**REGIONAL INSTITUTE FOR POPULATION STUDIES**
**AT THE**
**UNIVERSITY OF GHANA**

# FLOODING AND DIARRHOEAL DISEASE INCIDENCE IN URBAN POOR COMMUNITIES IN ACCRA, GHANA: INVESTIGATING THE EFFECTS OF RISK PERCEPTION MEASURES

**BY**
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**Acceptance**

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**Declaration**

I hereby declare that, except for reference to other people's work which have been duly acknowledged, this work is the result of my research and that it has neither in part nor in whole been presented elsewhere for another degree.

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Date

**Dedication**

This work is dedicated to my wife, Asana Mohammed and my two sons, Salman-Faris Junoor and Mohammed Yeng-Naa.

**Acknowledgement**

First and foremost, I would like to thank the Almighty Allah for his mercies, grace, good health and understanding. Secondly, my sincere gratitude goes to my supervisors Prof. Samuel N.A. Codjoe, Prof. Samuel K. Adiku and Prof. Francis Dodoo whose constructive criticisms, suggestions and innovative ideas contributed to the success of this work. Again, my profound gratitude goes to the entire faculty of the Regional Institute for Population Studies who contributed in diverse ways to this success. More so, I would like to thank all my colleagues at RIPS for their contributions and encouragements. I would also like to thank my entire family for their prayers, love and support during the period I embarked on this journey.

Finally, to all individuals whose names I cannot mention because of the lack of space, I would like to say to them thank you and may the Almighty Allah bless you for your unflinching support and prayers.

Abu Mumuni

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# Abstract

Flooding is an environmental challenge faced by many nations in the 21st Century. Studies have shown that recent floods in cities are responsible for the outbreak of cholera and non-cholera diarrhoea, but there is little work on the risk perceptions of diarrhoea resulting from flooding. Also, it is not known how risk perceptions of diarrhoea mediate the relationship between flooding and diarrhoeal disease. The risk perceptions people develop resulting from their exposure to floods is the key driver of the measures they will employ to avert the health effects of it. Measurement of risk perceptions has, therefore become an important topic to policy makers concerned with risk management, communication and safety issues. Accurate measurement of risk perceptions is considered a crucial aspect of managing hazards as it directs the development of hazard mitigation strategies. This study examines how three risk perception measures of diarrhoeal disease explain the flooding and diarrhoeal disease relationship in urban poor communities in Accra. Two main sources of data were used for the study. Firstly, time series data on rainfall from the Ghana Meteorological Agency and data on reported diarrhoea cases from the Center for Health Information Management, Ghana Health Services, for Ashiedu-Keteke sub-Metropolitan Area of Accra were used to examine the relationship between flooding and diarrhoeal disease in the study communities. Second, cross-sectional data from two urban poor neighbourhoods (*Agbogbloshie* and *James Town*) in Accra, Ghana, consisting of five enumeration areas (EAs) from *Agbogbloshsie* and nine enumeration areas from *James Town,* were used to examine the effects of the three risk perception measures on the relationship between flooding and diarrhoeal disease. A total of 401 households involved in the study were asked to rate the chance of a member of their household being diagnosed with diarrhoeal disease within the first four weeks after the October 26th 2011 flooding of Accra on a 0-100% numerical risk perception scale and a verbal and comparative risk perceptions scale with five descriptive categories each. The study employed the Granger causality test to examine whether flooding predicts incidence of diarrhoea in the Ashiedu-Keteke sub-Metropolitan area of Accra. To examine the effect of risk perceptions on the relationship between flooding and diarrhoea, binary logistic regression analysis was used. The study revealed that flood Granger cause incidence of diarrhoea in the Ashiedu-Keteke sub-Metropolitan Area of Accra. Experience of the October 26th, 2011 floods predict incidence of diarrhoea in the study communities. The numeric, verbal and comparative risk perception measures were all significant predictors of incidence of diarrhoea in households. Overall, the numeric risk perception measure did best in identifying households at high or low risk of diarrhoea than the verbal and the comparative risk perception measures. Other significant predictors of diarrhoeal disease were household source of drinking water, distance to the nearest refuse collection point and presence of cockroaches in households. The study recommends research into risk perceptions of people in addressing critical global issues and also calls for education on water and sanitation, which are critical in diarrhoeal disease transmission in the event of flooding.

# Chapter One

# Introduction

## 1.1 Background of the Study

Generally, flooding has serious effects on the social, economic, environmental, physical, health and the psychological wellbeing of people (WHO 2005; Messner et al. 2005; Dasgupta et al. 2009). The effects of flooding on water and sanitation infrastructure in poor neighbourhoods predispose the population to diseases (Hashizume et al. 2007; Rain et al. 2011). Water and poor sanitation for instance, contribute to approximately 94 percent of the four billion cases of diarrhoea that occur globally each year (WHO/UNICEF 2010). Of particular interest to demography and public health is the relationship between flooding and diarrhoeal disease, one of the leading causes of morbidity and mortality among children in low-income countries (Black et al., 2010). Recent global trends in flooding in cities, coupled with their high population densities, should trigger increases in diarrhoea incidents in poor neighborhoods (Ghana Statistical Service (GSS) 2012), United Nations Environment Programme/United Nations Office for Coordination of Humanitarian Affairs (UNEP/OCHA), 2011).

There are studies that specifically examine the relationship between flooding as a consequence of rainfall and its impact on diarrhoeal disease (Hashizume et al. 2008; Kunii et al. 2002; Mondal et al. 2001), yet none of the studies have examined a fundamental issue in this relationship, that of risk perceptions about diarrhoea resulting from flooding. The argument here is that the increase in the amount of rainfall or changes in the seasons may themselves not be a problem; but, the hazards it brings such as floods may be the major driver of health outcomes such as diarrhoeal disease. Climate predictions suggest an increase in the amount of rainfall in some parts of West Africa (Christensen et al. 2007; Tschakert et al. 2010), which have experienced some major floods in recent years (Centre for Research on the Epidemiology of Disaster (CRED) 2013). Coincidentally, these are also places that have experienced increases in cholera and non-cholera diarrhoea cases over the period (CRED 2013). One plausible explanation for the rise in diarrhoea in these places, however, may be found in the perception people have about conditions that trigger the disease. There is usually a recognition by communities about increases in hazards. However, risk reduction and vulnerability are often not salient issues until the disaster has occurred (Cutter et al. 2008). The curative approach often results in higher cost on hygiene than a preventive approach. The ability to introduce preventive measures into a population depends on adequate understanding of how the population perceives their risk of the event and their willingness to have the problem addressed.

Risk analysis methods have generally relied on objective risk measures rather than subjective risk measures in the management of hazards in communities until recently (Schanze 2007). This was because policy makers did not see the relevance of subjective risk perceptions in decision making. Subjective risk perceptions of people are known to influence the way they do things (Cutter et al. 2008; Levy et al. 2006; Price 1993), and this is expected to play a significant role in how people respond to flooding and its associated consequences. Risk perceptions of populations are used in diverse disciplines such as demography, medicine, psychology and environmental science to test models that hypothesize relationships between risk perceptions and health behaviour (MacCaul et al. 1996; Aiken et al. 1994; Harris et al. 1991; Weinstein et al. 1991). They are also used to identify populations at greatest risk of certain events and the possible public health interventions required to address the situation (Levy et al. 2006). Finally, accurate assessments of risk perceptions of populations are useful to government and other policy makers in the implementation of policies to avert health problems.

There are recent studies on people's perceptions about their experiences with flooding and its relation to health outcomes (Tapsell, et al. 2008; Ahern et al. 2005; Tapsell et al., 2002), but there is rarely any study on risk perceptions of diarrhoeal disease resulting from flooding and how this is related to incidence of diarrhoea in households. Risk perceptions of people are assessed to help achieve governments' risk reduction policies. There is, however, little consistency in the approaches used to measure risk perceptions. This study examined three most common measures of risk perceptions (Numeric, Verbal and Comparative) to ascertain the role they play in the flooding-diarrhoeal disease nexus.

## 1.2 Statement of the Problem

There is a growing consensus that urban dwellers are more likely to be exposed to the risks of floods, due to increased impermeable surfaces that are paved which prevent infiltration, and thus lead to water run-off, limited parks and other green spaces to absorb water run-off, and bad drainage systems that are often clogged by waste materials (Huq et al. 2007; Andjeilkovic, 2001). This trend of flooding will exacerbate the already poor health conditions in urban poor communities and put more pressure on the limited health budget. This is because, the health budget will be overdrawn by climate-related hazards and stifle efforts being made in the region to achieve the Millennium Development Goals (MDGs) 4 (reducing child mortality rates), and 6 (combating HIV/AIDS, malaria, and other diseases). The problem with addressing this issue is that data on flooding and diarrhoea are difficult to find in Africa and, where they exist, they are hardly used as evidence to inform policy. There are meteorological and disaster management agencies in almost all African countries that keep records of disasters but the data collected are poor in most of the countries. Also, data on morbidity in the region are not comprehensive because of the high patronage of traditional medicine and self-medication where records of patients are not kept. Despite these weaknesses, the data collected by the institutions when supported with cross-sectional information from communities can provide very useful information for policy directions in urban poor communities.

Globally, flooding is correlated with increased incidence of diarrhoea (UNEP/OCHA 2011; de Magny et al. 2008; Hashizume et al. 2007). However, the effect of flooding on diarrhoea in urban poor communities in Africa remains the least understood both demographically and socio-environmentally (Songsore et al. 2006; Fobil and Atuguba 2004). Urban settlements south of the Sahara have high risk of instability due to their haphazard nature, which creates unpredictable changes in the environment that can fuel disease outbreaks. In Ghana, urban settlements are vulnerable to a number of environmental hazards and diseases due to the unplanned nature of settlements and inadequate infrastructure provision (Rain et al. 2011; Karley 2009; Afeku 2005). There are limited access to sanitation facilities and pipe borne water in the dwellings of the majority of the population residing in urban poor communities (Hashizume et al. 2007; Songsore et al. 2006). Also, there is the problem of rapid accumulation of waste in these settlements, and this creates conducive atmosphere for infectious diseases transmission.

Flooding is a serious environmental problem affecting Accra (Rain et al., 2011). Certain parts of the city flood almost every year and this usually leads to the loss of lives and property. The October 26$^{th}$, 2011 flood in Accra, for instance, was estimated to have affected about 43,000 people in vulnerable communities; and about 17,000 people lost their homes and 14 people lost their lives during the flood or as an effect of it (UNEP/OCHA 2011). There were also reports of unhygienic pollution from sewage-polluted water in inundated areas, and an increase in cholera and non-cholera diarrhoea incidents one week after the flooding. Despite these problems, it has not been established whether urban poor communities perceive diarrhoea as a stressor of flooding.

Flooding has the potential to exacerbate diarrhoea-related mortality in Ghana. It has been estimated that children under five years experience between 100 to about 500 diarrhoea-related deaths per 100,000 children annually (Santosham et al. 2010). In addition, it has been established that densely-populated urban areas are susceptible to diarrhoea and poor environmental challenges (Rain et al. 2011; Haines and Patz 2004; Zulu et al. 2002). Inhabitants in such environments are expected to develop some risk perceptions about their susceptibility to the hazards in the area, which should inform the way they maintain hygiene at home or purify their water before drinking. However, most of the risk assessments that have been conducted in urban poor places were based on physical risk assessment with little work done on subjective risk assessment of the inhabitants. The problem is that, physical risk assessment can help determine how vulnerable a place is to hazards but subjective risk assessment help to determine the willingness of the population to take measures to address the situation. As a result, one key question in this study is whether households in Agbogbloshie and James Town observed increases in diarrhoeal disease incidence resulting from recent flooding in the communities?

In addition, whereas there have been some studies on perceived neighbourhood environmental problems and health in urban poor communities in Ghana (Songsore et al. 2008; ILGS & IWMI, 2012; Codjoe et al. 2014), no study has examined households' measure of diarrhoeal disease risk in urban poor communities as a result of their experience of flooding. However, it is the risk perceptions that people develop as a result of their experience of flooding that determines the kind of coping strategies they adopt to avert diarrhoeal disease in their households. Generally, flood victims in urban poor communities are neglected or in situations where support is provided, it is usually inadequate. The loss of personal possessions and inadequate support for victims expose them to diseases such as cholera and non-cholera diarrhoea (Ohl and Tapsel 2000; Fullilove 1996; Lutgendorf et al. 1995).

Two communities studied in this thesis are located in flood prone areas of the Accra Metropolis (Ludlow 2009). These communities are known to have high outbreak of cholera and high incidence of non-cholera diarrhoea and other diseases in the city (UNEP/OCHA 2011; Songsore et al. 2006). Furthermore, these are also neighbourhoods with low-income and high proportion of children under five years who may have weak immunity to frequent environmental problems. It is conceivable that flooding will pre-dispose the spread of diseases in these and other communities. However, it is not known how people in urban poor places perceive their risk of diarrhoea as a result of flooding, and it is also unknown whether different measures of perceptions of diarrhoeal disease risk trigger different levels of diarrhoea incidence among households in urban poor communities. Addressing these general issues will provide useful information to public health practitioners on how to design specific programmes to meet the needs of specific populations.

Against this backdrop, five specific research questions were tabled:

i. Is there any association between flooding and diarrhoea incidence?
ii. Do household experiences of flooding predispose them to incidence of diarrhoea?
iii. Are risk perception measures valid measures in the flood-diarrhoeal disease nexus?
iv. Are there differences in numeric, verbal and comparative risk perception measures of diarrhoeal disease and incidence of diarrhoea?

v. What is the role of other factors (demographic, water, sanitation, and environmental risk factors) in the flood-diarrhoea incidence nexus?

## 1.3 Rationale

Diarrhoea is a critical health issue among the general population over the past two decades (UNEP/OCHA 2011; Songsore et al. 2006). In recent times, the Ministry of Health, Ghana has increased its educational campaign on diarrhoeal disease prevention because of the increasing trend of diarrhoea cases in the country. Diarrhoea is responsible for the deaths of over two million people annually, representing four percent of total worldwide mortality, and it is also known to mostly affect poverty-stricken populations (Liu et al. 2012). It causes 1.3 million deaths in children younger than five years every year (Black et al. 2010). The distributions of diarrhoea mortality, and the causes of the disease, vary from one country to another. Diarrhoea related deaths among children younger than five years are very high in some countries in South Asia and Africa (Breyette et al. 2006). Also, children younger than five years in developing countries have a median of three episodes of diarrhoea every year (Kosek et al. 2003). Increases in environmental problems have brought about increases in diarrhoea incidence in some regions (Hashizume et al. 2008). Even though, the development of oral rehydration solution in the 20$^{th}$ century has served as a remedy for dehydration from diarrhoea, it does not lessen diarrhoea incidence (Santosham et al. 2010).

In Ghana, a number of studies have established a relationship between water quality and sanitation and the incidence of diarrhoeal disease (Benneh et al. 1993; Shier et al. 1996; Gyimah 2003; Boadi and Kuitunen 2005) which, sought to explain some environmental conditions that often lead to diarrhoea. In addition, Boadi and Kuitunen (2005) discussed some cultural and traditional risk factors that inflict diarrhoeal disease on children. However, these studies did not examine the risk perceptions of diarrhoea resulting from households experience of flooding. Risk perceptions are critical in decision making at the household level. The study of risk perceptions has helped to provide very useful policy suggestions to policy makers. For instance, the study of people's risk perceptions on HIV and AIDS in Malawi helped in understanding the spread of the disease in the country (Smith and Watkin 2004).

