [ ]
23. What is the daily number of service hours?
1. 24 hours [ ] 2. 12-23 hours [ ] 3. 6-11 hours [ ] 4. 3-5 hours [ ]
5. 1-2 hours [ ] 6. 30 - 50 min [ ] 7. Less than 30 minutes [ ]
24. Does the number of service hours affect the quantities you collect from this source?
1. Yes [ ] 2. No [ ]
25. How does the daily number of service hours affect the quantities you collect from this source?
……………………………………………………………………………………………………
……………………………………………………………………………………………
26. Who owns the water source?
1. My household [ ] 2. Private owner [ ] 3. Land lord [ ] 3. Ghana water company[ ] 4. Community [ ] 5. Project [ ] 6. No-one [ ]
7. Other (specify) ………….
27. Who supervises the water supply?
1. My household [ ] 2. Private Owner [ ] 3. Land lord [ ] 4. Community care taker [ ] 5. Other community representative [ ] 6. Project staff [ ] 7. No-one [ ] 8. Other (specify) ……………………..

28. Who is responsible for operating the source?
1. My household [ ] 2. Private Owner [ ] 3. Land lord [ ] 4. Community [ ]
5. District assembly/ Town council [ ] 6. Government agency [ ] 7. No-one [ ]
8. NGO/Donor [ ] 9. Don't know[ ]

29. Who did the actual construction of the water supply?
1. My household [ ] 2. Private Owner [ ] 3.Land lord [ ] 4. Community [ ]
5. NGO/Donor [ ] 6. Contractor [ ] 7. Government agency [ ]
8. District Assembly/Town council [ ] 9. Don't know [ ]

30. When was the water source constructed?
1. 0- 6 Months [ ] 2. 6 – 12 Months [ ] 3. 1 – 3 years [ ]
4. More than 3 years [ ] 5. Don't know [ ]

31. Who is responsible for cleaning the area around the source?
1. My household [ ] 2. Owner [ ] 3. Land lord [ ] 4. Community [ ]
5. District assembly/ Town council [ ] 6. Government agency [ ] 7. No-one [ ]
8. NGO/Donor [ ] 9.Don't know[ ]

32. How often is the cleaning done?
1. Daily [ ] 2. More than once a week [ ] 3. Weekly [ ] 4. more than once a month [ ] 5. monthly [ ] 6. Less than once a month [ ] 7. Don't know [ ]

33. Is there a restriction on how much water a person takes from the source?
1. Yes [ ] 2. No [ ]

34. If yes, why is there a restriction?
1. Source has low flow [ ] 2. Too many people use the source [ ] 3. Limited time for care taker [ ] 4. Non –domestic uses of water [ ]
5. Other (specify) ………….. 6. Don't know [ ]

35. Which of the primary sources you mentioned is nearest to your home? ………………

36. Which source is farthest? ………………………….

37. What is the walking time from your home to the primary water source? (Minutes) …………………………….

38. How long does it take to go there, get water, and come back? (Minutes) ………………

39. How much time do you spend at the source? …………………… (Minutes)

40. Does the source dry up? 1. Yes [ ] 2. No [ ]

41. If yes, how often does the source dry up?
1. Daily [ ] 2. Monthly [ ] 3. Seasonaly [ ] 4. Occasionally [ ]

42. What is your perception of the economic efficiency of this water source?
1. Water source is perceived to be unfavourable. [ ]
2. Water source is perceived to be somewhat favourable. [ ]
3. Water source is perceived to be favourable. [ ]
4. No comment given by the informant, or no effect. [ ]

43. Please give reasons for your answer in Q 42.
……………………………………………………………………………………………
…………………………………………………………………………………………

44. Social interaction with other people affects your decision to use the water source.
1. Strongly agree [ ] 2. Agree [ ] 3. Uncertain [ ] 4. Disagree [ ]
5. Strongly disagree [ ]

45. If you agree, please describe the strength the social interaction
1. The social interaction mildly affects my decision to use the water source [ ]
2. The social interaction strongly affects my decision to use the water source [ ]
3. The social interaction has no effect on my decision to use the water source [ ]

46. Social interaction with other people affects your decision not to use the water source.
1. Strongly agree [ ] 2. Agree [ ] 3. Uncertain [ ] 4. Disagree [ ]
5. Strongly disagree [ ]

47. If you agree, please describe the strength the social interaction
1. The social interaction mildly affects my decision not to use the water source [ ]
2. The social interaction strongly affects my decision not to use the water source [ ]

3. The social interaction has no effect on my decision not to use the water source [ ]

48. Daily Water Withdrawal per Capita from All Sources (Litres) …………………….
49. Do you ever collect rain water? 1. Yes [ ] 2. No [ ]
50. Do you buy water from vendors? 1. Yes [ ] 2. No [ ]
51. If yes, how often do you buy water from a vendor?
1. Daily [ ] 2. More than once a week [ ] 3. Weekly [ ] 4. more than once a month [ ] 5. other……………….. 6. don't know [ ]
52. For what purpose do you use water collected from the vendor?
Please rank 1- 5 with 1 being highest and 5 being least]
1. Drinking [ ] 2. Cooking [ ] 3. Washing dishes [ ] 4. Bathing [ ]
5. Washing clothes [ ] 6. Livestock/poultry [ ] 7. Cleaning [ ]
8. Gardens/irrigation [ ] 9. Beer making [ ] 10. Vending [ ]
11. All domestic uses [ ] 12. All domestic, except drinking [ ]
13. Agriculture (livestock + garden) [ ] 14. All uses [ ]
53. How much water do you buy for the first (1st) purpose indicated?
1. 1- 10 liters [ ] 2. 11- 20 liters [ ] 3. 21 – 30 liters [ ] 4. 31 – 40 liters [ ]
5. Above 40 liters [ ]
54. How much do you pay per container from the vendor? ………………………
55. Where does your water vendor obtain water from?
1. Private owner [ ] 2. Ghana water company [ ] 3. Community [ ]
4. Project [ ] 5. Public tap/standpipe [ ] 6. Don't know [ ] 7. Other Specify ……………….
56. Why do you buy water from the vendor?
[Please rank from 1- 7 with the highest reason being 1 and the least being 7]

REASON	RANK	REASON	RANK
Lack of assistance in the home		No other source/ Restricted access	
Proximity/Time		Personal/family/health problems	
Cost		Quality	
Inadequacy		Other	
		………………………………………….	

57. What is your perception of the economic efficiency of the water that is vended to you?
1. Water source is perceived to be unfavourable. [ ]
2. Water source is perceived to be somewhat favourable. [ ]
3. Water source is perceived to be favourable. [ ]
4. No comment given by the informant, or no effect. [ ]
58. What is your perception of the quality of the water that is vended to you?
1. Unacceptable water quality [ ] 2. Favourable water quality [ ] 3. Highly favourable water quality [ ] 4. No comment [ ]

C. WATER COLLECTION, TREATMENT AND STORAGE

1. Who is the primary drawer of water?
1. Female adult [ ] 2. Female + children [ ] 3. Children [ ]
4. Male adult [ ] 5. Male + female [ ] 6. Male + female + children [ ]
7. Porter/vendor [ ]
2. Please give reasons for your answer in QC 1.
……………………………………………………………………………………………
3. By which means do you transport water ?
1. Walking [ ] 2. Bicycle [ ] 3. Cart-hand-drawn [ ] 4. Cart-animal [ ]
5. Animal [ ] 6. Water tanker [ ] 7. Vehicle (car or truck) [ ]
8. Other (Specify) …………………

4. Total amount of water you collect a day ………………………(litres)
5. How far is the primary water source from your house?
1. < 10 m [ ] 2. < 100 m [ ] 3. < 10m-500m [ ] 4. 500m-1000 m [ ] 5. 1000m-1500 m [ ] 6.Can't tell [ ]
6. Time of day trips are often made.
1. Morning only [ ] 2. Afternoon only [ ] 3. Evening only [ ] 4. Morning and evening [ ] 5. Afternoon and evening [ ] 6. Morning and afternoon [ ] 7. Morning, Afternoon and evening [ ] 8. Don't know [ ]
7. Type of container is used to collect water to the house
1. Bucket [ ] 2. Jerry can [ ] 3. Barrel/ drum [ ] 4. Clay-pot [ ]
5. Basin pan [ ] 6. Jug [ ] 7. Kettle [ ] 8. Bottles [ ]
9. No container [ ] 10. Other …………………………………
8. Size of container used for carrying water to the house
1. Less than 5 litres [ ] 2. 5-9 litres [ ] 3. 10-14 litres [ ]
4. 15-19 litres [ ] 5. 20-24 litres [ ] 6. 25-29 litres [ ] 7. 30-34 litres [ ]
8. 35-39 litres [ ] 9. 40 or more litres [ ]
9. When water is conveyed to the house is it transferred into a storage vessel?
1. Yes [ ] 2. No [ ]
10. If yes, how often ?
1. less often [ ] 3. often [ ] 4. Very often [ ] 5. Uncertain [ ]
11. Do you store water in the household? 1. Yes [ ] 2. No [ ]
12. How often is water stored in the home?
1. Daily [ ] 2. More than once a week [ ] 3. Weekly [ ] 4. more than once a month [ ]
13. How many storage containers are you using to store water currently?
Capacity ……………………(liters) Number of containers ……………………
Capacity ………………….. (liters) Number of containers ……………………
Capacity ………………….. (liters) Number of containers ……………………
Capacity ………………….. (liters) Number of containers ……………………
14. Where do you keep or store water?
1. In kitchen [ ] 2. In dwelling [ ] 3. On compound[ ] 4. In store room [ ]
5. Overhead storage tank [ ] 6. Ground storage tank [ ]
15. What type of container do you use to store drinking water in the house?
1. Bucket [ ] 2. Jerry can [ ] 3. Barrel/ drum [ ] 4. Clay-pot [ ]
5. Basin pan [ ] 6. Jug [ ] 7. Kettle [ ] 8. Overhead storage tank [ ]
9. Bottles [ ] 10. Ground storage tank [ ] 11. No container [ ]
12. Other ………………
16. How wide is the mouth to the storage vessel? ……………………………..
17. What is the volume/size of the storage vessel?
1. Less than 5 litres [ ] 2. 5-9 litres [ ] 3. 10-14 litres [ ]
4. 15-19 litres [ ] 5. 20-24 litres [ ] 6. 25-29 litres [ ]
7. 30-34 litres [ ] 8. 35-39 litres [ ] 9. 40 or more litres [ ]
18. Does the vessel have a cover? 1. Yes [ ] 2. No [ ]
19. At present is the vessel covered? 1. Yes [ ] 2. No [ ] 3. Partially [ ]
20. Do you do anything to your water before you drink it? 1. Yes [ ] 2. No [ ]
21. If yes, what do you do to it?
1. Boil [ ] 2. Add bleach/chlorine [ ] 3. Strain it through a cloth [ ]
4. Use water filter (ceramic, sand, composite, etc.) [ ]
5. Solar disinfection [ ] 6. Let it stand and settle [ ]
7. Other (*specify*) ____________________
8. Don't know [ ]
22. What do you use to get/pour drinking water out of storage container?
[Please rank by 1 – 8, with 1 being the most frequent and 8 being least frequent]
1. Cup [ ] 2. Laddle [ ] 3. Pitcher [ ] 4. Bowl [ ] 5. Bucket [ ]