The recent climatic extremes and their consequences for public health have demonstrated that even countries with high adaptive capacity remain vulnerable to the adverse impacts of climate extremes, and that vulnerability to climate-change impacts is unevenly distributed even within societies (IPCC, 2007; Confalonieri et al. 2007; Wilbanks et al. 2007). The heterogeneity of urban poor neighbourhoods, coupled with the density of the population, makes it relevant to examine the risk perceptions of diarrhoea that households develop as a result of their experience of flooding within the study communities, and how this affects the incidence of diarrhoea in households.

### 1.4 Objectives of the study

The main objective of the study is to address the knowledge gap of how household risk perceptions of diarrhoea resulting from experience of flooding affect incidence of diarrhoea in urban poor communities in Accra.

Specifically, the study seeks to:

i. Examine the relationship between flooding and diarrhoeal disease incidence at the sub-metropolitan level.
ii. Examine the role of risk perception measures in the flooding-diarrhoeal relationship in *Agbogbloshie* and *James Town*.

iii. Examine the role of household characteristics, water, sanitation and environmental risk factors in the flooding-diarrhoeal relationship in *Agbogbloshie* and *James Town*.

iv. Test the validity of the numeric, verbal and comparative risk perception measures of diarrhoeal disease in urban poor communities in Accra.

v. Examine the differences in the numeric, verbal and comparative risk perception measures in predicting incidence of diarrhoeal disease resulting from flooding.

### 1.5 Definition of Terms

**Diarrhoea:** It is the passage of three or more loose or liquid stools per day, or more frequently than is normal for the individual (World Health Organisation (WHO) 2013).

**Flood:** A flood is defined as a temporary condition of surface water (river, lake, sea), in which the water level and/or discharge exceeds a certain value, thereby escaping from its normal confines. However, this does not necessarily result in flooding (Munich-Re 1997).

**Flooding:** Flooding is defined as the overflowing or failing of the normal confines of for example, a river, stream, lake, sea or accumulation of water as a result of heavy precipitation through lack of drains or a situation where the amount of water exceeds the discharge capacity of drains, both affecting areas which are normally not submerged (Douben and Ratnayake 2005).

### 1.6 Organisation of Study

The study is organised into nine chapters. Chapter one which is the introductory chapter, comprises of the background of the study, statement of the problem and research questions, rationale, objectives of the study, definition of some concepts and the organisation of the study. The second chapter is dedicated to literature review and the conceptual framework while chapter three discusses the study area and the methodology. The fourth chapter focuses on flooding and diarrhoeal disease incidence in the Ashiedu-Keteke sub-Metropolitan Area of Accra with analyses on household characteristics and preventive strategies used by households in chapter five. Chapter six examines risk perception measures, flooding and incidence of diarrhoeal disease in *Agbobloshie* and *James Town* while chapter seven focuses on bivariate analysis of flooding, risk perceptions, controls and incidence of diarrhoea. Chapter eight is dedicated to multivariate analysis of flooding, risk perception, controls and diarrhoeal disease. Chapter nine which is the concluding chapter presents the summary, conclusions and recommendations.

# Chapter Two

# Literature Review

## 2.1 Introduction

Flooding is the most universally experienced natural hazard across the globe (CRED 2013; IPCC 2007; Noji 1991). It accounts for 40 percent of all natural disasters worldwide and causes about half of all deaths from natural disasters (Centre for Research on the Epidemiology of Disaster, 2013; Noji, 1991). It is evident that sub-Saharan African countries are amongst the most vulnerable to climate-related hazards, a situation aggravated by the interaction of multiple stressors occurring at various levels, with accompanying low adaptive capacity (Boko et al. 2007). The demographic implications of climate-related hazards have been under-studied. Flooding events may cause enormous economic, social and environmental damage and even loss of lives. The rapid increase in the proportion of the world's urban population, with its fastest growing cities located in low and middle income nations will result in environmental problems including climate-related hazards which have recently become a problem in cities of developing countries (Codjoe et al. 2014; Rain et al. 2011). It is estimated that almost all the increase in the world's population over the next 20 years and beyond is likely to be in urban centres in low and middle income nations (United Nations (UN) Habitat 2008). The growth of the population will result in additional constraint on the already limited resources in these economies.

The effect of population growth and infrastructural expansion in urban places and its associated environmental and health challenges in low and middle income countries requires urgent attention. For instance, the urban landscape of Accra, Ghana has transformed over the years especially poor neighbourhoods where there is less supervision on infrastructural development. Almost every space has been occupied with a structure compromising environmental quality which affects urban health. Generally, the increase in urban growth in low-income countries will bring about challenges in management of solid and liquid waste, uneven distribution of sanitation services, poor quality of water supply, poor infrastructural development, differences in socio-economic status, increased segregation in neighbourhood characteristics and paving of open space (Songsore et al. 2008). It is expected that recent trend in flooding in urban poor places will exacerbate the health situation in urban areas.

Flooding will exacerbate poor health conditions including diarrhoeal disease in low income communities (Hashizume et al. 2008; Ohl and Tapsel 2000). At the global level a lot of studies have been conducted in this area in both developed and developing countries aimed at addressing recent rise in gastrointestinal challenges and diarrhoea cases as a result of flooding (Hashizume et al. 2007). At the national level, not much has been done in this area even though, there is public health concern to curb the recent rise in cholera and non-cholera diarrhoea challenges in Ghana. There is no specific study in Ghana that focuses on the impact of flooding on diseases. The study area has however, been part of some other studies that examined urban environment and health challenges in Accra (Rain et al. 2011; UNEP & OCHA 2011). These studies mapped out the flood-prone areas in Accra and described the consequences of flood events in these areas. In addition, these studies juxtaposed the health consequences of the vulnerability of these communities to flooding without much empirical evidence. In order to identify the gap within the subject area a detailed review of literature in the subject area was conducted. Apart from reviewing literature on what has been done in the area globally and in sub-Saharan Africa, a substantive review of works related to the subject area in Ghana was done in this study.

## 2.2 Overview of flooding and diarrhoea

Since ancient times, people have settled in flood-prone areas due to favourable geographic conditions which facilitate economic growth, such as accessibility (transportation) and food production (fertile land) (Blaikie et al. 1994). There are several types of floods but most communities experience few of them. Floods can be grouped broadly into riverine flooding, urban drainage, ground failures, fluctuating lake levels and coastal flooding and erosion. Within these groups there are several types of floods but the most common ones are surface water runoff, river floods and flash floods. Surface water runoff can lead to localized flooding if the rainfall intensity exceeds the evaporation rate and infiltration capacity of the soil and also when there is inadequate drainage to accommodate rainfall. River floods are caused by flooding of the river outside its boundaries often as a result of high precipitation levels. "Flash floods" on the other hand is defined as the rapid and extreme flow of high water into a normally dry area, or a rapid rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). However, the actual time threshold may vary in different parts of the country. Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters" (National Weather Service Manual 10-950, 2006). 'Flash flood' can be more severe and damaging than all the other forms of flooding because of the speed with which it occurs (possibly hindering evacuation or protection of property), the high velocity of water, and the debris load can have major impact on human life.

The past two decades have been a very significant period in relation to floods around the world for several reasons. Firstly, some of the most severe and damaging floods have occurred in developed countries such as the Mississippi Basin in the United States of America in 1993, Australia in 2010 and 2011, Great Britain and Ireland in 2012 and Colorado in the United States of America in 2013. Secondly, floods in less developed countries have been on the increase over the last two decades. For instance, 100-year floods (a flood event that has 1% probability of occurring in any given year) were occurring almost yearly in China and Bangladesh (Wisner et al. 2004). In Africa, there were reports of floods in Mozambique and Malawi in 2000, Ethiopia in 2006, Angola, Ghana, Niger, Burkina Faso, and Benin in 2009, and Nigeria in 2012. Thirdly, even though flooding has been occurring in these countries over the years (Lawford et al. 1995; Dhar and Nadargi 2002; Schanze et al. 2006), an increased frequency especially during the past two decades is evident and this has been partly attributed to climate change (Easterling et al. 2000; Milly et al. 2002; IPCC 2007). Fourthly, the failure of engineering measures in developed countries to avert flood situations has triggered a lot of questions as to how developed countries can help developing countries to address flood situations.

Floods are usually triggered by heavy rainfall but the magnitude and duration are influenced by other factors such as topography, land use, urbanisation, vegetation and soil (Nyarko, 2000). However, not all floods are as a result of excess rainfall. River flood that results from periodic water stored behind or within glaciers cannot be attributed to extreme precipitation. Further, floods can be generated by human activities. For instance, the construction of the Akosombo Dam aggravated incidence of flooding in some communities in Ghana. Notwithstanding some positive consequences of flooding that have been perceived in some literature such as the ability to irrigate and flush out salt and toxins from soil and watercourse (Smith 1996; Blaikie et al. 1994), the negative impacts such as injury, diseases and loss of properties are enormous.

The trends in flood frequencies and flooding damage seem to be increasing, primarily due to a growing vulnerability arising from societal changes such as interference by occupation, developments, investments and land-use changes in flood-prone areas (Douben 2006). Most floods occur in developing regions where the impacts on public health are substantial, the number of people displaced is often large, and the number of deaths is high (BMJ 2000). In the aftermath of flooding, deaths and injuries not only result from the physical characteristics of the event but are also determined by the prevailing socio-economic and health conditions of the community and any endemic infectious diseases. Increased rates of diarrhoea (including cholera and dysentery) and diseases borne by insects have been described as occurring after flooding in developing areas. Diarrhoea for instance, has been endemic in developing countries in the 18th Century and periodically broke out, but the recent frequency of flooding in the region has led to increased incidence of diarrhoea (Reacher et al. 2004).

In most developing and middle income countries, the transmission of diarrhoeal disease occurs mainly through contaminated food or drinking water, bacterial and viral pathogens (Podewils et al. 2004). These transmission routes are facilitated by environmental and climatic factors which affect human health (Checkeley et al. 2000; Singh et al. 2001; Hashizume et al. 2007). For instance, the provision of quality water and good sanitation in deprived urban communities is a problem faced by many countries in the south (Machdra et al. 2013). Some of the sanitation problems are lack of infrastructure, indiscriminate disposal of waste water, lack of control for collection and disposal of solid waste and open defecation. The effects of open defecation in particular are many. Not only does it pollute ground waters, it contaminates agricultural produce, and leads to the spread of diseases such as cholera and non-cholera diarrhoea (WHO & UNICEF 2010). Researches have shown that diarrhoea is correlated with extreme climatic conditions and has a seasonal pattern (Hashizume et al. 2007; Lipp et al. 2002;

Rose et al. 2000; Checkley et al. 2000; Cairncross et al. 1993). A study of drinking-water-related outbreaks of acute gastrointestinal illness in the United States by Rose et al. (2000) revealed that 20% and 40% of groundwater and surface water outbreaks, respectively, between 1971 and 1994 were statistically associated with extreme precipitation.

In general, people affected by floods are often apprehensive about the potential and long-term adverse effects of exposure to contaminants and toxic substances that may be present in their homes after clean up. Unfortunately, there are no data that address these concerns (BMJ 2000). This apprehension, however, results in people developing some risk perceptions about flooding and its impacts, which inform measures that are taken by affected people to avert similar occurrence in the future. The inability to assess risk perceptions of people affected by flooding is the cause of the failure of most flood intervention programmes in affected communities (Macri and Mullet 2007).

### 2.3 Overview of natural disasters and hazards in Ghana

Natural disasters in Ghana can be classified into epidemics, floods, droughts, earthquakes and wildfire. These disasters are not new because they date back to colonial times. The first earthquake in Ghana was recorded in 1615 (Amposah 2004). There have also been other major earthquakes after this in 1862, 1906 and 1939. In recent times, the focus of disasters in the country is on three main areas – floods, epidemics and industrial fires. However, the major natural disaster that affects more people in Ghana is flooding.

According to information available on the OFDA/CRED International Disaster Database, flood is second to epidemics in terms of number of occurrence (Figure 2.1) and people killed as a result of disaster (Table 2.2). Over the period 1968-2011, 3,805,017 people were affected by floods in Ghana and 298 people died (Tables 3.1 and 2.2). Even though the 1983 drought affected the entire country and can easily be remembered by most Ghanaians, floods are the most frequent natural disaster in the country. In terms of epidemics, cholera outbreaks, acute watery diarrhoea syndrome and meningitis are the most reported epidemics in Ghana (Table 2.2). These epidemics have also killed 682 people over the reported period with one of the highest deaths occurring in recent times – September 2011. The issue of flooding and epidemics are major concerns that need urgent attention from policy makers to help avert the consequences that come after these events.

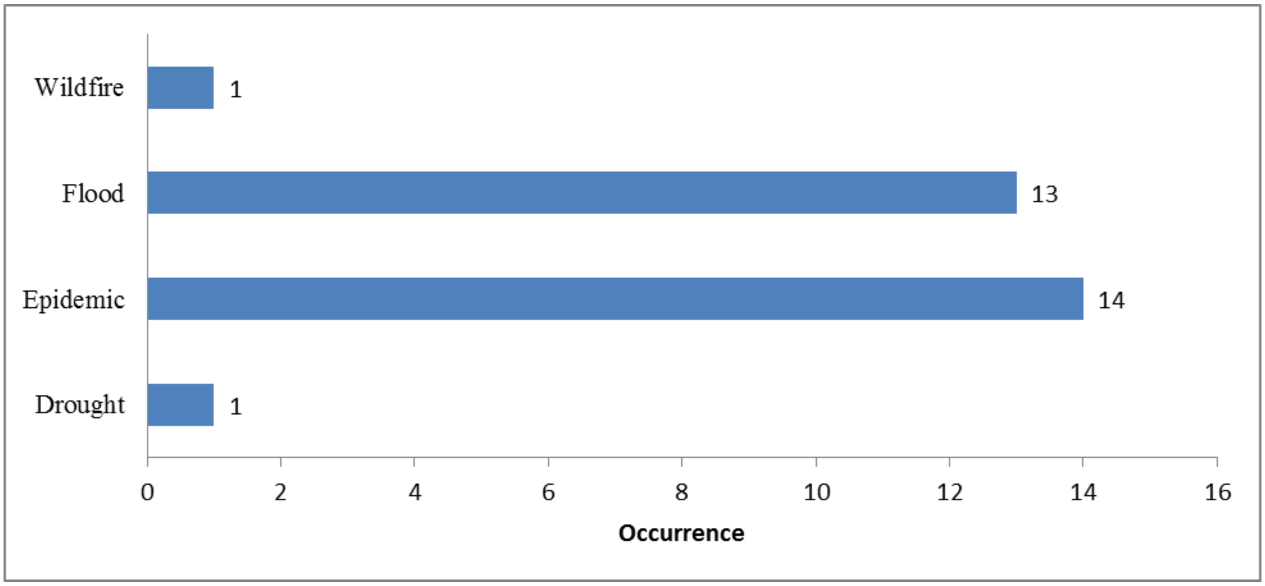


**Figure 2.1 Reported occurrence of natural disasters and hazards, 1980-2010, Ghana**

Source: Centre for Research on the Epidemiology of Disaster (2013), Based on available data from EM-DAT: The OFDA/CRED International Disaster Database, Available at www.em-dat.net Accessed 31 August, 2013.