6. Poured directly from container [ ] 7. Nothing [ ] 8. Use of spigot [ ]
9. Other (specify) …………………………………

23. How often do you clean the vessel used to draw water?
1. Daily [ ] 2. More than once a week [ ] 3.Weekly [ ] 4. More than once a month [ ] 5. Monthly [ ] 6. Less than once a month [ ] 7. Every 6 months [ ]
8. Once a year [ ] 9 . Rarely [ ] 10. Never [ ] 11 .Don't know [ ]

24. Presently, where is the primary means (device) which you mentioned in Q22 placed?
1. Floor [ ] 2. Table/ chair [ ] 3. In cupboard [ ] 4. On vessel [ ]
5. Other………………..

25. How many times a day do you collect water?
1. Once per day [ ] 2. Twice per day [ ] 3. Three times per day [ ]
4. Four times per day [ ] 5. 5 times [ ] 6. More than 5 times [ ]

26. How often do you clean your water storage container?
1. Daily [ ] 2. More than once a week [ ] 3.Weekly [ ] 4. More than once a month [ ] 5. Monthly [ ] 6. Less than once a month [ ] 7. Every 6 months [ ]
8. Once a year [ ] 9 . Rarely [ ] 10. Never [ ] 11 .Don't know [ ]

27. How long is your water stored before it is finished?
1. One day [ ] 2. Two days [ ] 3. Three days [ ] 4. 3 -7 days [ ] 5. One week [ ] 6. More than a week [ ]

28. Do you treat water from your storage container before giving it to your children to drink?
1. Yes [ ] 2. No. [ ] 3. Can't tell [ ]

D. WATER USE

1a. Can you estimate the total amount of water you use a day? ………………………(liters)

1b. Who is the primary custodian of water use in the household?
1. Father [ ] 2. Mother [ ] 3. Male Adult [ ] 4. Female Adult [ ]
5. Children [ ] 6. Other (Specify) ………………………………

2. What is the primary location for the use of water?
1. Home [ ] 2. Outside home/at source [ ] 3. Both [ ]

3. What use is water put to within the location identified in ***QD2 [Please rank 1- 5 with 1 being highest and 5 being least]***
1. Drinking [ ] 2. Cooking [ ] 3. Washing dishes [ ] 4. Bathing [ ]
5. Washing clothes [ ] 6. Livestock/poultry [ ] 7. Cleaning [ ]
8. Gardens/irrigation [ ] 9. Beer making [ ] 10. Vending [ ]
11. All domestic uses [ ] 12. All domestic, except drinking [ ]
13. Agriculture (livestock + garden) [ ] 14. All uses [ ]

4. What is the number of functional Taps in the Household? ………………………..

5. What is the number of functional Bathtubs in the Household? ……………………….

6. What is the number of functional Showers in Household ? ………………………….

7. What is the number of functional Hot Water Heaters in Household? ……………

8. Where do you frequently wash clothes?
1. At Source [ ] 2. Home [ ] 3. Laundry [ ] 4. Home and source [ ]
5. Home and laundry [ ] 6. Home, source, and laundry [ ]

9. Do you have any perception that there is an advantage in using Piped Water Supply
1. Yes [ ] 2. No [ ]

10. If yes, please rank the following advantages
[Please rank by 1 – 7, with 1 being the most advantageous and 7 being least advantageous]
1. Labour saving [ ] 2. Cheap [ ] 3. Use more [ ] 4. Healthier [ ]
5. Tastier [ ] 6. Available at all times [ ] 7. Cleaner [ ]

11. Do you have any perception that there is a Disadvantage of using Piped Water Supply
1. Yes [ ] 2. No [ ]

12. If yes, please rank the following disadvantages **[Please rank by 1 – 7, with 1 being the most disadvantageous and 7 being least disadvantageous]**

1. Cost [ ] 2. Limit on use [ ] 3. Do not get to source [ ] 3. Dirty[ ]
4. Waste more [ ] 5. Become lazier [ ] 6 Less tasty or less cool [ ]
7. Cannot check leakage [ ] 8. Have to boil [ ] 9. Sudden stoppage possible [ ]
10. Bureaucratic procedure for connection [ ]

13. Would you go in for other sources when there is a shortage in your household water?
1.Yes [ ] 2. No [ ]

14. When there is a shortage, what source will be the household's first choice?
……………………………..

15. Why will you choose the source mentioned when there is a shortage?
1. Known about but not used [ ] 2. No need [ ] 3. Water not good [ ]
4. No facilities for catching rainwater-for using source [ ]
5. Free or cheaper/low cost [ ] 6. Washing laundry or garden only [ ]
7. Used, no explanation given [ ] 8. Proximity/ease of access [ ]
9. Good quality of water [ ] 10. Reliable supply [ ] 11.Other ……………….

16. What is the daily total use of water in litres when there is shortage? ………………….

17. When there is no shortage, what is the daily per-capita use/consumption in litres?
……………………………..

18. Describe the nature of alternative sources.
1. Only one source used all year round (01 Source) [ ]
2. Two sources used all year round (Source01 + another) [ ]
3. Second source used only in dry season [ ]
4. More than two sources used all year round [ ]
5. More than two sources used in dry season [ ]

19. Do you use water for productive uses? 1. Yes [ ] 2. No [ ]

20. Please provide reasons for your answer.
1. Means of livelihood [ ] 2. Water is not sufficient for productive activities.
3. working environment is conducive. [ ] 4. working environment is not conducive [ ]
5. others ……………………………..

21. If yes, which productive uses do you put water to? **Please tick.**
1. Consumption by livestock [ ] 5. Vending water [ ]
2. Brewing beer [ ] 6. Others …………………………….
3. Irrigating crops [ ]
4. Constructing blocks [ ]

22. Please provide the quantities for each.

E. WATER QUALITY

1. Perception of drinking water quality.
1. Unacceptable water quality [ ] 2. Favourable water quality [ ] 3. Highly favourable water quality [ ] 4. No comment [ ]

2. Do you own any animals? 1. Yes [ ] 2. No [ ]

3. If yes, how do you dispose of animal stools?
1. Put/rinsed into toilet or latrine [ ] 2. Put/rinsed into drain or ditch [ ]
3. Thrown into garbage (solid waste) [ ] 4. Burried [ ] 5. Left in the open [ ]

4. Does your drinking water have any taste? 1. Yes [ ] 2. No [ ]

5. How will you describe the odour of your water?
1. No odour [ ] 2. Mild odour [ ] 3. Strong odour [ ] 4. Uncertain [ ]

6. How will you describe the colour of your water?
1. No colour [ ] 2. Mild coloration [ ] 3. Strong coloration [ ] 4. Uncertain [ ]

7. How often do you see visible particles in the water?
1. No visible particles [ ] 2. less often [ ] 3. often [ ] 4. Very often [ ]
5. Uncertain [ ]

8. Has water from your primary source ever been tested

1. Yes [ ] 2. No[ ] 3.Can't tell [ ]

9. If yes, when was the last time water from your source was tested?
   1. Last week [ ] 2. Two weeks ago [ ] 3. Three weeks – One month ago [ ]
   4. More than a month ago [ ] 5. Previous month – Six months ago [ ]
   6. Six months – a year ago [ ] 7. More than a year ago [ ] 8. Has been tested but can't remember when [ ] 9. Don't know [ ]

10. Who was responsible for the testing?
    1. My household [ ] 2. Owner [ ] 3. Land lord [ ] 4. Community [ ]
    5. District assembly/ Town council [ ] 6. Government agency [ ] 7. No-one [ ]
    8. NGO/Donor [ ] 9. Don't know[ ]

11. Were the results of the water test communicated to you? 1 .Yes [ ] 2. No [ ]

F. SANITATION & HYGIENE

1. How is household waste water disposed?
   1. Open ground [ ] 2. Water body [ ] 3. Latrine [ ] 4. Bucket latrine [ ]
   5. Septic tank [ ] 6. Sewer-no treatment[ ] 7. Sewer-treatment [ ]
   8. Soak-away pit[ ]
2. By which means do you dispose of refuse?
   1. Burning [ ] 2. Garbage bin [ ] 3.Open field [ ] 4. Burrying [ ]
   5. Incineration [ ] 6. Composting [ ]
3. Is a latrine available within your household ? 1. Yes [ ] 2. No [ ]
4. If yes what is the nature of ownership? 1. Privately owned [ ] 2. Shared [ ]
5. If yes, what type is it?
   1. WC in house/dwelling [ ] 2. In compound pit [ ] 3. In compound Pan [ ]
   4. In compound KVIP [ ] 5. In compound WC [ ]
6. If shared, how many households in total use this toilet facility daily? ……………….
   1. One only [ ] 2. 2-5 households [ ] 3. 6-9 households [ ]
   4. 10-14 households [ ] 5. 15-49 households [ ] 6. 50+ households [ ]
   7. Not known [ ]