**Table 2.1: Top Ten Natural Disasters in Ghana for the period 1968 to 2011, sorted by the number of people affected**

| Event | Date | Number of people affected |
|---|---|---|
| Drought | Oct. 1983 | 12,500,000 |
| Flood | 14/07/1991 | 2,000,000 |
| Flood | 5/07/1995 | 700,000 |
| Flood | 10/08/2007 | 332,600 |
| Flood | Sept. 1999 | 324,602 |
| Flood | 27/06/2001 | 144,025 |
| Flood | 17/09/2009 | 139,790 |
| Flood | 26/10/2011 | 81,000 |
| Flood | July 2008 | 58,000 |
| Flood | July 1968 | 25,000 |

Source: Centre for Research on the Epidemiology of Disaster (2013), Based on available data from EM-DAT: The OFDA/CRED International Disaster Database, Available at www.em-dat.net Accessed 31 August, 2013.

**Table 2.2: Top Ten Natural Disasters in Ghana for the period 1968 to 2011, sorted by the number of people killed**

| Event | Date | Number of people killed |
|---|---|---|
| Epidemic | Nov. 1996 | 411 |
| Flood | 5/7/1995 | 145 |
| Epidemic | Feb. 1984 | 103 |
| Epidemic | Sept. 2011 | 101 |
| Epidemic | Oct. 1998 | 67 |
| Flood | 10/08/07 | 56 |
| Flood | Sept. 1999 | 52 |
| Flood | 20/06/2010 | 45 |
| Epidemic | Nov. 2005 | 40 |
| Epidemic | 2010 | 27 |

Source: Centre for Research on the Epidemiology of Disaster (2013), Based on available data from EM-DAT: The OFDA/CRED International Disaster Database, Available at www.em-dat.net Accessed 31 August, 2013.

## 2.4 Causes of flooding in Accra

Recent studies have shown that flooding in Accra is as a result of several factors. These factors have been classified by the National Adaption Committee of Ghana as poor land administration and planning; poor sanitation and lack of drainage maintenance; building on water ways; defective engineering works; tidal influence of the sea; obstructive activities by utility agencies and inadequate funding for flood mitigation. The attempt to address one factor without addressing others may not yield the needed results. The growth of the city of Accra coupled with increased impervious surface has been identified as one of the primary causes of flooding in the city (Rain et al. 2011). In addition, the sanitary behaviour of the people especially with regard to disposal of solid waste has become a major concern. Disposal of solid waste into drains prevents the easy flow of water in the event of heavy rainfall and this usually leads to spill-overs which affect low-lying communities (Rain et al. 2011; Karley 2009). There has also been an increase in slums springing up in different parts of the city which has led to people building on water ways as well as living in deplorable conditions that encourages poor sanitation behaviour (Ministry of Local Government and Rural Development (MLGRD), 2010). The clogging of the Odaw River with household waste is the major cause of flooding in some parts of Accra including the study communities (Adanu 2004).

Globally, the pattern of rainfall has been associated with flood events in several parts of the world (Hashizume et al 2009; IPCC 2007); but the situation in Accra cannot be said to be same (Karley 2009). The increased occurrence of flooding cannot be associated with rainfall because the pattern has not changed much. However, the lack of drainage facilities and the maintenance of the existing drains to collect the storm water for safe disposal is the main cause of recent flooding in the city (Karley 2009). In addition the topography of Accra indicates a low-lying area and some communities have been identified to be flood-prone. The vulnerability of a community to flooding depends on the infiltration rate which is basically determined by the soil characteristics of the area (Nyarko 2000). It was observed that areas below 350 metre contour are prone to flooding in the city. These flood-prone areas are inhabited by people from diverse backgrounds and it is important to assess the capacity of these people to be able to withstand the challenges that are associated with flooding.

**2.5 Environmental hazards, vulnerable population and health outcomes**

The effects of environmental hazards on health are inextricably linked to global development policy and concerns for health equity. The poor in every society have been associated with worse challenges, be it health, environmental, political, etc. Addressing issues of the poor is, therefore, a global priority and has been given much attention in the United Nations Millennium Development Goals. However, raising health status and reducing health inequity will only be reached by lifting billions out of poverty. The question however, is how this can be done if there is not enough evidence on the most vulnerable populations that need this assistance. Environmental hazards have their greatest impact on those who are the poorest in the world because of the difficulty in adapting to changing conditions (Hashizume et al. 2008).

Globally, every continent is vulnerable to the impacts of changes in the environment (IPCC 2001). However, the African continent is highly vulnerable due to its weak adaptive capacity which is linked, among other things, to widespread poverty, inequitable land distribution, conflicts, natural resource management and dependence on rain-fed agriculture (IPCC 2007). The African continent is equally vulnerable to diseases, which are not only limited to environmental factors but also as a result of limited availability of health infrastructure, poor health management policies, insufficient public health education and low access to water and sanitation (Confalonieri et al. 2007). These and other factors have contributed to poor health outcomes in a number of places on the African continent.

Kovats and Akhtar (2008) asserted that the vulnerability of the urban poor is not limited to the physical impacts but also as they often experience increased rates of infectious diseases (including cholera, cryptosporidiosis and typhoid fever) after flooding. There is also evidence of an increased burden of diarrhoeal disease as a result of climate-related hazards and examples have been sighted in India and Bangladesh where there were evidence of flood-related increases in diarrhoea disease (Confalonieri et al. 2007). Urban populations in places where the current burden of climate sensitive disease is high will be disproportionately affected, primarily the urban poor in low-and middle income countries (Kovats and Akhtar 2008). The quality and extent of provision of infrastructure and other services play a significant role in the discourse on the environmental factors affecting the population of urban centres (Bartlett et al. 2008).

Environmental hazard may affect the availability of drinking water to urban populations, particularly in urban centres lacking adequate water resource management. In most urban centres, this is likely to have the greatest effect on household supplies in low-income areas, particularly informal settlements (Rain et al. 2011). The issue of availability of water is compounded by the lack of storage facilities in low income households. Therefore, it is difficult to establish the direct impact of environmental hazards on access to clean water, as a variety of factors – social, political and environmental determine availability (Bartlett et al. 2008).

Few comprehensive assessments on the effect of environmental hazards on health have been completed in low-income and middle-income countries, including Africa (Hashizume et al. 2008). Adverse health outcomes are likely to be greatest in low-income countries and among poor people living in urban areas, elderly people, children, traditional societies, subsistence farmers, and coastal populations (Castle 2002; Pelling 1997). Loss of healthy life years as a result of global environmental change (including climate-related hazards) is predicted to be 500 times greater in poor African populations than in European populations (McMichael et al. 2008). Studies on local environments have, however, shown that insanitary environments are susceptible to poor health outcomes in developing countries (Rahman, et al. 2010; Songsore et al. 1993). Despite these evidences, not much has been researched into how people who reside in poor sanitary environment perceive themselves to be vulnerable to poor health outcomes and how this translates into behaviour change among these populations.

The level of vulnerability of a community to a particular event determines how the community is affected by the event and the resilience of the community to recover from those conditions (Smith et al. 2006). The capacity of developing countries to respond to the negative health effects of environmental hazards relies on the generation of reliable, relevant, and up-to-date information. This is currently lacking in the literature and this work will contribute significantly to providing information on the relationship between flooding and diarrhoeal disease by critically examining the role of households' perceptions in disease incidence in urban poor settings.

### *2.5.1 Environmental hazards and health in Ghana*

In Ghana, the impacts of environmental hazards are being felt in both rural and urban places over the past three decades. In rural agricultural communities, environmental problems have had a major impact on the livelihood of the people by forcing families to adapt to alternative livelihoods such as trading and migration (Tschakert et al. 2010; Codjoe et al. 2011). Recent studies in urban places in Ghana have shown that the urban environment is vulnerable to climate impacts in diverse ways with some health implications (Songsore et al. 2008; Rain et al. 2011). Flooding for instance has become a major concern in Accra and it occurs during both the major and minor rainy seasons (Songsore et al. 2005). Some studies have shown that, the pattern of rainfall in Accra is one of the major causes of floods while others link flooding in the city to some engineering problems such as inadequate drains and increased paving space (Rain et al. 2011; UNEP & OCHA 2011). Generally, there is no empirical study that shows that flooding in Accra is as a result of climate change. It has been proven, however, that the frequency of flooding in the city has increased over the last decade (Rain et al. 2011, Songsore et al. 2005).

Diarrhoeal disease on the other hand has been one of the top ten public health concerns in Ghana over the last two decades. Cholera for instance has become a critical public health concern in urban poor settings. Usually, there is an outbreak of cholera in most urban poor places in Accra at the onset of rainfall almost every year. A reason that has been given for these outbreaks is poor sanitation in the affected districts. These affected districts also experienced high non-cholera diarrhoeal disease (e.g. Ashiedu-Keteke sub-Metropoitan Area of Accra, and Ayawaso sub-Metropolitan Area of Accra) which is also linked to poor sanitation. It has been established that poor handling of food and water during floods could easily lead to contamination (Gerencher 2005). The Ministry of Health, Ghana, and the Ghana Health Service have put in measures to address diarrhoeal related cases in communities in Ghana but it keeps on fluctuating with diarrhoea being among the five top-most reported cases at the out-patient departments in the country.

There have been quite a number of studies on the relationship between the environment and health outcomes in urban places in Ghana (Boadi and Kuitune 2005; Shier et al. 1996; Agbodaze and Owusu 1989). These studies are, however, limited to examining the relationship between a single predictor variable and health outcome; perception of urban residents' vulnerability to environmental hazard and its relation to their socio-economic status and the role of causal agents (e.g. crawling insects and poor sanitation conditions) in the transmission of diarrhoeal disease. The role of environmental hazards on the health of people in urban poor settings has been under-researched. Also, the complex interaction between flooding, risk perceptions and water and sanitation has equally not received attention.

Disasters have generally increased in Ghana because of lack of consistent Government policy on risk reduction (Aboagye 2012). Disasters such floods and outbreaks of cholera are common phenomena in most urban places in Ghana. The environmental quality in urban areas predisposes inhabitants in such places to diseases (Fobil et al. 2011). Poor sanitation condition is usually a major problem and it has been found in a number of studies that the density of refuse dump predicts incidence of diarrhoea in communities (Osei and Duker 2008; Osumanu 2007). Further, it has been established that incidence of diarrhoea is related to the socio-economic status of households (Fobil 2010; Osumanu 2007). Households with low socio-economic status are more likely to be diagnosed with diarrhoea than those with high socio-economic status.

In summary, previous studies in Ghana focused on the physical vulnerability of a place and its relation to diarrhoeal disease. In addition, emphasis was placed on the causes of diarrhoea and diarrhoeal disease related mortality without any focus on how risk perceptions as a result of exposure to environmental hazard influence the dynamics of the disease in households. A community concerned about a particular environmental hazard, determines how people will device various measures to address the situation (Smith et al. 2004).

### 2.6 Overview of risk perception studies

Assessment of risk perceptions is critical in population science and demographic analysis, but this has been scarcely used to motivate a number of researches in this field. Risk perceptions have become an important topic to policy makers concerned with risk management and safety issues (Kellens et al. 2011). Research on risk analyses have generally relied on objective risk measures until recently where subjective risk assessments such as risk perceptions have been recognised as an essential component of risk management (Schanze 2007). Risk perceptions are useful to the understanding of qualitative risk characteristics (e.g., concerns, fears, values, priorities etc.,) of the people (Terpstra et al. 2006; Slovic 1987). In an analysis of public perceptions of flood risk on the Belgian Coast, Kellens and others (2011) found that actual flood risk estimates, previous experience of flood hazards, age and gender of the population are the factors that influence the risk perception of the people.

The first study of risk perception came from White (1945) groundbreaking thesis on human adjustments to floods in the United States. He observed that people's past experience with a hazard directly influence their behaviour because of the fear of the possible effect of the hazard. White, thus, pioneered the research on human dimension of risk in a multi-hazard environment (Bird 2009; Brilly and Polic 2005). Further studies on population perceptions came from the nuclear debate and its effects on human population in the 1960s (Sowby 1965; Starr 1965). Generally studies on risk perceptions in the 1960s had a political agenda on new technologies, especially nuclear technology. As a follow up to these studies, other researches on risk perception a decade later focused on psychological experiments and public surveys which led to the development of theories in this field of study.

There are several schools of thought on risk perception study. These can, however, be grouped into three: ecological, psychological and epidemiological (Brikholz et al. 2014; Liao et al. 2013; Cutter et al. 2008; Slovic and Peters 2006; Alhakami and Slovic 1994). Under each of the school of taught are various disciplines that share a common idea and so most risk perception studies have become interdisciplinary. Most psychological studies in this area were built around the theory of *Affect* (Slovic and Peters 2006) while other geographical and epidemiological studies in the area were conceptualized around the vulnerability theory (Stuart and Susan 2013; Linnekamp et al. 2011; Levy et al. 2006). In each situation, the goal is to identify the population at risk so that policy interventions could be targeted at these populations. Risk in the modern world is generally perceived and acted upon in two ways – risk as *feelings* and risk as *analysis* (Slovic and Peters 2006). Risk as *feelings* is one of the predominant ways of how humans evaluate their risk, which is usually informed by their exposure to a hazard (Alkahami and Slovic 1994). One of the critical ways of helping a population to reduce their vulnerability to a hazard is to first help them understand their risk and how they measure it. Drawing from the theory of affect, which is one of the dual-process theories of thinking; people apprehend reality in two forms. It can be natural, non-verbal and experiential or analytical, deliberative and verbal (Esptein 1994). Both systems of thinking are critical, but the complexity of things that surround human population led to the development of risk assessment tools to better understand the rationality of systems of thinking.

Generally, populations develop risk perceptions about a hazard based on several factors. Keller et al. (2006) found that risk perceptions are influenced by length of time in risk information, previous experience of hazard and affect. They noted that there is usually the tendency to evoke fear in risk communication, which usually lead to increased risk perception among the population. Populations exposed to risk communication for a long time are expected to express high risk perceptions. Previous experience of a hazard is an effective source of people's knowledge and that informs their risk perceptions (Sychareun et al. 2013; Pagneux et al. 2011). There is, however, no correlation between awareness, risk estimation and worry. Thus, individuals' adaptive capacity plays a critical role in the way they assess their risk of a hazard.

In communities where there is high social involvement in activities at the local level, awareness about hazard risk is usually high and people are always willing to take action (Lara et al. 2010). The collective participation of people in community activities is a critical channel in addressing hazard risk in communities.

In addition, people develop risk based on how directly they are affected by a hazard. Arthur et al. (2009) noted that people perceive their risk based on how hazards affect their domestic property. The effects of hazard on public amenities are usually viewed as being less important. However, the impact of hazards on public amenities can have a serious consequence on people. For instance, if a public water pipe line is polluted through flooding, this can have serious effects on households even though households may never factor such things into how they perceive their risk. Also, populations' perceptions on hazard depend on the place of residence of people, solidarity and insurance against the hazard (Brilly and Polic 2005). Populations located in hazard-prone areas are expected to express high risk perceptions, however, such risk are sometimes compensated when people have insurance packages that compensate for their losses during hazards. In such situations, some people prefer to locate in hazard communities.

Also, risk perceptions differences can be found among groups depending on the societal set-up and the culture of the people (Ge et al. 2010). The perception of a group of people who live in hazard-prone environments will be different from societies that rarely experience these hazards. The architectural designs of some localities are made to help reduce the risk of certain hazards. Further, risk perceptions differ by various stakeholders depending on the activities of each stakeholder (Heitz et al. 2006). For instance, risk perceptions among citizens, farmers and counsellors will differ depending on the location of these groups within the catchment. The geographical differences in locations and changes in climate play a critical role in how hazards affect different populations differently (Haque et al. 2012; Hurlbert 2011; Cutter et al. 2008). Sometimes, certain hazards may be perceived by a population as a risk but may not be the most important, or the most severe risk in their lives (Lopez-Marrero and Yarnal 2010). These do happen because of the kind of risk communications that the people are exposed to.

In recent times, risk communication has become an important tool for helping hazard-prone communities to prepare for hazards. Communicating hazards risk to populations is essential to help them prepare for hazards, but providing them with precautionary measures they could employ to avert the situation is the best way to help people reduce their risk against hazards (Grothmann and Reusswig 2006). However, personal experience of natural hazards and trust or lack of trust in authorities and expert have the most substantial impact on risk perception. Cultural and individual factors such as media coverage, age, gender, education, income, and social status do not play such an important role but act as mediators or amplifiers of the main causal connections experience, trust, perception and preparedness to take protective action (Wachinga et al. 2013).

Risk perceptions determine the actions that people take. It is, however, difficult to tell which risk perception measure best predicts the actions of people. In a study of seasonal influenza vaccination among healthy Chinese adults in Hong Kong, Liao and others (2013) found that beliefs about risk and feeling at risk among Chinese adults in Hong Kong are well differentiated. Feeling at risk, an affective cognitive dimension of risk predicts subsequent vaccination better than do probability judgment. Four scales were used in assessing probability judgment and the seven-point verbal scale offered the best predictive factors for subsequent vaccination up-take. Both cognitive and affective mechanisms influence citizens' preparedness intentions. In line with the affect heuristic, both positive (e.g., solidarity) and negative emotions (e.g., powerlessness) are related to previous hazard experiences (Terpstra 2011). Risk perception is found to be a mediating factor between hazard proximity and property value, although the relation might be partial rather than complete. Hazard proximity can act as a potential risk and an environmental amenity at the same time. These two perceptions operate in opposite directions when affecting housing value (Zhang et al. 2010).

Kellens et al. (2013) in a systematic review of empirical research on perception and communication of flood risks found that majority of the studies on risk perceptions are exploratory and most of them are not based on theoretical frameworks available in social science. As a result, a methodological standardization in measuring and analysing people's risk perceptions and their adaptive behaviours is hardly present. This notwithstanding, risk perceptions have played a critical role in informing policy and also, helped in the design of programmes to reduce the vulnerability of populations to a hazard (Sychareun et al. 2013; Zhang et al. 2010). There is, however, the critical issue about, which measure of risk perception is the best for identifying populations at risk of hazard. It is not also clear as to which theoretical frameworks in social science best explains the risk perceptions of people to hazards.

## 2.7 Theoretical approaches employed in examining the relationship between environmental hazards, public risk perceptions and health

Previous research on diarrhoeal morbidity focused on the biological agents and the environmental factors that trigger it (Osei and Duker 2008; Agbodaze and Owusu 1989) with very little attention on a host of social factors that play critical roles in this relationship. In recent times, studies on environment-health relationship have begun to consider the social factors that influence this relationship (Fobil et al. 2011; Fobil et al. 2010). As a result, the vulnerability assessment theory, which was employed in a number of environmental studies to examine the vulnerability of a system to a number of environmental hazards without necessarily relating it to other secondary outcomes is currently being merged with some social theories. The framework for examining the relationship between climate change and health by Patz (2005) has elements of both the vulnerability theory and a number of social indicators. In this study, the discussion is focused on flooding and its relationship with diarrhoea. As a result, a number of social indicators that measure the risk of people to an event were incorporated into the vulnerability assessment theory in examining the issues.

Vulnerability is the degree to which a system is or can be susceptible to or unable to cope with adverse impacts of hazards (IPCC 2001). There are various terminologies that are used in the literature of vulnerability such as risk, hazard, exposure, sensitivity, adaptation, adaptive capacity, resilience and coping strategies (IPCC 2001; Tapsell et al. 2002; Adger et al. 2002; Burton et al. 2002; Brooks 2003; Westerhoff and Smith 2009). Thus, vulnerability is a function of exposure of people to the impact of climate change which is influenced by their level of resilience to reduce the level of exposure. An individual or household is vulnerable to flooding if the risk will result in a loss of wellbeing where the individual or household is unable to cope (Heltberg and Bonch-Osmolovskiy 2011). Vulnerability is a function of exposure, sensitivity and adaptive capacity (Ford et al. 2006; Fay et al. 2010), and it occurs when there is inadequate interaction among various stakeholders (Community members, central and local government, community based organisations etc.) to map a strategy to reduce the impact of a hazard.

The vulnerability level of communities to flooding have been examined in a number of studies (Rain eat al. 2011; Ludlow 2009; Cutter et al. 2008; Nyarko 2000; Pelling 1997). As a result, most government agencies, planners and policy makers have an adequate perception and understanding of flooding but many people do not. The public knowledge of flooding, anticipation of future flooding and the willingness to accept adjustments caused by hazards are highly variable (Tschakert et al. 2010; ILGS & IWMI 2012). Residents in hazard locations often have other issues that assume priority and so do not dwell on the risk of the hazard (Cutter et al. 2008).

The health effect of flooding is complex because flooding is just one of the several factors that affect health. The effect of demographic, economic and social factors on health requires a critical investigation to be able to understand the true effect of flooding on diarrhoea. It is also complex to distinguish between individuals for whom flooding is the sole cause of diarrhoeal disease from those who were diagnosed with diarrhoea as a result of other factors. Further, it is difficult to distinguish the risk perception of diarrhoea resulting from experience of flooding from other risk perceptions people develop in urban poor communities. Nonetheless, exposure to hazard is critical in examining the health effects of hazards. Being exposed to the hazard places people at high risk of the consequences that are associated with it than those who have not been exposed (Yanal 2007; Pelling 1997). However, exposure alone may not trigger change in behaviour among the population if they do not perceive themselves at risk of the event.

Risk perceptions are developed based on the level of a population's exposure to hazards (Cutter et al 2008). Exposure is defined to include the location of the population, the infrastructure development and the composition of the population. The exposure level of a system, however, depends on the sensitivity of the system to the hazard. Indicators that define the sensitivity levels of households to hazards are income, level of education, household size, etc., (Adger 2006). These indicators, however, do not include risk perception of people, which has been incorporated in this study. The level of exposure and sensitivity can be reduced by household level of adaptive capacity, which includes things that are done in households to reduce their vulnerability to the hazard such good hygiene practices and water purification.

Generally, public risk perceptions are critical components of the socio-political context within which policy makers operate. Public risk can compel or constrain a political, economic and social action to address a particular risk. The sustainability of any climate-related policy will depend on public perceptions of the risk and how it is affected by climatic hazards (Alhakami and Slovic 1994).

**2.8 Conceptual framework**

It has been established that extreme precipitation and temperature have wide-ranging effects on health (Campbell-Lendrum and Corvalán 2007). There have equally been a number of studies on the trend of extreme rainfall and temperature in recent times, and their impact on human health (Haines et al. 2006; Patz et al. 2005; Haines and Patz 2004). Further, the attempt to examine the trend of precipitation and temperature in isolation of global environmental change has been addressed since changes in precipitation and temperature have been related to changes such as population growth, urbanization and land use changes, which also have effects on health (Haines and Patz 2004). Thus, it is clear that other global changes can amplify the effect of precipitation and temperature on human health.

The relationship between risk perceptions of diarrhoea resulting from flooding and incidence of diarrhoea could be explained using a socio-ecological framework. This is because diarrhoea is affected by multiple factors that make it difficult to establish the effect of one factor on it. The socio-ecological model provides a useful framework for achieving a better understanding of the multiple factors and barriers that impact on a disease, and, therefore, can provide guidance for developing culturally appropriate and sensitive intervention strategies for specific populations. It is an integrative framework that provides a better understanding of complex health relationships by examining an issue at multiple levels. It incorporates the social and environmental context within which behaviours are formed to address issues in communities. It assumes that behavioural influences have greater impact on disease than the physical environment. Also, disease incidence is dependent on where and how one chooses to live.

Improving the health of vulnerable people requires a better understanding of the risk perceptions of the people. The risk perceptions of households to a disease as a result of environmental events will determine the actions they will take to avert the situation. Interestingly, not much attention has been paid to the relationship between environmental hazards and the risk perceptions people develop about diseases. Other studies that examined the relationships between climatic events and health employed either the vulnerability theory or the socio-ecological model (Cutter et al, 2008; Robinson, 2008).

The vulnerability theory for instance has been used in assessing people's vulnerability to environmental hazards as well as some health conditions. The method has been used because it embraces three main components (exposure, sensitivity and adaptive capacity) in assessing people's vulnerability to an event (Cutter et al, 2008). It is a better model for examining vulnerability at the community level than at the individual level. The socio-ecological model on the other hand examines issues at both the individual level and beyond. It has been applied in health promotion programmes that incorporate social factors in examining individual's vulnerability to an event. It, however, does not have a robust assessment of the vulnerability of a place to an environmental event which is the strength of the vulnerability theory. Combining the two approaches provides a robust approach to the study. This is because, the study focuses on the effects of risk perceptions in flooding-diarrhoea relationship in urban poor settings which, requires a special approach. There are several problems confronting urban poor dwellers and flooding is just one of them. These problems trigger some perception among people residing in these settings. The effects of flooding, therefore, add to the existing perceptions and it is important to consider these in examining the determinants of diarrhoea diseases in urban poor communities.

Figure 2.2 suggests that household experience of flooding has a direct relationship with diarrhoeal disease. This is because, the bacteria that causes diarrhoea becomes active during flooding (Patz et al, 1995). Also, the risk perception of households resulting from exposure to floods has a direct relationship with incidence of diarrhoea. Normal floods in some regions are good for agricultural purposes, but a problem in other regions, which leads to loss of human lives and property.

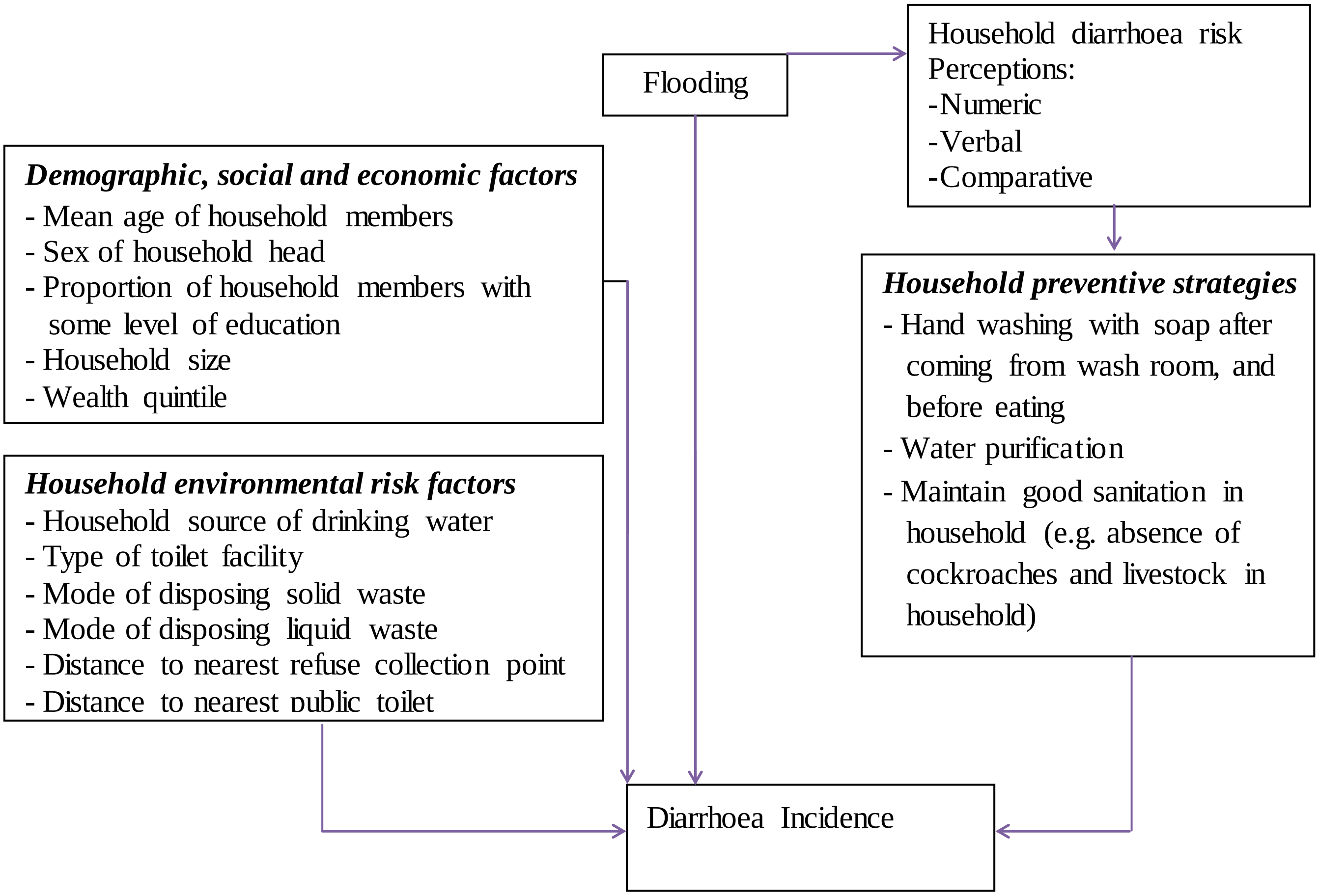


**Figure 2.2 Relationship between flooding and diarrhoeal disease**
Source: Author's construct, 2013

The vulnerable nature of urban poor environments to flooding and diseases including diarrhoeal disease will trigger households that live in flood-prone communities to develop a kind of risk perception for diseases that will invariably inform their actions. Risk perceptions are measured in several ways but the most common measures of risk are the numeric, verbal and comparative risk perception measures (Levy et al. 2006). Each of these risk perception measures determine whether a household will perceive itself at high or low risk of an event. Recent increase in flood incidence in the study communities coupled with increase in incidence of cholera and non-cholera diarrhoea in the area will result in various risk perceptions about diseases in households. These risk perceptions that are developed as a result of the increased climatic hazard informs how households will respond to preventive messages and also take actions to avert the health consequences of such hazards.

However, the most direct response to changing health risks arising from environmental events consists of policy measures and coping strategies that reduce risk and increase resilience of populations that are likely to be the most affected. Such measures are generally most effective if they are embedded in broader development plans, e.g., safe water supplies and waste disposal systems, disease surveillance and response programmes, and disaster and emergency risk-reduction and response systems. At the household level, personal hygiene such as washing of hands with soap before eating, after visiting the toilet, etc., are important measures for addressing disease transmission. Hand washing with soap helps to protect the population from diseases such as diarrhoea. In Ghana, a policy programme on hand washing with soap has been implemented by the Community Water and Sanitation Agency in collaboration with the Ministry of Health. Currently, there is some public-private sector partnership in this programme in Ghana aimed at preventing diarrhoea among the population. Also, because households in urban poor communities live in deplorable condition, it is expected that population in these settings will purify their water before drinking and also maintain good sanitation at home to avoid disease infections. The presence of cockroaches in household has been used to measure the level of sanitation in households because the bacteria that causes diarrhoea lives in cockroaches (Tachbele et al. 2006; Agbodaze and Owusu 1989). Also, the presence of livestock in households facilitates diarrhoea transmission by contaminating household food and water. These livestock may defecate around in the household and make it difficult to maintain good sanitation. Households that maintain good sanitation by eliminating cockroaches and also do not keep livestock are expected to report less incidence of diarrhoea compared to households who keep livestock and have poor sanitation.