7. If you do not own a latrine, what is your primary means of toilet disposal?
   1. WC in house [ ] 2. In compound pit [ ] 3. In compound Pan [ ]
   4. In compound KVIP [ ] 5. In compound WC [ ] 6. Public toilet [ ]
   7. Open defecation (Bush) [ ]
8. What arrangements are made for emptying the latrine contents?
   1. A person is contracted to empty the contents daily [ ]
   2. A Cespit company is contracted for emptying [ ]
   3. Septic tank [ ] 4. Hole [ ] 5. Piped to public sewer system [ ]
   6. Outside anywhere [ ] 7. No arrangements are made [ ] 8. Don't know [ ]
   9. Other (specify)……………………………………………….
9. Does your household reuse household waste water? 1. Yes [ ] 2. No [ ]
10. If yes, what is what arrangements are made for reuse?
…………………………………………………………………………………………………
………………………………………………………………………………………………
11. Does your household reuse the latrine contents? 1. Yes [ ] 2. No [ ]
12. If yes, what is what arrangements are made for reuse?
…………………………………………………………………………………………………
………………………………………………………………………………………………
13. Estimated number of people who use the household latrine daily? ………………..
14. How do you dispose off children's faeces?
    1. Do nothing [ ] 2. Place in latrine/bucket toilet [ ] 3. Bury in soil [ ]
    4. Throw in garden [ ] 5. Place directly in waste bin/heap [ ]
    6. Place in plastic bag and place in waste bin/heap [ ] (g) Other…………………..
15. Presence of soap in the house? 1. Yes [ ] 2. No [ ]

16. How frequently do you wash your hands with water and soap?
1. No washing with soap [ ] 2. less often [ ] 3. Often [ ] 4. Very often [ ]
5. Uncertain

G. HEALTH AND DIARRHOEA

1a. In general how would you describe your physical health today?
1. Very good [ ] 2. Good [ ] 3. Moderate [ ] 4. Bad [ ] 5. Very bad [ ]
6. Cant tell [ ]

1b. Which of the following **have you** suffered from in the past 2 weeks? Please tick
1. Not suffered any disease/symptoms [ ] 2. Cold/catarrh [ ] 3. Nausea/vomiting [ ]
4. Cough [ ] 5. Body pains [ ] 6. diarrhoea [ ] 7. Headaches [ ]
8. Fever [ ] 9. skin/eye infections [ ] 10. Other ………………………………..

2. Has **any member** of your household suffered from any of the following symptoms in the **past two weeks**?
a. Cold/catarrh 1. Yes [ ] 2. No [ ]
b. Nausea/vomiting 1. Yes [ ] 3.. No [ ]
c. Cough 1. Yes [ ] 2. No [ ]
d. Body pains 1. Yes [ ] 2. No [ ]
e. Headaches 1. Yes [ ] 2. No [ ]
f. Fever 1. Yes [ ] 2. No [ ]
g. skin/eye infections 1. Yes [ ] 2. No [ ]

3. Has any member of your household had diarrhoea in the past 2 weeks?
1. Yes [ ] 2. No [ ]

4. If yes, how many people in your household have had diarrhoea in the past 2 weeks?
………………………..

5. Has any member of your household had diarrhoea in the past 24 hours?
1. Yes [ ] 2. No [ ]

6. If yes, how many people in your household have had diarrhoea in the past 24 hours?
…………………………

7. How many child (ren) (0-5years) have had diarrhoea in the past 2 weeks
………………………….

8. How many child (ren) (0-5years) have had diarrhoea in the past 24 hours?
…………………………..

9. Has any member of your household had a stool with blood/ mucus in the past 2 weeks?
……………………………

10. Has any of your child (ren) (0-5years) had a stool with blood/ mucus in the past24 hours?
1. Yes [ ] 2. No [ ]

11. How do you define/explain diarrhoea?
………………………………………………………………………………………..

12. What causes diarrhoea? Please tick as many
1. Witchcraft [ ] 2. The supernatural [ ] 3. Excessive drinking [ ]
4. overeating [ ] 5. Poor water quality [ ] 6. Eating stale food [ ]
7. Being in body contact with one who suffers diarrhoea [ ] 8. poor sanitation and personal hygiene [ ] 9. Don't know [ ] 10. other …………………….

13. When your child (ren) experiences diarrhoea what is the first thing you do?
1. Seek medical attention [ ] 2. Call a friend [ ] 3. Treat/manage the illness at home[ ] 4. Other …………………………………..

14. Please provide the reasons why.
…………………………………………………………………………………………………
………………………………………………………………………………………………

15. If any member of your household suffers diarrhoea from where will you seek care? **Please rank 1- 3 with '1' being first '2' second, '3' third**.

Public Sector
1. Government hospital [ ] 2. Gov't health centre [ ] 3. Government health post [ ]
4. Village health worker [ ] 5. Gov't Mobile/outreach clinic
Private medical sector
6. Private hospital/clinic [ ] 7. Private physician [ ] 8. Private pharmacy
9. Private mobile/outreach clinic [ ]
Other source
10. Relative or friend [ ] 11. Shop/pharmacy [ ] 12. Traditional practitioner [ ]

16. Please provide reasons for your answer
……………………………………………………………………………………………………
…………………………………………………………………………………………………
17. What is the name of the index child? ……………………………………………..
18. What is the birthday of the index child ……………………………………..
19. Has (Name) had diarrhoea in the last two weeks? 1. Yes [ ] 2. No [ ]
20. During the last episode, did (name) drink any of the following?
Fluid from ORS Packet? 1. Yes [ ] 2. No [ ]
Recommended home made fluid? 1. Yes [ ] 2. No [ ]
Pre-packaged ORS fluid? 1. Yes [ ] 2. No [ ]
21. Did you seek advice or treatment for the illness outside the home? 1. Yes [ ] 2. No [ ]
22. If yes, from where did you seek care first? Please tick
Public Sector
1. Government hospital [ ] 2. Gov't health centre [ ] 3. Government health post [ ]
4. Village health worker [ ] 5. Gov't Mobile/outreach clinic
Private medical sector
6. Private hospital/clinic [ ] 7. Private physician [ ] 8. Private pharmacy
9. Private mobile/outreach clinic [ ]
Other source
10. Relative or friend [ ] 11. Shop/pharmacy [ ] 12. Traditional practitioner [ ]
13. Don't remember [ ]

23. Please provide reasons for your answer
……………………………………………………………………………………………………
…………………………………………………………………………………………………
24. What medicine was given?
1. Antibiotic [ ] 2. Paracetamol/panadol/Acetaminophen [ ] 3. Herbs [ ]
4. Asprin [ ] 5. lbupropfen [ ] 6. Other ……………………………….
7. Don't' know [**]**
25. Are there any cultural barriers to water quality interventions? 1 Yes [ ] 2. No [ ]
26. The last time (Name) passed stools, what was done to dispose of the stools?
1. Child used toilet/latrine [ ] 2. Put/rinsed into toilet or latrine [ ]
3. Put/rinsed into drain or ditch[ ] 4. Thrown into garbage (solid waste) [ ]
5. Burried [ ] 6. Left in the open [ ]
27. Do you know of any deaths of children from diarrhoea? 1. Yes [ ] 1. No [ ]
Please provide reasons for you answer ………………………………………………..
28. Have you ever had education on the management/treatment of diarrhoea?
1. Yes [ ] 2. No [ ]
29. If yes, by what means did you get educated?
1. Radio [ ] 2. Television [ ] 3. Midwife [ ] 4. Hospital staff[ ]
5. A formally organized briefing session [ ] 6. Can't remember
30. Sometimes children have severe illnesses and should be taken immediately to a health facility. What types of symptoms would cause you to take your child to a health facility right away?[**Please rank 1 - 6 with 1 being very severe and 6 being least severe.]**
1. Child not able to drink or breast feed [ ] 2. Child becomes sicker [ ]

3. Child develops a fever [ ] 4. Child has fast breathing [ ]
5. Child has blood in stool [ ] 6. Child is drinking poorly [ ]
7. Other (specify) …………………………………..

31. In the house, how often does your child play on the ground ?
1. Less often [ ] 2. Often [ ] 3. Very often [ ] 4. No allowed to playing on the ground [ ] 5. Uncertain [ ]

32. How frequently do you wash your hands **WITH SOAP** after visiting the toilet?
1. No washing with soap [ ] 2. less often [ ] 3. Often [ ] 4. Very often [ ]
5. Uncertain [ ]

33. Please provide reasons for your answer.
………………………………………………………………………………………………
……………………………………………………………………………………………

34. How frequently do you wash your hands **WITH SOAP** before feeding the children (0-5years)?
1. No washing with soap [ ] 2. less often [ ] 3. Often [ ] 4. Very often [ ]
5. Uncertain

35. Please provide reasons for your answer.
………………………………………………………………………………………………
……………………………………………………………………………………………

36. How frequently do you wash your hands **WITH SOAP** after cleaning the anus of the children/dispose children stools?
1. No washing with soap [ ] 2. less often [ ] 3. Often [ ] 4. Very often [ ]
5. Uncertain

37. Please provide reasons for your answer.
………………………………………………………………………………………………
……………………………………………………………………………………………

H. WILLINGNESS TO PAY & MAINTENANCE

1. Has your water source ever broken down? 1.Yes [ ] 2. No [ ]

2. When was the last time it broke down? ……………………………
1. Last week [ ] 2. Last Month [ ] 3. Previous six months [ ] 4. Last year [ ]
5. Last two years [ ] 6. More than two years ago 7 .Don't know [ ]

3. How long did it take to be repaired?
1.One day [ ] 2. Two – five days [ ] 3. One week- two weeks [ ]
4.One Month [ ] 5. More than a month [ ]

4. Who did the rehabilitation/major repairs when the primary water source broke down?
1. My household [ ] 2. Private Owner [ ] 3. Land lord [ ] 4. Community [ ]
5. District assembly/ Town council [ ] 6. Government agency [ ] 7. No-one [ ]
8. Don't know[ ]

5. Who paid for the repairs?
1. My household [ ] 2. Private Owner [ ] 3. Land lord [ ] 4. Community [ ]
5. District assembly/ Town council [ ] 6. Government agency [ ] 7. No-one [ ]
8. Don't know[ ]

6. Who is responsible for operating the source?
1. My household [ ] 2. Private Owner [ ] 3. Land lord [ ] 4. Community [ ]
5. District assembly/ Town council [ ] 6. Government agency [ ] 7. No-one [ ]
8. Don't know[ ]

7. How often is maintenance done on the primary water source?
1. Daily [ ] 2. More than once a week [ ] 3. Weekly [ ] 4. more than once a month [ ] 5. monthly [ ] 6. Less than once a month [ ] 7. every 6 months [ ]
8. Once a year [ ] 9. Don't know [ ]

8. Who is responsible for the maintenance on this water source?

1. My household [ ] 2. Private Owner [ ] 3. Land lord [ ] 4. Community [ ]
5. District assembly/ Town council [ ] 6. Government agency [ ] 7. No-one [ ]
8. Don't know[ ]