Diarrhoeal disease is influenced by a number of other factors that have been indicated in Figure 2.2 as control variables. The socio-demographic characteristics of a household, water and sanitation situations, and environmental risk factors of the household are important determinants of diarrhoea in the household. These control variables are relevant to this study for various reasons. Firstly, the mean age of household members determines how vulnerable a household is to diarrhoeal disease in the event of flooding. Households that have more children under five years will have a low mean age while households that have majority of household members above age 50 years will have a high mean age. Households that have more children and older persons are more vulnerable to diarrhoea because of their weak immunity compared to those that have majority of their members in their youthful ages. Also, during disasters like flooding, it is difficult to protect children and the aged from infections. In addition, this is the same group of people that are more susceptible to diseases after the flooding. The sex of the head of the household determines how much resources are available to the household in the event of flooding. Male-headed households generally have access to more resources than female-headed households and so are able to opt for better options for members in the event of a disaster. Female-headed households are more likely to be located in vulnerable areas in the community that will make their members more vulnerable to diarrhoeal disease than those in male-headed households.

In addition, the proportion of household members with some form of education helps the household to make informed decisions in the event of flooding to protect members from the health effects of it. All things being equal, households with a higher proportion of members with some form of education are expected to be knowledgeable than those with majority of the members having no education in times of flooding because education provides people with a lot of options in times of difficulties. Also, household size determines how the household is able to cope in the event of flooding. The larger the household size, the more vulnerable they may be compared to smaller household size in times of a disaster because the needs of larger households will be more difficult to provide for compared to smaller ones where a few people have to be attended to. The wealth status of the household also plays a critical role as to whether the household will be involved in acts that will make them more vulnerable to diarrhoea in the event of flooding. Households in the rich and richest wealth quintiles are expected to have their own home water closet toilets and also handle household refuse properly to avoid contamination with household food and water compared to households in the poor and poorest wealth quintiles who have to share sanitation facilities with other members of the community.

Secondly, household source of drinking water is an important predictor of incidence of diarrhoea. Households that have piped water into their dwelling are less likely to have their water contaminated and as a result will register low incidence of diarrhoea than those whose source of drinking water is from a public tap or those who drink “sachet”/bottled water. “Sachet”/bottled water have been found to cause diarrhoea because most of them are not properly regulated and they are produced under poor hygienic conditions (Dodoo et al. 2007). In terms of toilet facilities, households that use public toilets are more likely to be infected with diarrhoea than those who use water closet toilets at home. Also, the use of pit latrines predisposes households to diarrhoeal disease compared to those who use public water closet toilets. The mode of disposing household solid and liquid waste could also pose serious health problems to its members. In situations where household solid waste is disposed through unimproved methods such as indiscriminately disposing waste into community drains, it poses serious health risk to households in the event of flooding because the waste may pollute household water and food. Some of the improved methods of disposing solid and liquid waste are having solid waste lifted at home by a waste management company and disposing liquid waste into septic tanks. Also, unimproved disposal of liquid waste in the community exposes children in the community who play on the ground to disease infections. Households that adopt improved methods of disposing solid and liquid waste are less likely to have diarrhoea incidence than those who use unimproved methods.

Finally, the distance of households to the nearest refuse collection point or the nearest public toilet predisposes households to diseases. The sanitation condition around public refuse collection points is poor and households who reside closer to them are expected to have poor health conditions because of the pollution from the waste collection points. Also, household that reside closer to public toilets are expected to report more incidence of diarrhoea because of their proximity to the public toilet compared to those who reside far away from it. However, due to the upgrading of most public toilets from the Kumasi Ventilated Improved Pit (KVIP) to water closet ones, household proximity to a public toilet may not cause incidence of diarrhoea if the toilet is well maintained.

The influence of risk perceptions on the relationship between flooding and diarrhoea will be robust when these variables are controlled.

### 2.9 Hypotheses

i. There is a positive relationship between flooding (extreme rainfall) and diarrhoea incidence in Ashiedu-Keteke sub-Metropolitan Area of Accra.

ii. Households that have a high numeric risk perception of diarrhoea score are more likely to report diarrhoea incidence than those who have a low numeric risk perception score.

iii. Households that stated a very high verbal risk perception of diarrhoea are more likely to report diarrhoea incidence than those who stated very low verbal risk perception.

iv. Households that stated a much higher comparative risk perception of diarrhoea are more likely to report diarrhoea incidence than those who stated a much lower comparative risk perception.

v. Households that have pipe into their dwelling as their main source of drinking water are less likely to report incidence of diarrhoea compared to those who drink "sachet"/bottled water.

# Chapter Three

## Study Area and Methodology

### 3.1 Study Site

James Town and Agbogloshie have been chosen for this study for various reasons. The communities are among the most endemic areas of diarrhoeal diseases in the Greater Accra Region over the past 15 years. Within this period, Accra experienced seven episodes of floods (1995, 1997, 2001, 2002, 2007, 2009 and 2011). One of the most affected areas of the 1995 floods included Agbogbloshie (Sam 2009). The population density of the two communities exceeds 25,000 persons per $km^2$ compared to an overall average of 6930 persons per $km^2$ in the Accra Metropolitan Area (Ghana Statistical Service, 2005a; 2005b). They are both urban poor settlements with James Town predominantly inhabited by indigenous Ga and Agbogbloshie by migrants. The two study communities are located in the Ashiedu Keteke sub-Metropolitan Assembly in the Accra Metropolis. The two communities have physiographic features that offer the opportunity to examine the impact of flooding on diarrhoeal disease in urban poor settings. Of the two communities, *James Town* has a larger portion of paved area but the drainage channels in the community are small. As a result, rainfall infiltration is impeded and runoff removal is slow. Furthermore, the *James Town* community is located at the mouth of the Odaw River that drains Accra into the sea. This combination of features results in frequent flooding of the community.

The *Agbogbloshie* community on the other hand, is an unplanned community with inadequate drainage channels, poor sanitation and poor housing infrastructure. The community has also, received very little attention from government because of prolonged contestations between the Ghana Railway Company and the inhabitants of the place about who is the rightful owner of the place. It is located close to the major drainage of Accra that connects to the Odaw River, which empties into the sea. Due to the impeded flow of the Odaw River and poor drainage often aggravated with indiscriminate solid waste disposal, there is frequent spill-over of water from the Odaw River over its banks into the *Agbogbloshie* community. Generally, the *Agbogbloshie* land site is marshy and a wet-land and, therefore, inappropriate for human settlement.

According to a UN Habitat Report (2011), the two study communities are flood-prone areas in Accra. They are slums and have few drainage systems. Figure 3.1 is a map indicating the boundary of Accra and communities that are vulnerable to flooding including the two study communities.

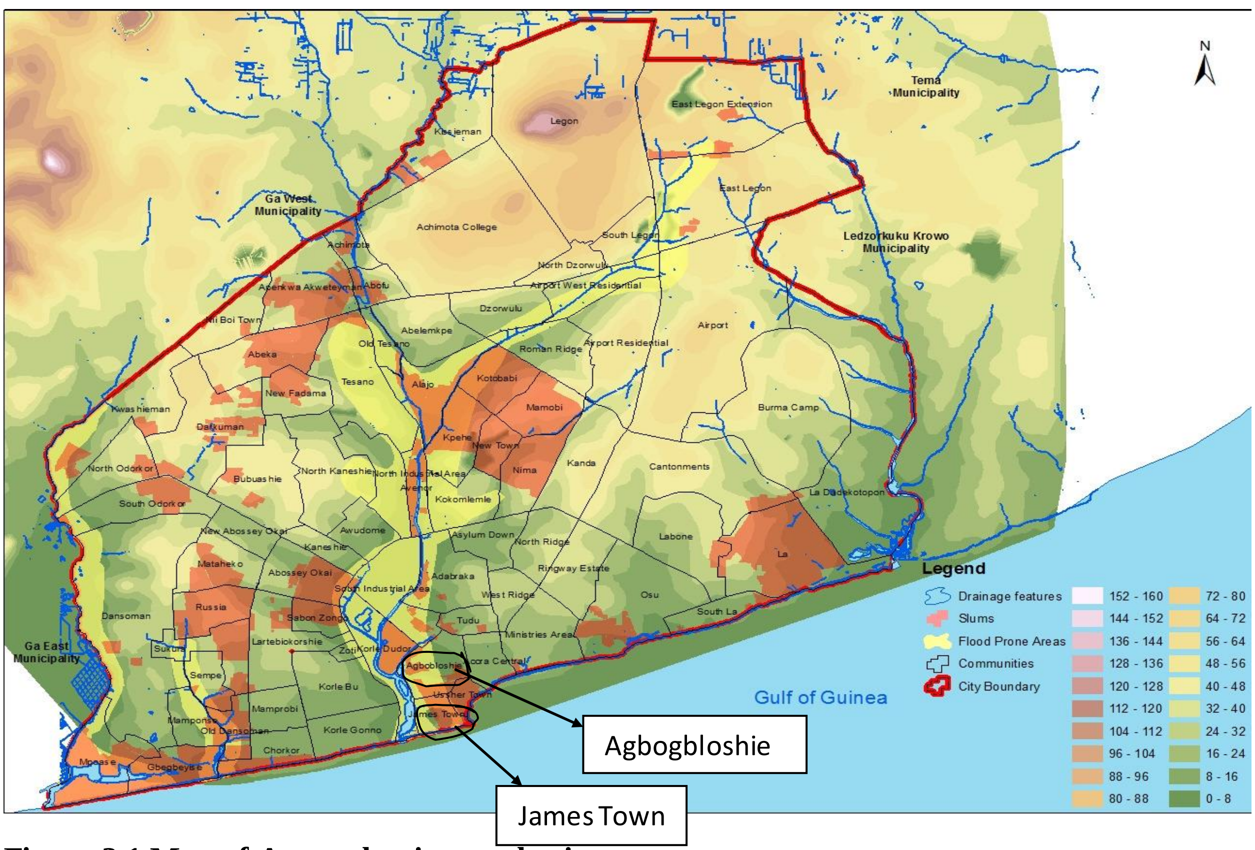


**Figure 3.1 Map of Accra showing study sites**
Source: UN Habitat 2011

### 3.1.1 Biophysical Vulnerability of Study Communities to Flooding and Diarrhoeal Disease

*James Town* and *Agbogbloshie* as indicated in Figure 3.2 are located in places in the city that are vulnerable to flooding as a result of channel overflow. Due to the unplanned nature of *Agbogbloshie* coupled with unavailability of minor drainage connecting to the major drainage, the community experiences more flooding than the *James Town* community. The principal streams that drain the major urbanised area of Accra including *Agbogbloshie* and *James Town* are the Odaw River and its tributaries. The clogging of the channels of the Odaw River with refuse is one of the causes of flooding in the study communities (Adanu 2004). The overflow volume of the Odaw River in *Agbogbloshie* is 30-67 ($m^2/s$) while that of *James Town* is 210-437 ($m^2/s$). This implies that *James Town* is more prone to the Odaw River overflow than *Agbogbloshie*. However, because of the poor maintenance and clogging of the main drainage of Accra that passes through the *Agbogbloshie* community that connects with the Odaw River, the community experiences more flooding than the *James Town* community.

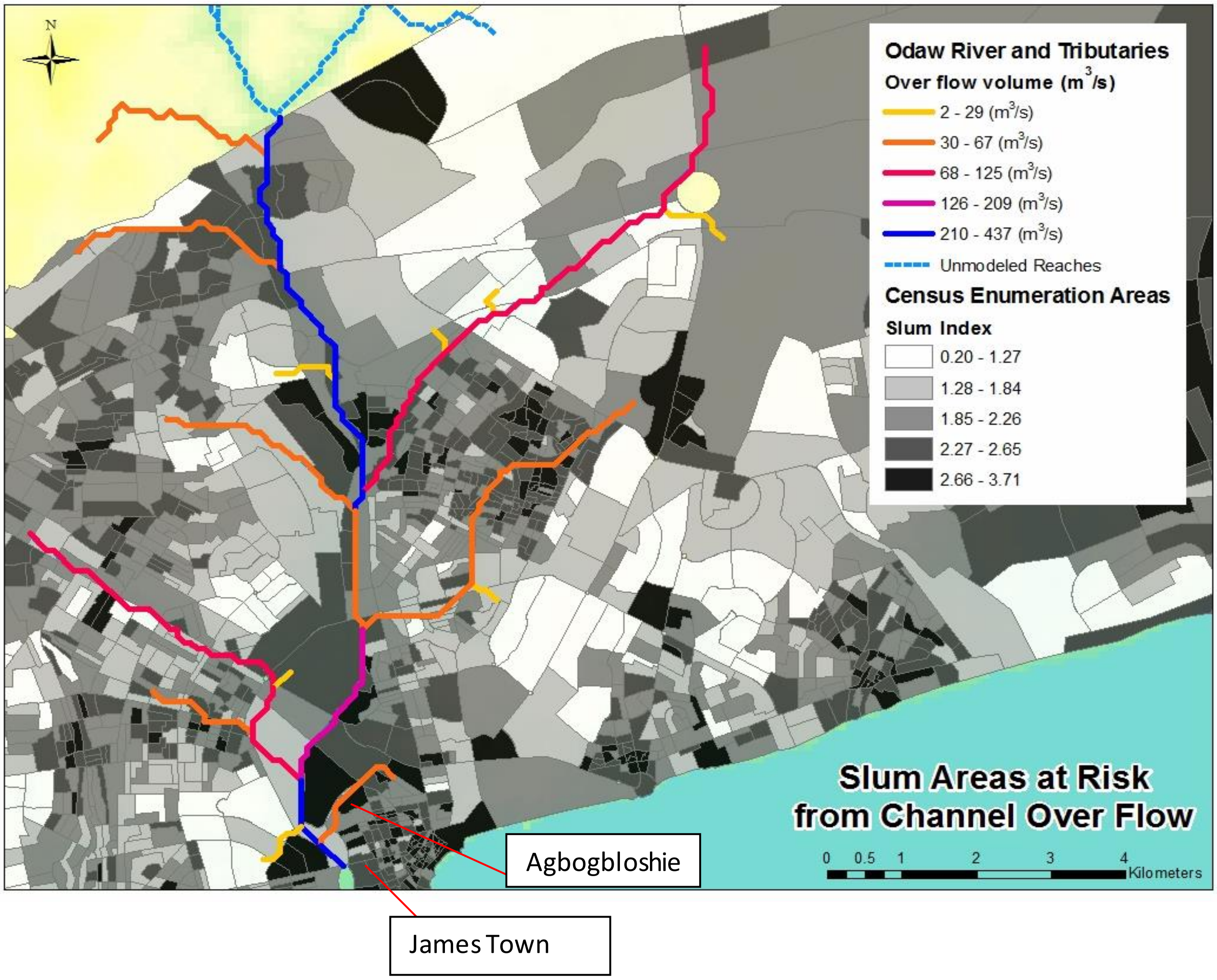


**Figure 3.2 Slum Areas in Accra at Risk from Channel Overflow**
Source: Ludlow 2009

### 3.2 Sources of data

Data for the study are from three sources. First, a time-series data on rainfall (1980-2010) in the Ashiedu Keteke Sub-Metropolitan Assembly from the Ghana Meteorological Service Department is used to determine flood frequencies during the 30 year period. Flood occurrence was defined as rainfall exceeding 59mm in the study communities because this was the least amount of rainfall that triggered flooding in the area. In addition, data on cholera and non-cholera diarrhoeal disease from the Centre for Health Information Management (CHIM) of the

Ministry of Health, over the same period are used to examine the trend of diarrhoea incidence in the sub-Metropolitan Area. These two sets of data are used to explore the relationship between flood events and diarrhoeal disease occurrence in the Ashiedu-Keteke sub-Metropolitan Area. It also helped to determine at the district level whether flooding predicts diarrhoeal disease before proceeding to a household level analysis.