9. Are you in easy reach of an expert who can repair you system when it breaks down?
1.Yes [ ] 2. No [ ]

10. When was the last time your storage container was cleaned?
1.One day [ ] 2. Two – five days [ ] 3. One week- two weeks [ ]
4.One Month [ ] 5. More than a month [ ]

11. What contribution has your household made towards water services in the last month?
……

12. Please indicate your level of satisfaction with water services in the district
1. Very dissatisfied [ ] 2. Unsatisfied [ ] 3. Satisfied [ ] 4. Very satisfied [ ]
5. Uncertain [ ]

13. Are you willing to pay more for water services to be improved?
1.Yes [ ] 2. No [ ]

14. Please give reasons for your answer.

15. In your opinion, what factors would improve the household water service delivery in the district?.

I. HOUSEHOLD WEALTH (Skip if dry season survey)

1. Residency
1. Urban [ ] 2. Peri-urban [ ] 3. Rural [ ]

2. Please indicate your possession of the following

Item **(No item = 0)**	**Score**	**Index**
Electricity = 2		**1 – 4 Low income** [ ]
ROOF		
Thatch/mud = **1**		**5 – 8 Lower middle income** [ ]
Plywood = **2**		
Metal = **3**		**9 – 12 Median Middle income** [ ]
Tile/concrete or tar = **4**		
		1**3 – 16 Upper middle income** [ ]
TRANSPORT		
Bicycle = **1**		**17 – 20 High Income** [ ]
Motor cycle = **2**		
Car = **3**		**21 or more – Very high income** [ ]
OTHER		
A working Radio = **1**		
A cassette player = **2**		
A working television = **3**		
A refrigerator = **4**		
Household utensils = **1**, **2** or **3**		

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DEPARTMENT OF GEOGRAPHY AND RURAL DEVELOPMENT
HOUSEHOLD OBSERVATION SCHEDULE
THIS OBSERVATION SCHEDULE IS TO BE COMPLETED BY THE ENUMERATOR

HOUSEHOLD INFORMATION PANEL		
HH1. Cluster number: ___ ___ ___	HH2. Household number: **Season:** Wet [ ] Dry [ ]	
HH3. Interviewer name and number: Name________________________ ___ ___	SERIAL NUMBER OF OBSERV. SCHEDULE: **GPS Location of dwelling** ___ ___ ___	
HH5 Name of Locality	**Domestic water code**	**Public water code**
HH7. Day/Month/Year of interview: ___ ___ / ___ ___ / ___ ___		

LOCATION AND WATER USE

1. GPS Location of house/dwelling ....
2. GPS Location of latrine ....
3. GPS Location of primary water source ....
4. Ground distance from home to the primary source? (Meters) …………………………..

(If the primary source is very far & not within reach of the tape measure leave blank)

5. Ground distance from latrine to water source ....
6. Ground distance from water source to dwelling ....
7. Ground distance between latrine and dwelling ....
8. What is the nature of terrain of path from home to the water source? (*Observation*)
9. GPS Location of water storage container? ....
10. How wide is the mouth to the storage vessel? ……………………………..
11. Distance between latrine and water storage container..

WATER QUALITY INSPECTION

1. Is drinking water kept in a separate container? 1. Yes [ ] 2. No [ ]
2. Is drinking water container kept above floor level and away from contamination?
   1. Yes [ ] 2. No [ ]
3. Do water containers have a narrow mouth/opening? 1. Yes [ ] 2. No [ ]
4. Do containers have a lid/cover? 1. Yes [ ] 2. No [ ]
5. At present is the vessel covered? 1. Yes [ ] 2. No [ ] 3. Partially [ ]
6. How is water taken from the container? 1. Poured [ ] 2.Cup [ ] 3. Other utensil [ ]
7. Is the utensil used to draw water from the container clean? 1. Yes [ ] 2. No [ ]
8. Is the utensil used to draw water kept away from surface and stored in a hygienic manner?
   1. Yes [ ] 2. No [ ]
9. Is the inside of the drinking water container clean? 1. Yes [ ] 2. No [ ]

10. Is the outside of the container clean? 1. Yes [ ] 2. No [ ]

SANITARY INSPECTION

1. Presence of faecal matter on the compound (*Observation)* 1. Yes [ ] 2. No [ ]
2. Presence of animals on the compound 1. Yes [ ] 2. No [ ]
3. Is a functional latrine available within dwelling ? 1. Yes [ ] 2. No [ ]
4. Is a functional latrine available within compound? 1. Yes [ ] 2. No [ ]
5. What type of wall does the latrine have? (*confirm by Observation*)
   1. No walls [ ] 2. Mud and wattle [ ] 3. Other non-permanent materials[ ]
   4. Metal [ ] 5. Concrete [ ] 6. Brick [ ] 7. Stone [ ] 8. Timber[ ]
6. Does your latrine have a door? (*confirm by Observation*) ? 1. Yes [ ] 2. No [ ]
7. Does your latrine have a lid? (*confirm by Observation*) ? 1. Yes [ ] 2. No [ ]
8. Are faeces observed around the pit-hole/slab? (*confirm by Observation*) ?
   1. Yes [ ] 2. No [ ]
9. Does the latrine have a roof? (*confirm by Observation*) ? 1. Yes [ ] 2. No [ ]
10. If yes, please indicate the material
    1. Thatch/grass [ ] 2. Other non-permanent materials [ ] 3. Timber [ ]
    4. other permanent materials [ ] 5. Iron sheet [ ] 6. Other ……………………….
11. What type of floor does your latrine have? (*confirm by Observation*)
    1. Mud/earthen [ ] 2. Concrete only [ ] 3. Timber only [ ]
    4. Concrete with timber [ ] 5. Tile [ ] 6. Other…………………………
12. What is the hygienic state of the latrine? (*confirm by Observation*)
    1. No faecal matter present on latrine floor [ ]
    2. Small amount of faecal matter present on latrine floor [ ]
    3. Large amount of faecal matter present on latrine floor [ ]
13. What is the hygienic state around your latrine? (*confirm by Observation*)
    1. No faecal matter present [ ]
    2. Small amount of faecal matter present [ ]
    3. Large amount of faecal matter present [ ]
14. Presence of soap in the house ? (*confirm by Observation*)
    1. Yes [ ] 2. No [ ]
15. Floor material
    1. Earth [ ] 2. Wood/ stone [ ] 3. Cement screed [ ]
    4. Concrete brick [ ] 5. Other ....
16. House roof material
    1. Tile / Concrete [ ] 2. Iron sheet [ ] 3 . Asbestos [ ] 4. Grass [ ]
    5. Other ....
17. Dwelling wall material
    1. Concrete [ ] 2. Burnt bricks [ ] 3. Wood [ ] 4. Cement [ ]
    5. Pole and mud [ ] 6. Iron sheet [ ] 7. Other material ....

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STAKEHOLDERS INDEPTH DISCUSSION GUIDE
THIS DISCUSSION IS TO BE CONDUCTED WITH WASH STAKEHOLDERS.

INFORMATION PANEL – STAKEHOLDERS	
Number of participants: ___ ___ ___	SERIAL NUMBER ___ ___ ___
Interviewer name and number: Name________________________ ___ ___	**GPS Location**
FGD 3. Name of Locality	Start Time: End Time:
FGD 4. Day/Month/Year of FGD:	___ ___ / ___ ___ / ___ _

Start the meeting by giving a general introduction of personnel and yourself. Assurances of confidentiality and secrecy. How the data will be used and how it will advance the cause of the community. Show evidence of permission from KNUST and all stake holders. Outline format for contributions & encourage participants to be open. Begin with a general discussion on relevance of water for human life.

1. **A. Water**
   - Community History., Water history., Water infrastructure for community; history, types, location, companies involved in construction, year of construction etc., Water infrastructure for households; history, types, location, companies involved in construction, year of construction etc., Ownership/Operation. Time; Safety of environment surrounding infrastructure., Maintenance responsibility, often, etc, Cost implications; for individuals, households.

   - Willingness to pay., Procedure for water acquisition, perceptions, difficulties in raising funds., Water delivery/supply, consumption problems. Specific and general.; quantity and quality. Duties of the unit committees' members in solving water problems., Monitoring water quality etc.
   - Decision making and water delivery; problems; gender inclusion in decision making., Recommendations for solving water and water related problems.

1. **B. Sanitation**
   - Sanitation history., Sanitation infrastructure for community; history, types, location, companies involved in construction, year of construction, etc.
   - Sanitation infrastructure for community; quantity & quality.
   - Sanitation infrastructure for households/individual homes; quantity and quality., Sanitation for children.
   - Open defecation practice, who, when, how and why?

- Ownership / operation. time. Safety of environment surrounding infrastructure., Maintenance; at community level & household. Who, when, & how., Monitoring., Cost implications.
- Duties of the WASH committees members in solving sanitation problems; how & when., Decision making and sanitation delivery; problems; gender inclusion in decision making., Recommendations for solving sanitation and sanitation related problems.

2. **Health**
   - Solid and liquid waste disposal; how is it carried out by the committee and individual households., Solid and liquid waste disposal frequency, companies involved, infrastructure, tolls, infrastructure available for solid and liquid waste.
   - Location of infrastructure; reasons; effectiveness of use etc.
   - Prevalent diseases., Health infrastructure availability, access and patronage.
   - Knowledge of diarrhoea.., Causes and treatment; Level of community awareness of environmentally related diseases; which mode of education will be most effective, involvements of chiefs and family heads.
   - Water storage, sanitation and hygiene education level; level of community understanding & household understanding. Record of community education on WASH. Interdepartmental collaboration on environmental & health related issues/education in the community in general and households to be specific. Any interactions between GHS & WASH committees, Nurses/Doctors and Committee members.
   - Sanitary inspectors; number, frequency of inspections, number of arrests/summons, difficulties with salaries, manpower, duties or roles, political influences.
   - Recommendations for solving health and sanitary related problems.

3. **Household hygiene & household environmental health**
   - Household environmental inspection. Frequency; mechanisms put in place etc., Household environmental health; awareness/consciousness.
   - Knowledge of disease transmission in the household, pathways/mechanisms.
   - Household safety, housing infrastructure and influence on health.
   - Rating on the level of poverty in the community, rating on individual poverty., Poverty and water, sanitation and health.
   - Poor household practices negatively influencing health.
   - Radio as a communication medium.
4. **Child health**
   - Diseases children frequently suffer.
   - Environments that children frequently play in, frequency. Bare floor, rubbish dumps.
   - Regulation and control of movements of children., General attitude towards child health by community leaders, parents, community members.
   - Knowledge and of causes of childhood diarrhoea.
   - Knowledge of management/treatment of childhood diarrhoea.