Second, a household survey was conducted in the two study communities, namely, *Agbogbloshie* and *James Town* to incorporate risk perceptions of diarrhoea in the flooding – diarrhoeal disease nexus. The time period of interest was the first four weeks after the October 26, 2011 flooding of Accra. The survey instrument was administered to household heads in the study communities. In all, 401 households were interviewed in both communities (202 from *James Town* and 199 from *Agbogbloshie*).

**3.3 Sampling Methods**

The study was located in two of the field sites of the Regional Institute for Population Studies (RIPS), University of Ghana. Following on previous surveys done in the communities in 2011 during the EDULINK[1] Survey by RIPS, a sampling frame from the study was used to select participants for the study. A total of five enumeration areas (EAs) from *Agbogbloshsie* and nine (9) from *James Town* were chosen for the study. These EAs were used because RIPS had already established itself in these EAs providing prior knowledge about the culture and the geography of the area. These EAs are also representative of the study communities.

[1] EDULINK is an urban health and poverty project that is conducted at the Regional Institute for Population Studies. The aim of the project is to link research to communities. RIPS currently use James Town, Ussher Town and Agbogbloshie as its study sites. So far, three rounds of data have been collected in these communities since 2010. The sites are also used as population training and research capacity for students at RIPS.

The selection of households for the study was based on a simple random sampling from household list provided by RIPS in EDULINK research in 2011. There were more sampling in the EAs in *Agbogbloshie* as compared to that of *James Town* because of the larger number of EAs in *James Town*. Approximately, 40 households were targeted for each of the EAs in *Agbogbloshie* and so a total of 200 households were sampled. In *James Town*, on the other hand, a total of 25 households were targeted for each EA and a total of 225 households were sampled. In all, 199 households were interviewed in *Agbogbloshie* and 202 households were interviewed in *James Town* making a total of 401 households in both communities. The response rate in the study area is approximately 94 percent.

### 3.4 Data collection and management

Structured questionnaires were used to query the general characteristics of households such as age and sex of the members of households, household size, educational level, assets, experience of flooding, being diagnoses of diarrhoeal disease in the last 12 months preceding the survey, perceptions about flooding and diarrhoeal disease, source of drinking water, sanitation and hygiene issues. A sample questionnaire is provided in Appendix A. The questionnaire was administered to household heads. The administration of the study instrument was done by the researcher and three research assistants who were trained as community facilitators on the climate change and human health project in the study communities. The climate change and human health project was a three year project conducted by the Regional Institute for Population Studies with funding from the International Development Research Centre (IDRC), Canada. The researcher was provided funding for the research under the project. All the three research assistants were recruited from the study communities and that helped in data collection. They were given two days training on the research instrument prior to the data collection in the communities. The researcher has also worked in the study communities for over four years and had established a good rapport in the communities. As a result, the selected households for the study did not express any difficulty in providing information to the team of data collectors. Data collection was done in two local languages (*Ga* and *Twi*) that are widely spoken in the study communities. The interviewers visited the selected households in their homes and administered the questionnaire to them.

The data collection lasted for a period of two months - beginning from the third week of September, 2012 and ending in the second week of November, 2012. The management of the data was done by the researcher. First, a data entry screen was designed using CsPro. All the data entry was done by the researcher. After the entry, the data was exported into Stata 12. Data cleaning was done in Stata and all other analyses were equally done in Stata.

## 3.4 Description of Variables

### *3.4.1 Dependent Variable*

The dependent variable is whether any member of a household was diagnosed with diarrhoeal disease in the first four weeks after the October 26, 2011 flooding in Accra or not. Household incidence of diarrhoeal disease was measured as a dichotomous variable - whether a member in a household was diagnosed with diarrhoeal disease during the period under investigation or not (Appendix A).

### *3.4.2 Independent Variable*

The independent variable for the study is household experience of the October 26, 2011 flooding in the study communities. Experience of flooding in this sense was defined as a household being located in the community and also being present on October 26, 2011 when the flooding occurred. In order to distinguish between households that had experienced the flooding and those that did not, information on the year and the month in which households experienced flooding was collected (Appendix A). Some households did not experience the flooding in the community because they are located on elevated areas in the community while others experienced the flooding because they are located close to the lagoon, sea, main storm drain or reside in low lying areas of the community.

***3.4.3 Mediating Variables***

The mediating variable in the study is household perceived risk of diarrhoea as a result of experience of flooding. Household risk of diarrhoeal disease was measured using three different scales: numeric, verbal and comparative. Numerically, households were asked to rate the chance of members of their households being diagnosed with diarrhoea as a result of heavy rainfall on a 0% to 100% scale. A score of 0% means no chance of diarrhoeal disease while 100% indicates a definite incidence of diarrhoea in household. There is no gold standard for cutoffs in the literature. Using a cutoff of 40%, the numeric was categorised into five age groups to put it on an equal scale of measurement as the other measures. All households with a score of 40% and above were classified as households perceived to be at high risk of diarrhoea while those with scores below 40% were classified as low risk. The 40% cutoff was arrived at through series of iterations to determine the probability levels at which individuals will classify themselves to be at high risk or not. In clinical studies, a 10% numeric probability of a disease outbreak in an area will qualify the area as high risk zone. In social science, however, where most of the measures are based on subjective views of the respondent, the application of iterations to arrive at such cutoffs is the most appropriate approach (Levy et al. 2006).

The verbal scale had five descriptive categories (very low, moderately low, neither high nor low, moderately high and very high), and the comparative scale also had five categories (much lower, lower, about the same, higher and much higher) (Appendix A). Each of these scales was examined to ascertain how they influence the flooding and diarrhoeal disease nexus.

### *3.4.4 Control Variables*

In order to examine the true strength of each of the other variables on diarrhoeal disease, it was important to control for the effect of other variables. These include household preventive strategies, socio-demographic characteristics, water and sanitation, and environmental risk factors. Household preventive measures include hand washing with soap before eating and after visiting the wash room, purification of water before drinking, and maintaining good sanitation (absence of cockroaches and livestock in household). These household preventive strategies are developed based on households' risk perceptions of diarrhoea resulting from flooding.

With regard to water purification the study investigated whether as a result of suspicions that the households might have about the source of drinking water, they purify it before their members use it. This is measured as a dichotomy (yes=1, no=2). Also, some hygienic practices in household that could easily lead to food contamination were examined. Household hygiene practices such as washing of hands with soap before eating and after visiting the toilet were investigated. There has been several "hand wash" programmes in developing countries aimed at increasing awareness towards good hygiene (Saade et al, 2001). In addition, the presence of livestock like sheep and goats, and the number of times cockroaches are seen in household in the past seven days preceding the survey were also used to assess household sanitary condition. Livestock are known to carry the bacteria that cause diarrhoea in their droppings and their presence in household could lead to contamination with household water and food. Cockroaches are also known to be carriers of the bacteria that causes diarrhoea and their frequent presence in households could lead to diarrhoeal disease incidence (Agbodaze and Owusu 1989). Household preventive strategies such as presence or otherwise of livestock in household, washing of hands with soap before eating and after coming from wash room are measured as a dichotomy (yes=1, no=2). The presence of cockroaches in households is measured as follows: First, households that have never seen cockroaches in their households in the last seven days preceding the survey is an indication of good sanitation in household. Second, households that have seen cockroaches 1-3 times, indicating that they reside in locations where other neighbours do not keep their environment clean, even though, they do. Third, households that have seen cockroaches 4 times or more reside in poor sanitary environment and also do not keep their households clean. The argument in this thesis is that, households' measure of diarrhoeal disease risk informs actions that are employed by the households to address the situation which ultimately have implications for incidence of diarrhoea in the households.

Household socio-demographic characteristics such as mean age of household members, sex of household head, proportion of household members with some form of education, household size, and wealth quintile are factors that have been found in literature to affect diarrhoea incidence (Black et al. 2010; Fobil et al. 2010; Hashizume et al. 2008; Osumanu 2007; Hashizume et al. 2007). Age is measured as a continuous scale in years in the model, sex is measured as a categorical variable (male=1, female=2), proportion of household members with some education is measured as categorical (no member had education=1, less than 50% had education=2, 50% and above had education=3, all members had education=4), household size is treated as a continuous scale in the model, and wealth quintile is measured as a categorical variable (poorest=1, poor=2, middle=3, rich=4, richest=5).

Also, household water and sanitation are critical factors in examining factors that affect diarrhoea incidence. It has been established that household source of drinking water is a significant predictor of diarrhoea incidence (Hashizume et al. 2008; Dodoo et al. 2007).

Household source of drinking water is measured as a categorical variable (piped into dwelling=1, piped into yard=2, public tap/stand pipe=3, "sachet"/bottled water=5). The type of toilet facility that is used by the household is also examined as a control variable that predicts diarrhoea incidence. Type of toilet facility is measured as categorical (bucket pan/pit latrine=1, WC/flush toilet=2, KVIP=3, public toilet=4). Other household sanitation variables that were examined are mode of disposing household solid and liquid waste.

Mode of solid and liquid waste disposal of the households was categorised into improved and unimproved methods based on World Health Organisation (WHO) classifications (2006). The improved sources of disposing solid waste are: availability of refuse bins or containers collected regularly by public or private companies. The unimproved means of disposing solid waste are: using the services of truck pushers (*kaya bola*), indiscriminate disposal of waste especially into community drains. In the case of liquid waste, the improved method is disposal into septic tank and the unimproved liquid waste disposal methods are backyard deposition and indiscriminate disposal of liquid waste into drains.

Epidemiologically, it has been established that environmental risk factors such as distance to nearest refuse collection point and distance to nearest public toilet are significant predictors of diarrhoeal disease (Osei and Duker 2008; Songsore et al., 2006; Boadi and Kuitune, 2005; Agbodaze and Owusu, 1989). The distance to the nearest public toilet or nearest refuse collection point was measured as households that live within less than 50 metres or more than 50 metres from these service points. This 50 metres threshold was based on WHO norms (WHO, 2006).

### 3.5 Analytic Approach

The data for the study were analysed through multiple approaches. Firstly, rainfall and diarrhoea incidence data were presented to show years and months of high and low rainfall and incidence of diarrhoea as well as trends of rainfall and diarrhoea in the Ashiedu-Keteke sub-Metropolitan Area. Correlation analysis and Granger causality test were used to explore the relationship between flooding and diarrhoeal disease incidence in the Ashiedu-Keteke sub-Metropolitan Area of Accra. The correlation was used to establish association between flooding and diarrhoeal disease while the Granger causality test was used to predict the effect of flooding on diarrhoeal disease. Granger causality operates on the principle of stationary data. As a result, Dicky-Fuller test was used to test how stationary the rainfall and diarrhoea data were before proceeding to Granger causality test.

Secondly, the survey data were analysed by means of univariate descriptive statistics to describe the variables of interest in the study. Also, a bivariate analysis between the dependent variable and the mediating and the control variables was done to find the statistical associations between the variables. A chi-square statistical test was employed to examine the statistical association between the dependent variable and the independent variables.

In addition, the three risk perception measures of diarrhoea that were postulated to mediate the flooding-diarrhoeal disease nexus were validated to ensure that they do not explain the same construct. In order to do this without biases in the analysis, the validity of the verbal, numeric and comparative measurements of risk perceptions of diarrhoeal disease were assessed. First, the traditional categories of construct validity was used focusing on convergent validity (the degree to which each measure correlates with other measures of the same construct), discriminant validity (the degree to which each measure does not correlate with measures of different constructs), and predictive validity (the relationship between the measure and the criterion it is supposed to predict). Convergent validity was assessed by examining the correlation of each risk perception measure with the other risk perception measures.

Discriminant validity was assessed by examining the correlation of each risk perception measure with a measure of diarrhoeal disease concern. Predictive validity was assessed by examining the correlation between each risk perception measure and incidence of diarrhoeal disease.

Also, there was a correlation assessment of how absolute risk measures varied by age, sex, level of education, household size, wealth quintile, household source of drinking water, type of toilet facility, mode of disposing solid waste, mode of disposing liquid waste, distance to nearest refuse collection point, distance to nearest public toilet, presence of livestock in household, presence of cockroaches in household, location of household in community and households hygiene practices. This was done to examine how the three risk perception measures predict incidence of diarrhoea differently.

Because there was no gold standard for very low or high risk perception of diarrhoea that was set in the literature, a latent class analysis was used to assess the sensitivity and specificity of each measure. In this method, all of the measures are assumed to be subject to error (i.e., misclassification) that is independent across measures. Initial estimates of the ‘‘true’’ classification of each participant (e.g., very high risk perception or not) are revised iteratively using maximum likelihood estimation until convergence occurs. This method has been applied to measurements in some epidemiologic studies (Walter et al. 1988; Walter et al. 1991). To conduct the analysis, the numerical risk perception measure was categorised into five groups, i.e., 0 to 19, 20 to 39, 40 to 59, 60 to 79 and 80 to 100. This became consistent with the scale measures for the verbal and comparative measures.

The sensitivity and specificity measures for the two outcomes: very high risk and very low risk, were based on responses above the highest cutoff point on each measure (≥40% for numeric, "very high" for verbal, and "much higher" for comparative measure). Households that are within this cutoff point were classified as those with high risk perception of diarrhoeal disease. The lowest cutoff point on each scale (<40% for numeric, very low for verbal, and ≤2 on the 5-point comparative measure) were classified as those with very low risk perception of diarrhoeal disease. In addition, the negative and positive predictive values of the risk perception measures were calculated to test the likelihood of the perceptions of diarrhoea that households develop resulting from experience of flooding. These predictive values are critical to evaluating whether households who perceive themselves at high or low risk of an event are actually at that level of risk when the event occurred.

Finally, a multivariate analysis of the independent and mediating variables on one hand, and the dependent variable on the other hand, was undertaken by controlling for demographic, economic, social and other environmental factors. This was done to establish the statistical association between these variables and the dependent variable. In all, three models were run for the study. The first model examined the association between household experience of flooding and incidence of diarrhoeal disease. The second model examined household experience of flooding, household risk perceptions of diarrhoea and diarrhoeal disease incidence. In the third model, all the variables in model two were combined with households' preventive strategies, demographic and economic characteristics of household members, household water and sanitation, and environmental risk factors to examine how they impact on diarrhoeal disease incidence in households.

### 3.6 Limitations of the study

The methods used for the study have the following shortcomings: Firstly, the arrangement of the risks perception questions were done randomly to avoid earlier problems that were detected by other researchers (Levy et al., 2006, Taylor et al. 2002) which revealed that the ordering of risk perception questions does affect the responses. The general observation was that verbal measure responses that followed comparative measures were usually higher than if they were asked before questions on comparative measure. Also, the numeric measure had some influence on the verbal and comparative measures because of explanations that are given in the local dialect to enable respondents understand the question. Notwithstanding this, the size of the effect was small to substantially affect the ranking of the measures.