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COLLEGE OF ARTS AND SOCIAL SCIENCES
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DEPARTMENT OF GEOGRAPHY AND RURAL DEVELOPMENT
FOCUS GROUP DISCUSSION GUIDE
(FEMALE HEAD OF HOUSEHOLD / MOTHERS/CARERS)

THIS DISCUSSION IS TO BE CONDUCTED WITH THE FEMALE HEADS OF THE HOUSEHOLDS/MOTHERS

FGD INFORMATION PANEL	
FGD1. Number of participants: ___ ___ ___	SERIAL NUMBER OF **FGD.** ___ ___ ___
FGD 2. Interviewer name and number: Name________________________ ___ ___	**GPS Location of FGD** ___ ___ ___
FGD 3. Name of Locality	FGD Start Time: FGD End Time:
FGD 4. Day/Month/Year of FGD: ___ ___ / ___ ___ / ___ ___	

Start with a general discussion on the importance of water to daily life.

1. **Water Sources**
   - Source of domestic water for the household and reasons for the choice, Sources of drinking water & the reasons behind the choices, What water source is used to provide water for children under 5 years and why, Seasonal variations in water sources & reasons.
2. **Water containers**
   - Which containers are used to store water (description, Advantages, disadvantages), Which containers are used to collect water to the household (characteristics, kinds, reasons for preferences), Care for the containers, placement & cover of container, Are the same containers used to store drinking water? Reasons, What is used to draw water for drinking? & placement, What is used to draw water for child under 5 years? Placement
3. **Water collection**
   - Who collects water & reasons. Any cultural/social reasons? When, how is water collected to the household & reasons? Cost of fetching water (time, money, physical exhaustion, loss of school hours etc)
   - Queues, Water flow regularity, Distance and quantity issues.
4. **Custodians for water use**
   - Decisions for water use, Dominance or interference.What will make you use more water? & why?, - Productive uses of water
5. **Water shortages**
   - Coping strategies, Seasonal shortages?
6. **Difficulties in sharing water**
   - Difficulties in sharing water in compound houses, Bills, payment, frustrations , experiences. Responsibility for cleaning, maintenance etc.
7. **Water quality**
   - Taste, Odor, color, visible particles, testing.
   - Is clean water a high priority & why?

8. **Water storage**
   - Type of vessel & why, Environment around which storage container is placed & why? - Placement of storage container & reason, - Frequency of water collection and storage, - Amounts of water collected per day & why, - Cleaning of storage containers & reason. - Covering of water. - How often water withdrawal vessel is dipped into storage container.
9. **Hygiene practice**
   - **Personal hygiene**

     Household environment (presence of animal and human faecal matter, knowledge of their health implications), Sweeping cleaning, Personal health and wellbeing.
   - **Hand hygiene**

     -. Why the need for hand washing

     -. Child defecation behavior (Ask of Adult defecation behavior too)

     -. Cleaning anus of children

     -. Water enough for daily bathing of children and household chores?

     -. Need to teach children hand washing, cleaning and washing hands of children.

     -. Sanitation, visiting the public latrine/practicing open defecation, frequency of washing hands

10. **Diarrhoea**
    - What are existing knowledge and perceptions about diarrhea?
    - Understanding about childhood disease transmission & water borne disease transmission
    - Knowledge of causes (Cultural definitions) & Prevention
    - Dysentry
    - Management & treatment options
    - child feeding (normal, during diarrhea and after)
    - Experiences with diarrhea cases on index children
    - Ever given any form of training?
    - Children ever left to roam & play on the ground
    - General health of index child and household

11. **Decision making**
    - Who makes decisions about household expenditures (water bills).
    - Inclusion of women in decision making in water provision.
    - Willingness to pay.
    - What changes in water provision, sanitation and health care are needed.
    - Who controls the household budget?
    - Who takes care of water in the home & Why?
    - Who takes responsibility for water treatment & Why?
    - Who holds greater influences in household purchases & Why?
    - Power relations in the home

12. **General comments / requests**

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CONSENT FORM

Title of research project:
Household water use and their implications for childhood diarrhoea in the Atwima Nwabiagya District, Ghana.

Name of researcher:
Mr. Leslie Danquah, Department of Geography and Rural Development, CASS, KNUST.

Please initial **IN** the box.

I confirm that I have read and understood the information sheet for the above study and have had the opportunity to ask questions.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving reason.	
I am aware that every effort will be made to maintain confidentiality of the information I provide.	
I agree to take part in the above study	

Name of participant: ………………………………………
(Optional)

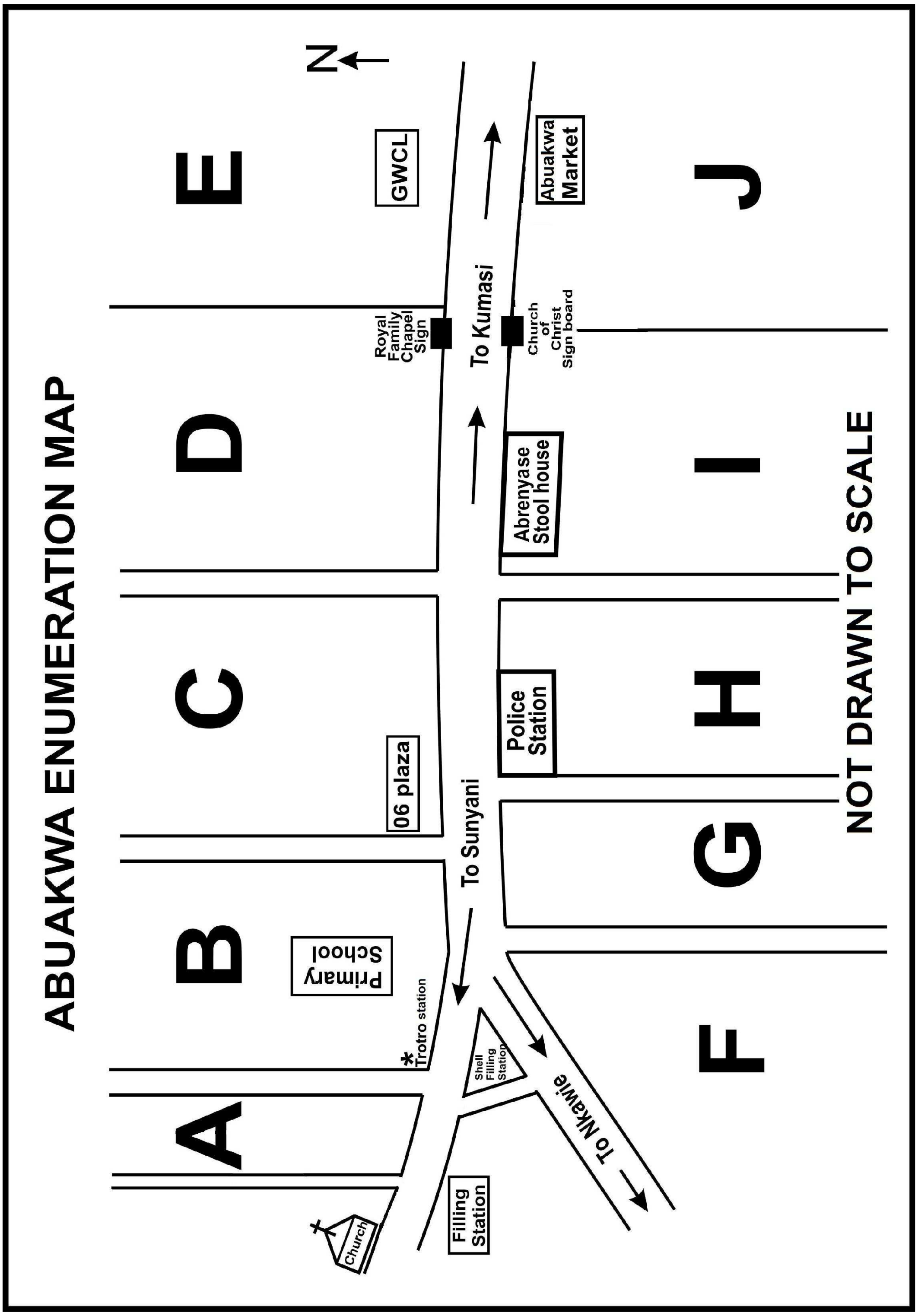
Date: …………………………………..

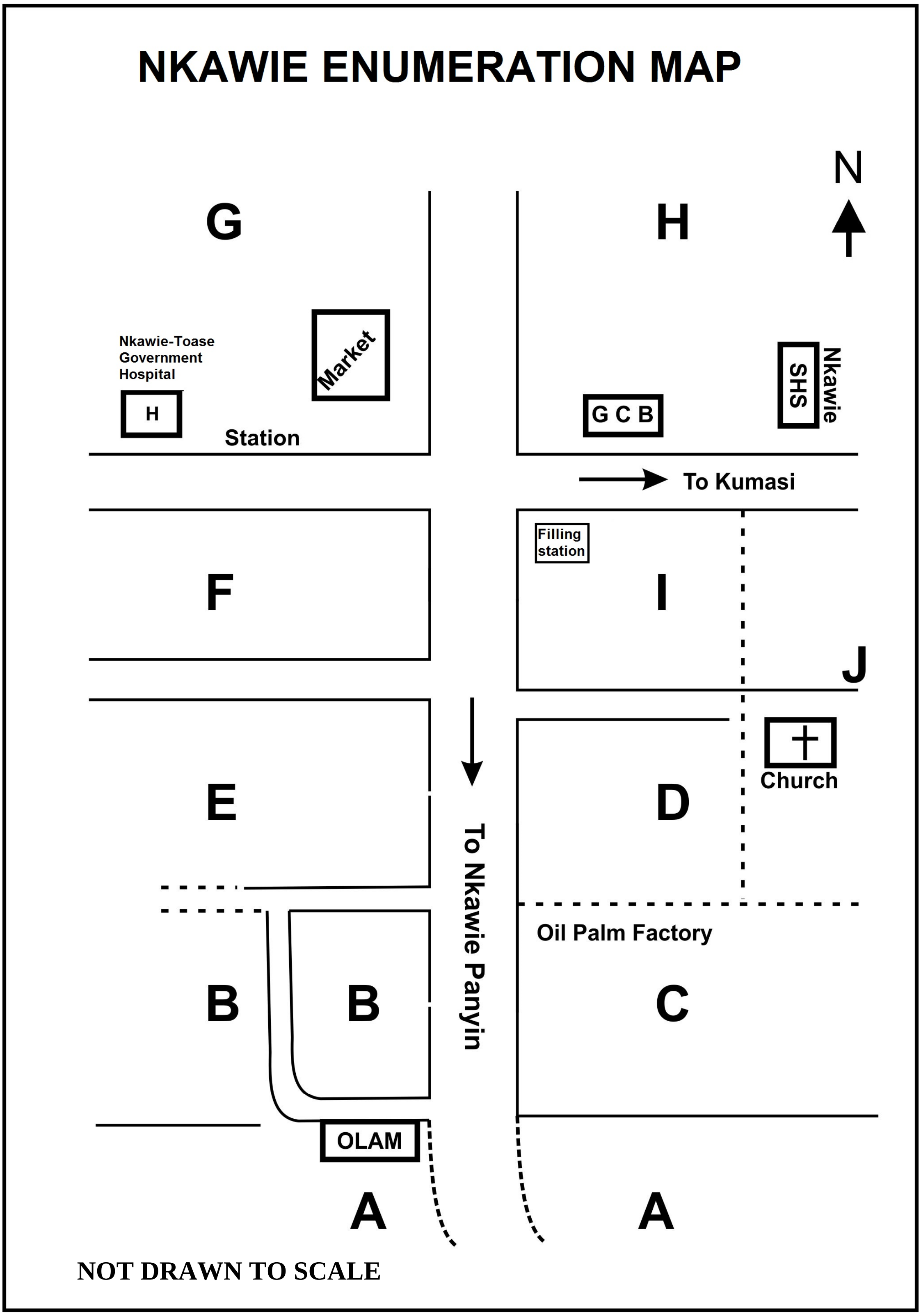
Initials/Signature:

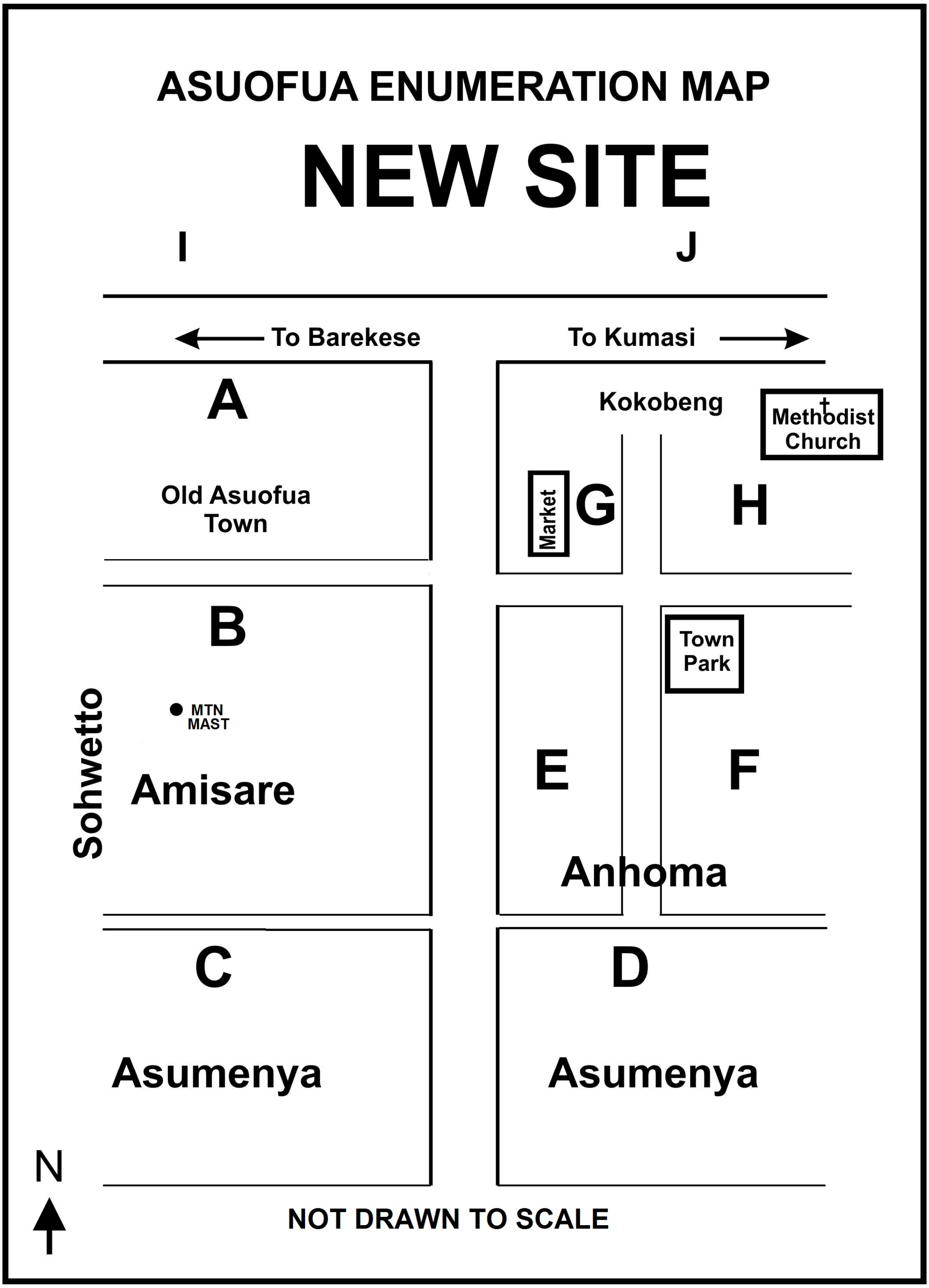
…………………………………………

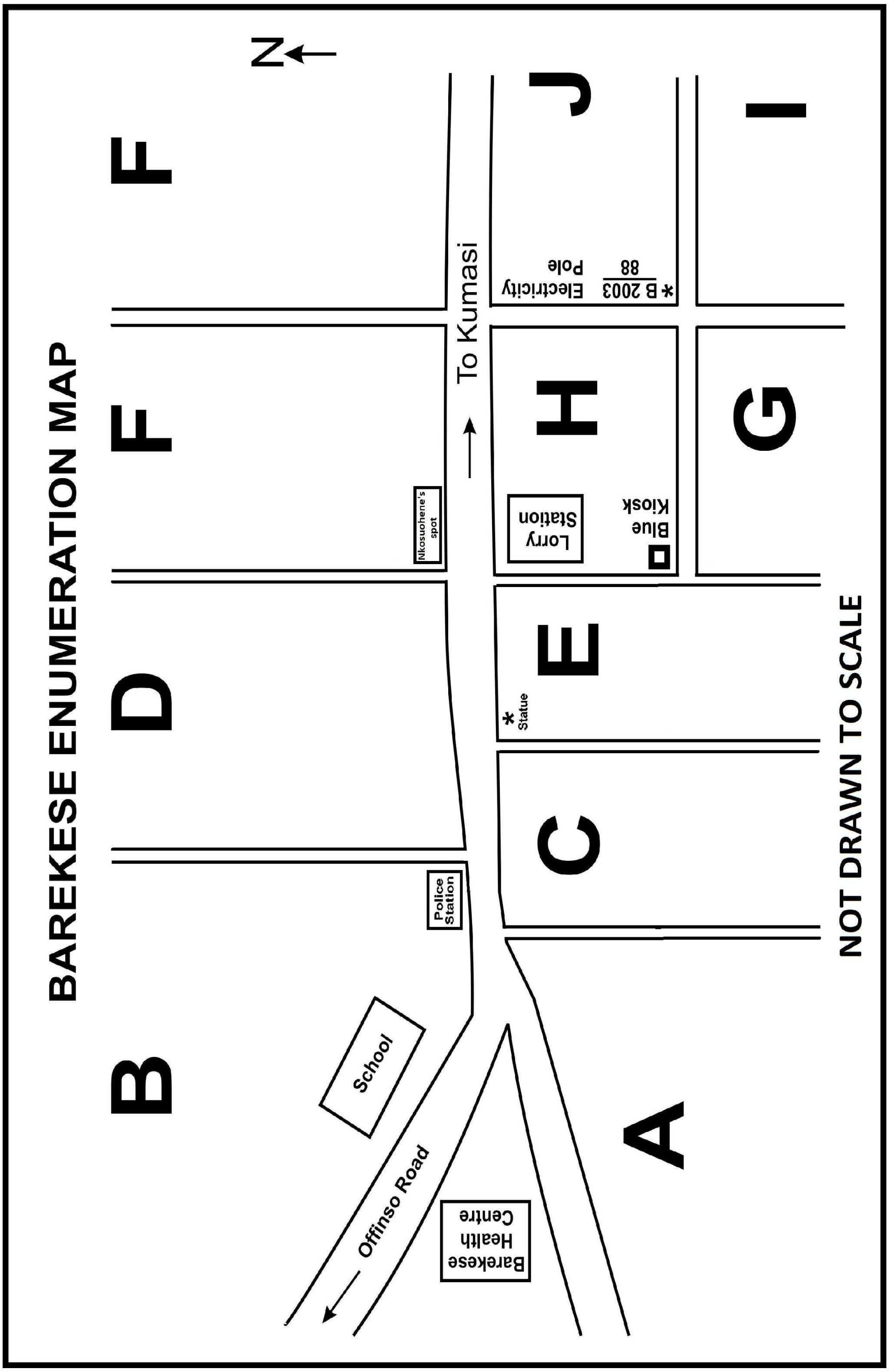
APPENDIX II

ENUMERATION MAPS




NKAWIE ENUMERATION MAP
N
G
H
Nkawie-Toase
Government
Hospital
H
Market
Station
G C B
SHS
Nkawie
To Kumasi
Filling
station
F
I
J
E
D
Church
To Nkawie Panyin
Oil Palm Factory
B
B
C
OLAM
A
A
NOT DRAWN TO SCALE


ASUOFUA ENUMERATION MAP
NEW SITE
I
J
To Barekese
To Kumasi
A
Old Asuofua
Town
Kokobeng
Methodist
Church
Market
G
H
B
MTN
MAST
Sohwetto
Amisare
Town
Park
E
F
Anhoma
C
D
Asumenya
Asumenya
N
NOT DRAWN TO SCALE