Secondly, the measure of diarrhoeal disease was self-reported and not from medical diagnoses which could compromise the understanding of the respondents as to what is meant by diarrhoeal disease. There were detailed explanations of what diarrhoeal disease is in the local language to minimize errors that respondents may make in deciding on what diarrhoeal disease means.

Finally, there were problems with time series data in the study area because the lowest unit of the data is at the sub-Metropolitan level and data were not available at the community level. Also, time series data on socio-demographic indicators and water and sanitation issues in the area were not available. However, the homogeneity of events in the sub-Metropolitan Area made it possible to use the sub-Metro data to support the findings from the cross-sectional data. Despite these limitations, the robustness of the methods used provides some lessons to researchers interested in similar studies in urban poor communities across the globe.

# Chapter Four

## Flooding and Diarrhoeal Disease incidence in the Ashiedu-Keteke sub-Metropolitan Area of Accra

### 4.1 Introduction

This chapter discusses extreme rainfall events and diarrhoeal disease incidence in the Ashiedu-Keteke sub-Metropolitan area of Accra. The situation at the sub-Metropolitan level was used as a proxy to help understand the flooding and diarrhoea situation in *Agbogbloshie* and *James Town*. It focuses on rainfall and flood analysis in the Ashiedu-Keteke sub-Metropolitan Area of Accra and the incidence of diarrhoeal disease in the sub-Metropolitan Area. In addition, factors such as household socio-demographics, water and sanitation, hygiene practices and risk perception measures of diarrhoeal disease were examined in this chapter. Furthermore, some factors that specifically affect flooding such as location of household in community and housing conditions were also examined to have an understanding of how households are exposed to flooding in the study communities.

### 4.2 Rainfall and flooding in Accra

Flooding is a major natural disaster that occurs in Accra and other urban places in Ghana mostly due to torrential rainfall and engineering challenges in the construction of drainage systems and location of buildings for human habitation (ILGS & IWMI 2012; Karley 2009; Afeku 2005). Accra receives the least amount of rainfall annually compared to the other synoptic stations in Ghana but has the highest frequency of flooding in the country. Even though flooding had been occurring in the city over the past 40 years, the frequency of flooding seems to have increased in four-fold over the last decade. Flooding has gradually become an annual issue in Accra and this happens anytime there is heavy rainfall. The increase in flood frequency seems to correlate with rapid increase in the population of the city. Since the year 2000, flooding has been occurring in Accra in every other year as opposed to what pertained during the last three decades (Figure 4.1). There was about a 100 percent increase in flood frequency in the 1990s compared to the previous years (1970s and 1980s). These flood events in Accra affected communities that live along the Odaw tributary. Agbogbloshie and James Town are both located at various points of the Odaw River and have been part of the communities that have been adversely affected by flooding in Accra.

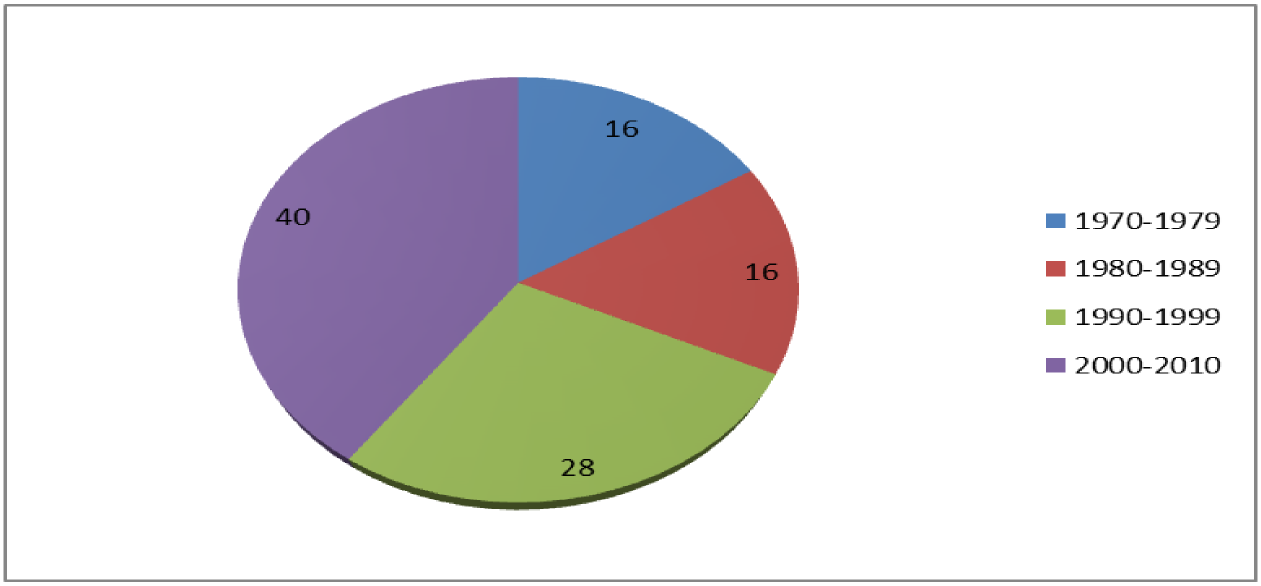


**Figure 4.1 Frequency of floods in Accra, 1970-2010**

Source: Centre for Research on the Epidemiology of Disaster (2013), Based on available data from EM-DAT: The OFDA/CRED International Disaster Database, Available at www.em-dat.net Accessed 31 August 2013.

The Government of Ghana has over the years addressed flooding issues in Accra through engineering methods, which include the Korle Lagoon Ecological Restoration Project from 1998 to 2008 (Afeku 2005) and the World Bank Urban Environmental Sanitation Programme. These approaches have, however, failed to fully address the causes of flooding because of indiscriminate disposal of waste into the Odaw River which empties into the Korle Lagoon. Anthropogenic factors such as indiscriminate disposal of solid waste into drains and building on water ways are major causes of flooding in Accra (Adanu 2004; Aboagye 2012; Okyere 2012). A change in the attitude of people usually emanates from the risk associated with the event that affects them. If people perceive that they are at a high risk of the event, they will take measures to prevent or protect themselves from the consequences of it. For instance, a change in the behaviour of people towards HIV and AIDS in sub-Saharan Africa gained popularity when people saw themselves at a high risk of the disease (Moore & Rosenthal 1991; Sarkar et al. 2005).

Flooding in Accra is as a result of excess water from rainfall that usually overflows the boundary of the drainage channel system in the city (Kweku and Duke 2007; Ludlow 2009). An examination of rainfall data for the Ashiedu-Keteke sub-Metropolitan Area of Accra for the period 1985-2010 shows a change in the trend of rainfall which could be a contributing factor to the high frequency of flooding over the past decade. The mean annual rainfall for the 26 year period is 760.0mm. The highest annual rainfall (1,264.7mm) was recorded in 2008 and the least (509.3mm) was in 1993. The difference between the highest and the least annual rainfall was 755.4mm. When the highest and the least annual rainfall values are compared with the mean annual rainfall for the period, the year 2008 experienced an excess rainfall of 504.7mm while 1993 fell short by 250.7mm. In all, the total annual rainfall values of 10 out of the 26 year rainfall data exceeded the mean annual rainfall. The last decade of the period recorded six of these events and this may be contributing to recent floods in the city (Figure 4.2).

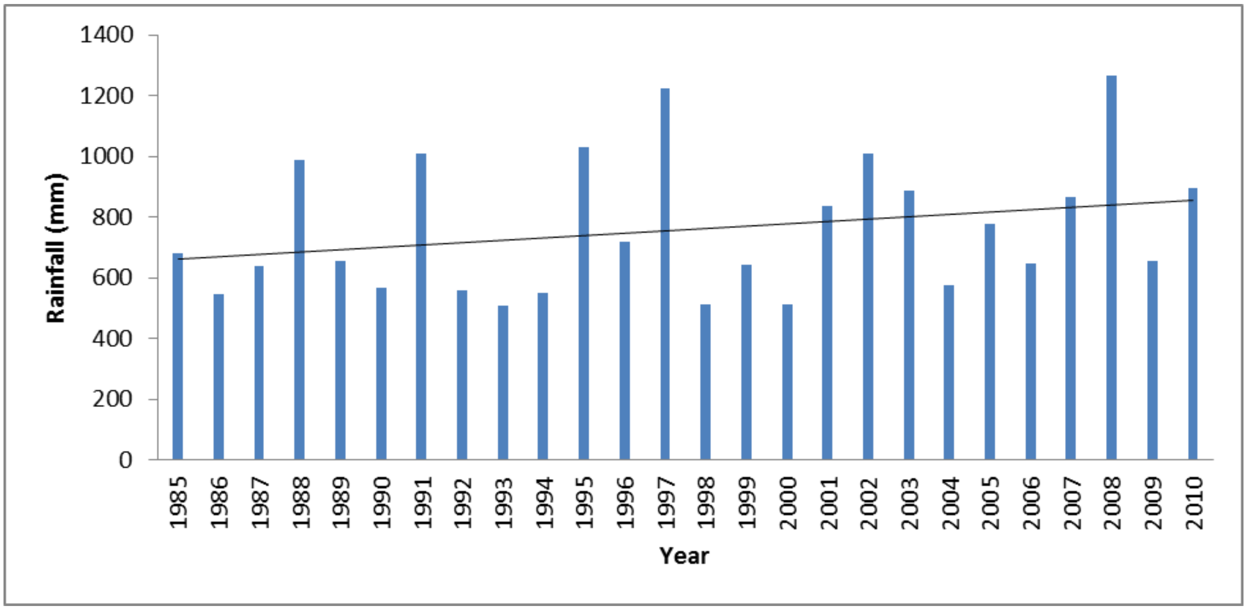


Figure 4.2 Trend in total annual rainfall in the Ashiedu-Keteke sub-Metropolitan Area of Accra (1985-2010)

The mean monthly rainfall and the mean number of rainy days in a month over a period of time in an area could explain the flood situations. For instance, the change in the mean number of rainy days in a month makes it difficult to prepare for the event since it becomes difficult to predict. Over the 26 year period, the trend in mean monthly rainfall in Accra indicates a bi-modal pattern which has its first peak in June and the second peak in October (Figure 4.3). Studies have shown that, there were more flooding in Accra over the last decade than in the previous decades (Centre for Research on Epidemiology of Disaster 2013; Songsore et al. 2006). It is therefore, critical to examine the flooding situation in the research area prior to last decade to see if the same situation pertains in the area. When the period under study is examined in decades, both the first (1985-1995) and the second (1996-2006) decades indicate a bi-modal pattern with peaks in June and October, an indication that the months with the highest rainfall in the bi-modal trend has not changed. However, Figure 4.4 shows that there has been an increase in the volume of average rainfall in the months when rainfall peaks in the second decade.

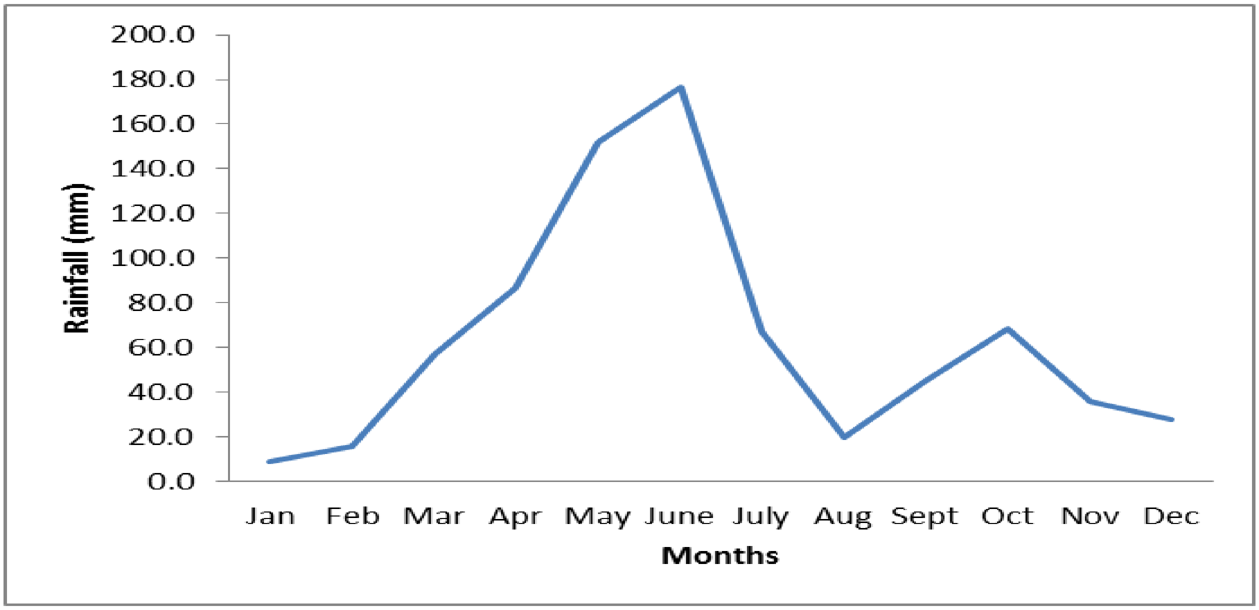


**Figure 4.3 Mean monthly rainfall in the Ashiedu-Keteke sub-Metropolitan Area of Accra - 1985-2010**

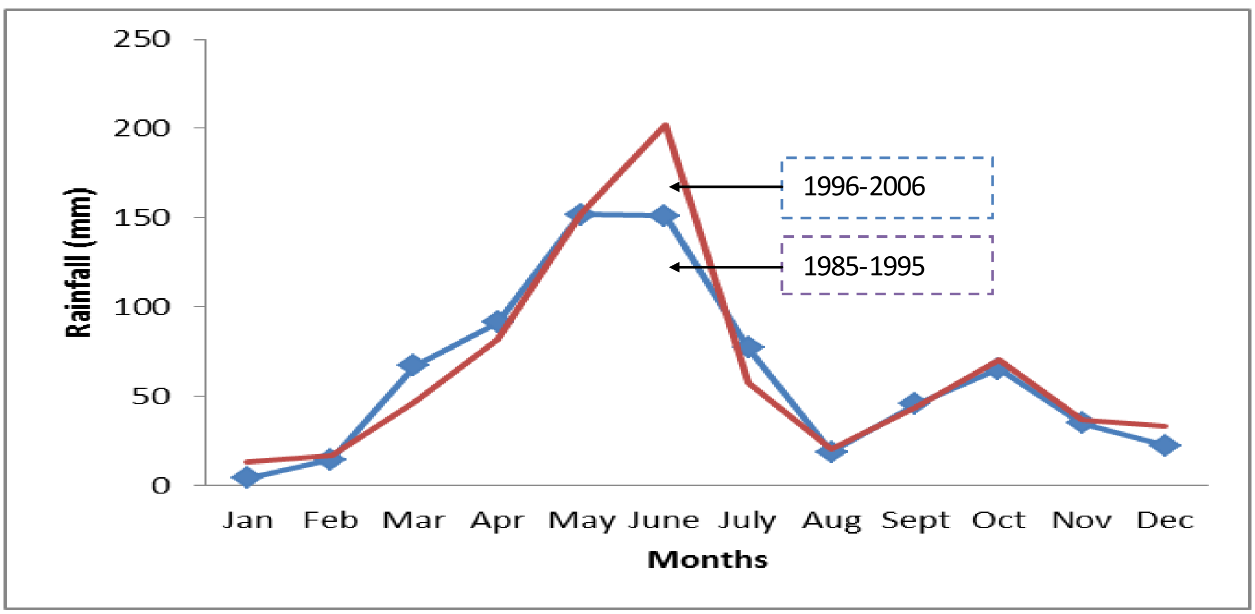


**Figure 4.4 Mean monthly rainfall in the Ashiedu-Keteke sub-Metropolitan Area of Accra over a period of two decades (1985-2006)**

There are two main seasons of rainfall in Accra. The major season is usually from May to June with average rainfall of about 355mm over the period while the minor season is from

September to October with an average rainfall of about 100mm over the period. With regard to the mean number of rainy days, the month of June recorded the highest number of rainfall in the major season while September and October recorded the highest in the minor season (Figure 4.5). When the period is divided into two decades, both the first and second decades saw the month of June recording the highest number of rain days in the major season and September and October recording the highest in the minor season. There was, however, a decrease in the number of rain days in August and November in the second decade (Figure 4.6). Conversely, the volume of rainfall in these months remained the same as indicated earlier in Figure 4.4. The rainfall in August and November, therefore, was torrential and this is what usually causes flooding. Furthermore, increases in the number of rain days and the volume of rainfall in the major and minor seasons can easily cause flooding if there are inadequate water channels to aid the flow of running water.