BAREKESE ENUMERATION MAP
N
F
F
D
B
J
I
H
G
E
C
A
To Kumasi
Electricity Pole
B 2003
88
Lorry Station
Blue Kiosk
Nkosuohene's spot
Statue
Police Station
School
Offinso Road
Barekese Health Centre
NOT DRAWN TO SCALE

APPENDIX III

WATER VESSEL AND EQUIVALENT VOLUME CHART (Page 1)

JERRICANS

TYPE					
SIZE IN LITERS	80 Liters	100 Liters	150 Liters	200 Liters	240 Liters
WEIGHT WHEN FULL	80 kg	100 kg	150 kg	200 kg	240 kg

BASINS

TYPE						
SIZE IN LITERS	30 Liters	40 Liters	60 Liters	70 Liters	80 Liters	80 Liters
WEIGHT WHEN FULL	30 kg	40 kg	60 kg	70 kg	80 kg	80 kg

APPENDIX III

WATER VESSEL AND EQUIVALENT VOLUME CHART (Page 2)

WATER STORAGE GALLONS

TYPE					
SIZE IN LITERS	5 Liters	10 Liters	20 Liters	20 Liters	25 Liters
WEIGHT WHEN FULL	5 kg	10 kg	20 kg	20 kg	25 kg

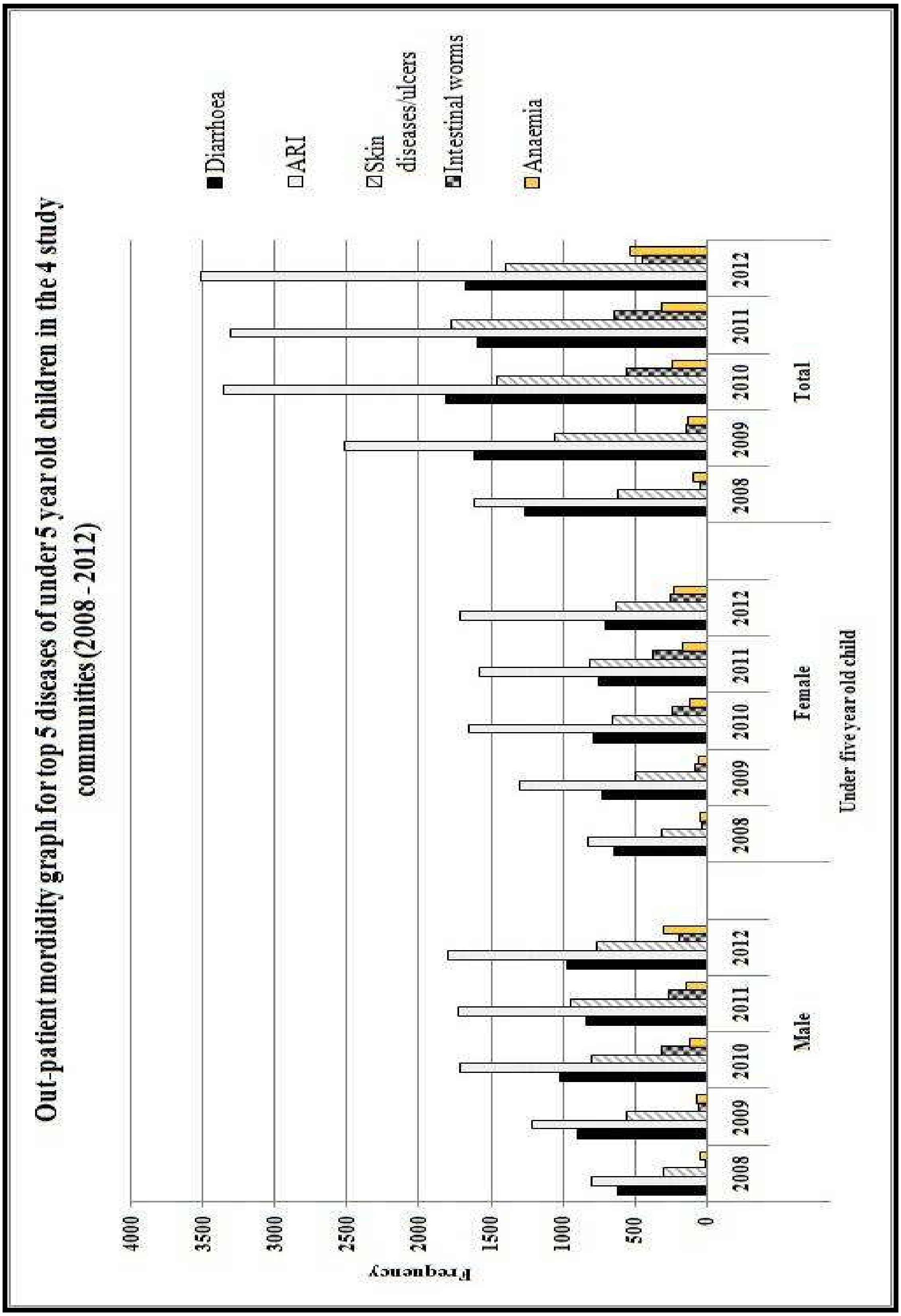
DRUMS

TYPE		
SIZE IN LITERS	200 Liters	250 Liters
WEIGHT WHEN FULL	200 kg	250 kg

BUCKETS

TYPE	SIZE IN LITERS	WEIGHT WHEN FULL
	5 Liters	5 kg
	7 Liters	7 kg
	10 Liters	10 kg
	15 Liters	15 kg
	23 Liters	23 kg

APPENDIX IV



Source: Ministry of Health, Health Information Unit , Kumasi. Accessed on 15/12/2011 and 9/05/ 2014

APPENDIX V

METHOD OF ESTIMATION OF ODDS RATIO

Definition: Odds ratio is the measure of association which compares the odds of disease of those exposed to the odds of disease for those not exposed. It indicates the strength of relationship between the outcome (diarrhoea) as a function of selected factors.

It was estimated using the formulae:

OR = (Odds of disease in exposed) / (odds of disease in the unexposed)

An example of a 2 by 2 table

	Cases (Suffered)	**Control (Not suffered)**	**Total**
Exposed	**a**	**b**	**a + b**
Unexposed	**c**	**d**	**c + d**
Total	**a + c**	**b + d**	**a + b + c + d**

Sources: IEA (2008: 175)

OR = (a/c) / (b/d)

= (a*d) / (b*c)

Where (a/c) is odds of disease in exposed and (b/d) is odds of disease in unexposed.

Interpretation:

An odds ratio of 1 means the exposure does not affect odds of outcome.

OR>1 means the exposure is associated with higher odds of outcome.

OR<1 means the exposure is associated with lower odds of outcome.

APPENDIX VI

Mean estimated volume of water collected per day by household category

Household	Wet Season			Dry Season		
	n	Total estimated volume collected daily (liters)	Mean used (liters)	n	Total estimated volume collected daily (liters)	Mean used (liters)
Abuakwa	95	31, 291	329.38	168	17, 641	105.01
Nkawie	45	14, 774	328.31	67	6, 838	102.06
Asuofua	65	13, 775	211.92	65	7, 925	121.92
Barekese	59	14, 916	252.81	65	6, 539	100.60
Urban	140	46, 065	329.04	235	24, 479	104.17
Peri-urban	124	28, 691	231.38	130	14, 464	111.26
Piped	31	7, 474	241.10	41	4, 483	109.34
Un-piped	233	67, 282	288.76	324	34, 460	106.36

Source: Author’s field survey, 2012 and 2013; n – number of households

APPENDIX VII

Regression of number of children with diarrhoea and daily per capita water use

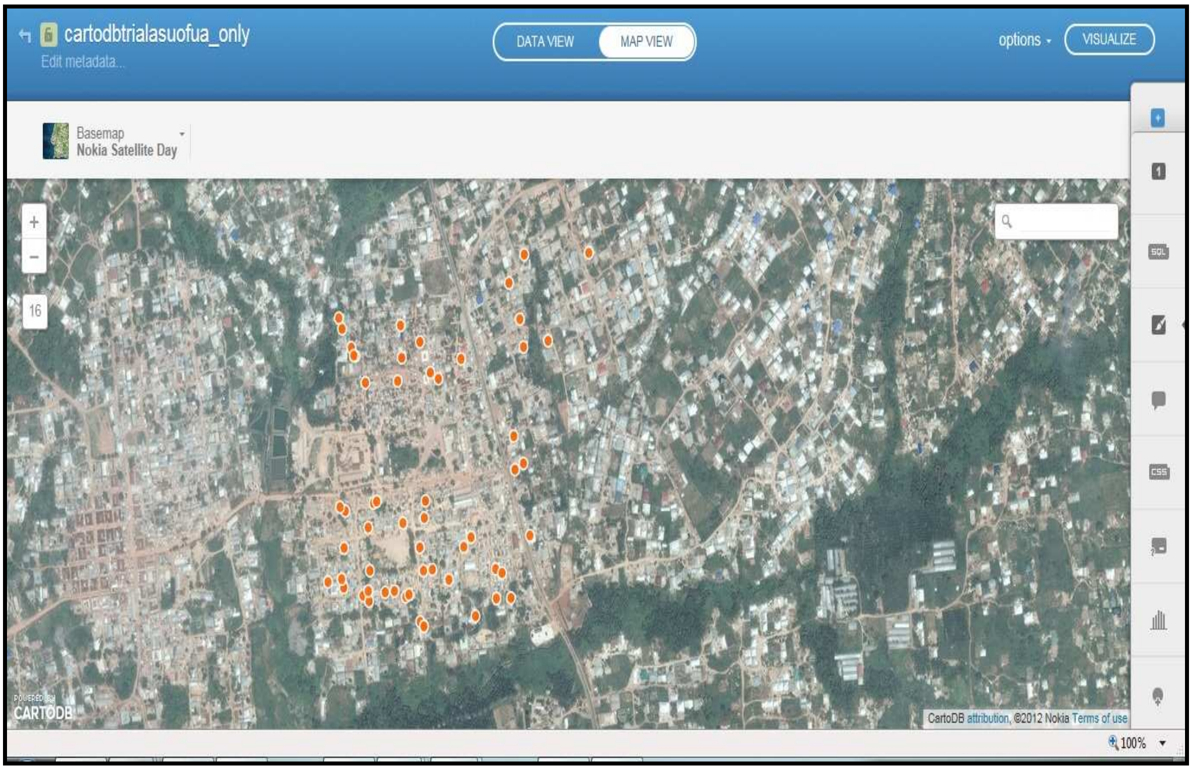
	Model	N	n	R	R^2	Adjusted R square	Significance (p-value)
Wet season	1. All households	378	262	0.003	0.00	-0.004	0.966
	2. Urban	242	139	0.061	0.004	-0.003	0.472
	3. Peri-urban	136	122	0.026	0.001	-0.008	0.774
	4. Piped	42	29	0.410	0.160	0.138	0.024*
	5. Un-piped	336	232	0.047	0.002	-0.002	0.474
	6. Abuakwa	175	94	0.106	0.011	0.001	0.308
	7. Nkawie	67	44	0.019	0.000	-0.023	0.902
	8. Asuofua	65	64	0.072	0.005	-0.011	0.569
	9 Barekese	71	57	0.083	0.007	-0.011	0.534
Dry season	1. All households	378	361	0.106	0.011	0.009	0.043*
	2. Urban	242	233	0.122	0.015	0.011	0.063
	3. Peri-urban	136	127	0.072	0.005	-0.003	0.418
	4. Piped	42	39	0.086	0.007	-0.019	0.596
	5. Un-piped	336	321	0.137	0.019	0.016	0.014*
	6. Abuakwa	175	166	0.122	0.015	0.009	0.118
	7. Nkawie	67	66	0.123	0.015	0.000	0.320
	8. Asuofua	65	63	0.088	0.008	-0.008	0.490
	9. Barekese	71	63	0.049	0.002	-0.014	0.699

Source: Author's field survey, 2012 and 2013; * $p \leq 0.05$; N – Sample size.

APPENDIX VIII

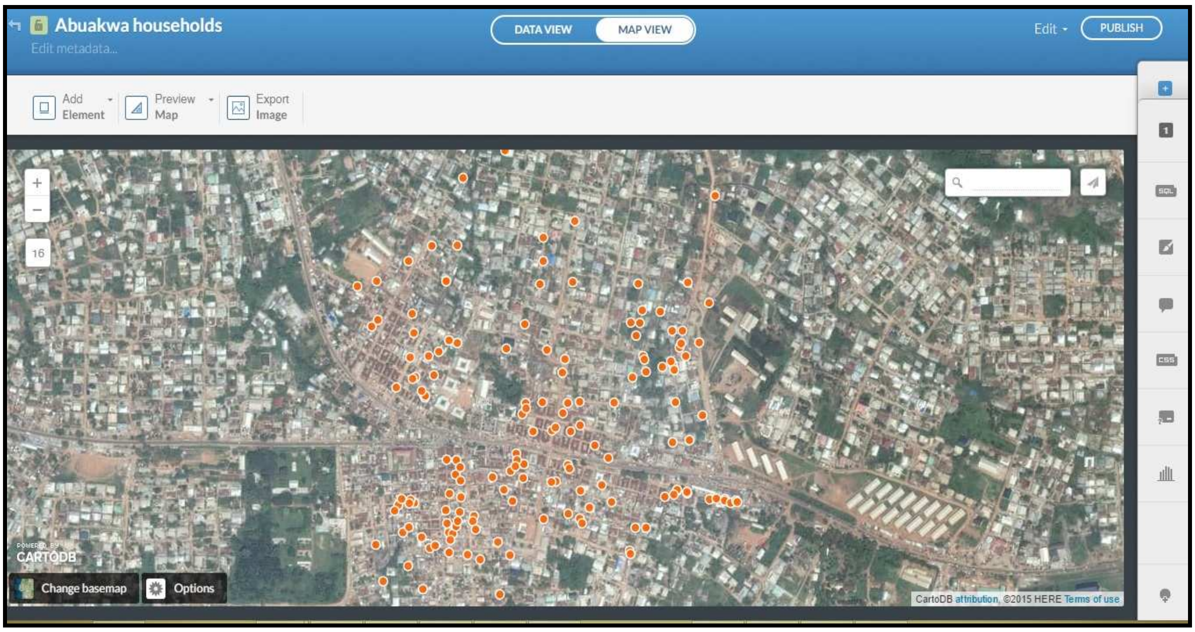
Spatial distribution of studied households

Asuofua



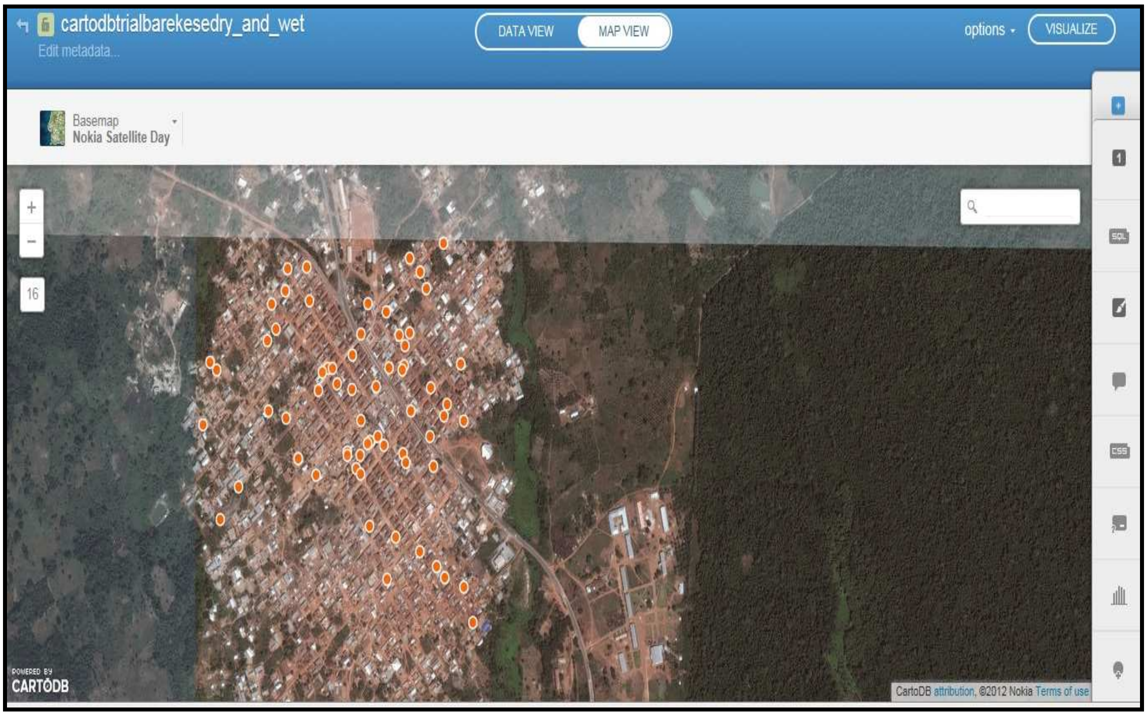
Source: Authors' enumeration data - GPS location of households 2012; CartoDB®

Abuakwa



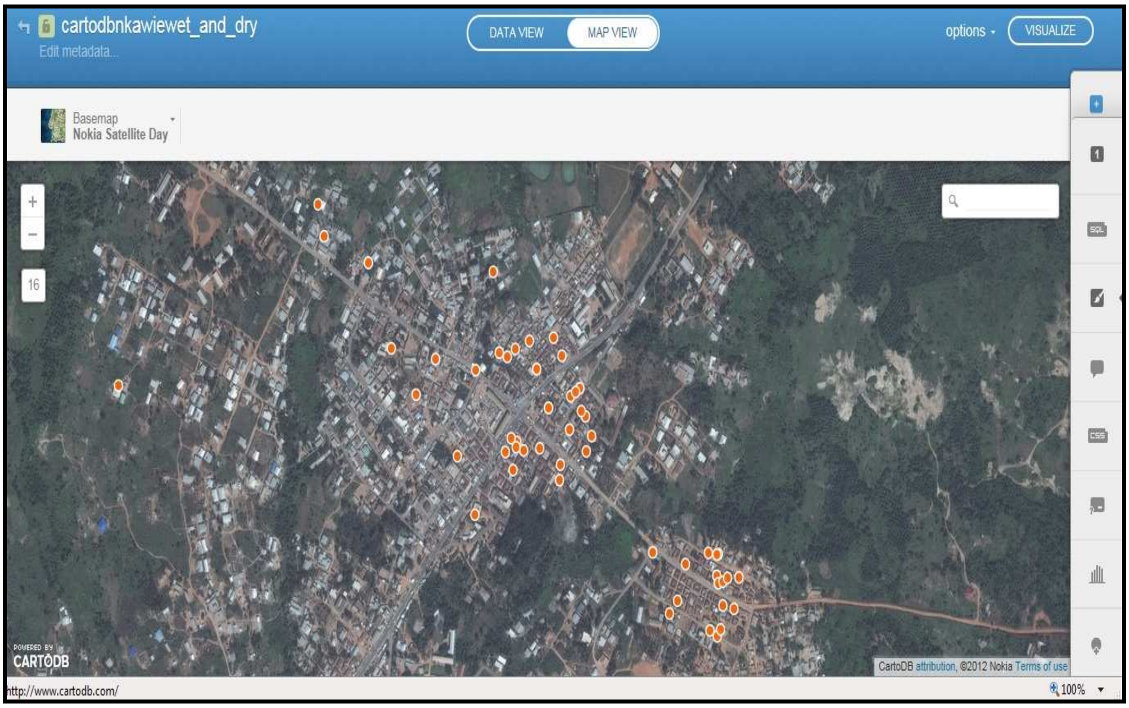
Source: Authors' enumeration data - GPS location of households 2012. CartoDB®

Barekese



Source: Authors' enumeration data - GPS location of households 2012; CartoDB®

Nkawie



Source: Authors' enumeration data - GPS location of households 2012; CartoDB®

APPENDIX IX

Plate I

SAMPLE SURVEY PICTURES

Plate I shows a child on the compound of a house in Asuofua. Water collection vessels are placed on the floor. Also wet floor patches is indicative of possible waste water disposal.

Plate II

Plate II shows women engaging in water collection activity in Nkawie. Water is being drawn from a protected well into water collection basins.

Plate III

Plate III shows a research assistant engaging in data collection during a training session in Kobeng. In the background, water collection vessels are placed on the floor less than 10m from a latrine.

Plate IV

Plate IV shows a public latrine in Barekese. Portions of the land adjacent to the latrine is littered with faecally contaminated paper.