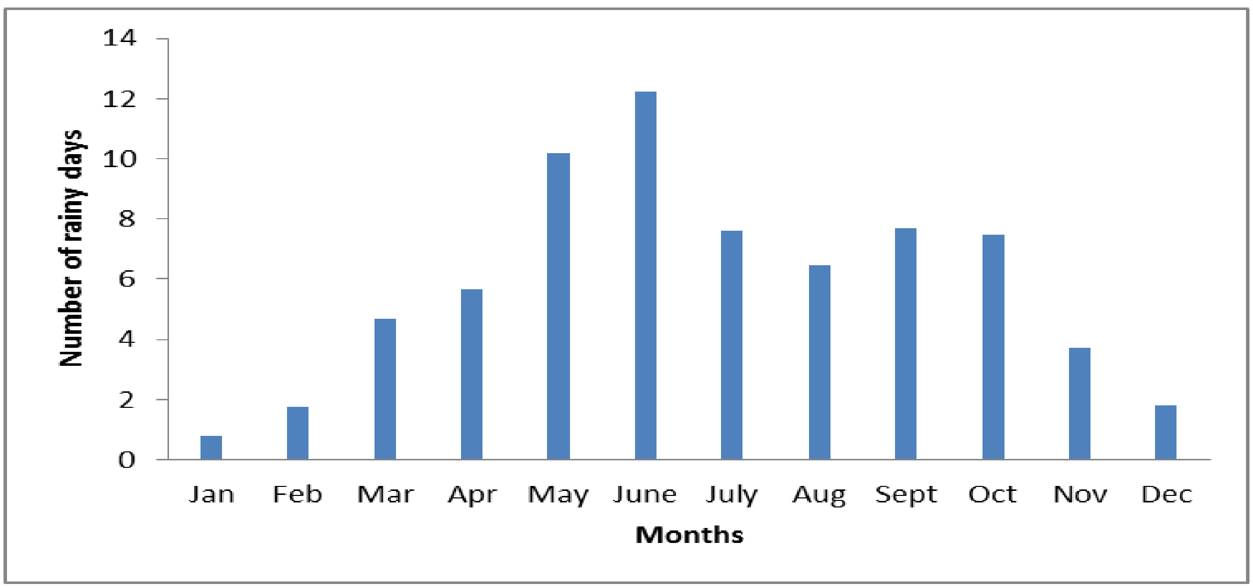


**Figure 4.5 Mean number of rainy days in Ashiedu-Keteke sub-Metro of Accra - 1985-2006**

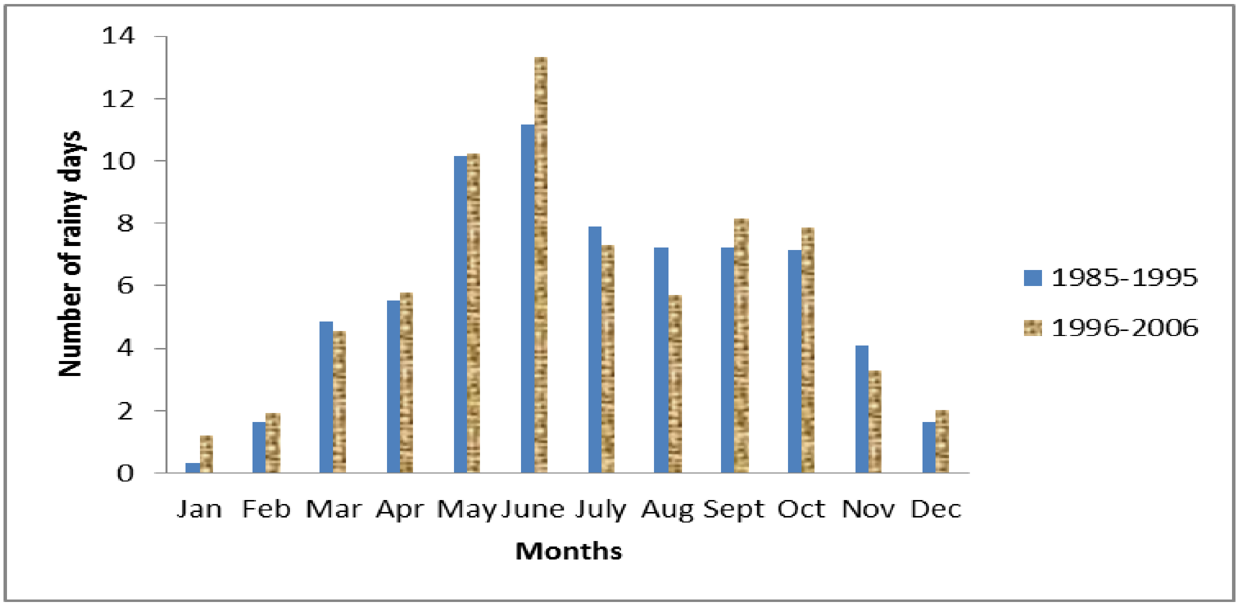


**Figure 4.6 Mean number of rainy days in Ashiedu-Keteke sub-Metropolitan Area of Accra over a period of two decades (1985-1995 and 1996-2006)**

Also, there was an analysis of rainfall data for the month of October, 2011, which is the reference point for this study. This was done to determine if the October 26, 2011 flooding of the Accra was triggered by extreme rainfall or not. In all, there were seven rainy days in the month of October, 2011 using 1.0mm threshold to measure a rainy day. The latter part of the month experienced more rainfall. There were heavy rainfalls (58.3mm and 97.7mm) on the $24^{th}$ and $25^{th}$ of the month respectively. The $26^{th}$ of the month also experienced a rainfall of 1.3mm but this was the day that the study communities got flooded. The October, 26, 2011 flooding in the study communities was triggered by the heavy rains that were experienced in the communities on the $24^{th}$ and $25^{th}$ October, 2011 (Figure 4.7).

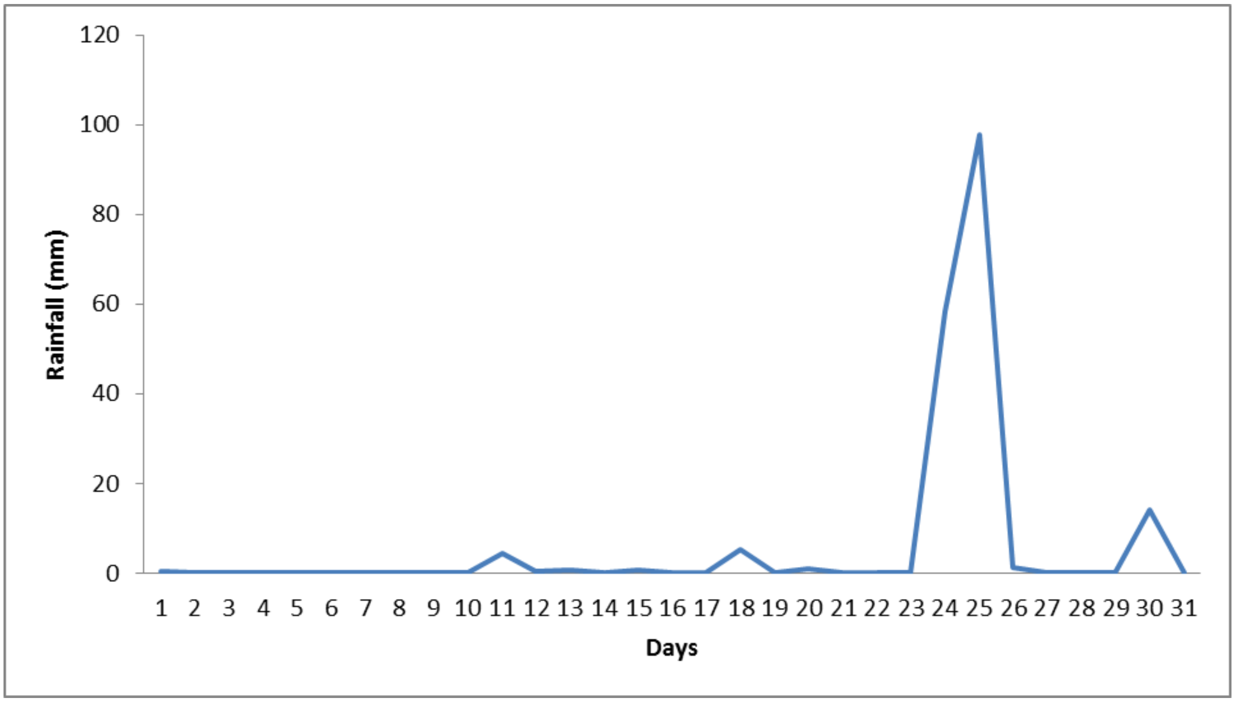


**Figure 4.7 Daily rainfall distribution for the month of October, 2011**

### 4.3 Diarrhoeal disease in Accra

Diarrhoeal disease in poor neighbourhoods in Accra has become a major public health concern to health practitioners over the years. Figure 4.8 shows that the trend in the incidence of diarrhoeal disease in the Ashiedu-Keteke sub-Metropolitan Area of Accra had been fluctuating in the 1980s and the 1990s. There were sharp increases in diarrhoeal disease incidence in 1987 and 1994, but the rest of the years in the 1980s and 1990s recorded a decline in diarrhoea incidence. In 1999, diarrhoea disease incidence began to increase again with the year 2005 recording the highest increase in the 2000s. The trend of diarrhoeal disease incidence since 2006 has been fluctuating. Statistics from the Centre for Health Information Management indicates that communities in the Ashiedu-Keteke sub-Metropolitan Area are among the communities in Accra that have higher reported cases of diarrhoeal disease. These communities have also been identified by the Ministry of Health as hotspots for cholera outbreaks in the city. It is also suspected that poor sanitation in these communities have worsened the health conditions of the population in recent times as a result of frequent flash floods anytime it rains heavily.

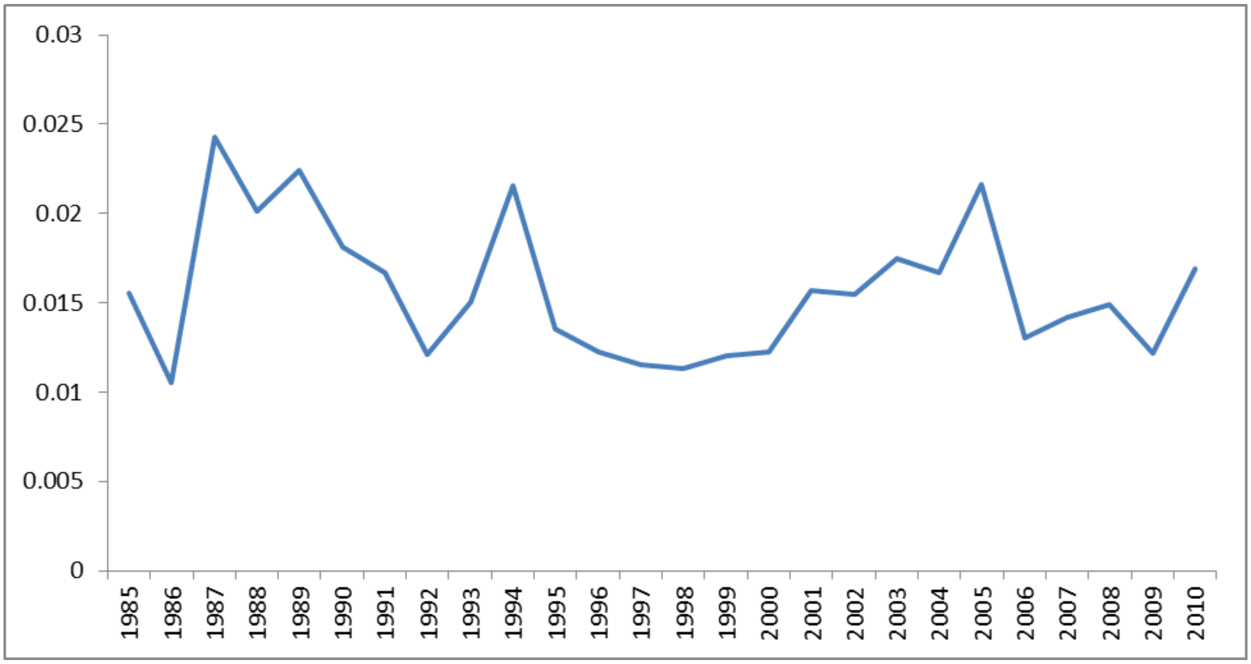


**Figure 4.8 Incidence of diarrhoeal disease in the Ashiedu-Keteke sub-metropolitan area of Accra - 1985-2010**

## 4.4 Relationship between flooding and diarrhoeal disease in Ashiedu-Keteke sub-Metropolitan Area of Accra

Diarrhoeal disease in poor neighbourhoods in Accra has become a major public health concern to health practitioners over the years. Tables 4.1 and 4.2 present a detailed analysis of the relationship between flooding and diarrhoeal disease in the Ashiedu-Keteke sub-Metropolitan Area of Accra. The analyses indicate that there is a correlation between extreme rainfall and diarrhoea. In Table 4.1, the spearman correlation analysis indicates that monthly extreme rainfall days were positively correlated with monthly cases of diarrhoea in the sub-Metropolitan Area throughout the study period ($r^2$ ranged from 0.34 to 0.35) with a strong lag effects on the relationship. There was a strong positive lag effect at zero and one month compared to two months lag. Flooding may or may not immediately result in diarrhoeal disease because the period of flooding is usually the development stage of diseases and the impact of most of the diseases will be known some weeks after the flooding. The lag time is, therefore, critical in examining the relationship between flooding and diarrhoeal disease.

**Table 4.1 Correlation between monthly extreme rainfall and diarrhoea in the Ashiedu-Keteke sub-metropolitan area of Accra, 1985 – 2010**

| Monthly climate variables | Lag (months) | $r^2$ | P-value |
|---|---|---|---|
| Monthly extreme rainfall days (≥59.2mm) | 0 | 0.35 | 0.039 |
| Monthly extreme rainfall days (≥59.2mm) | 1 | 0.35 | 0.039 |
| Monthly extreme rainfall days (≥59.2mm) | 2 | 0.34 | 0.044 |

In Table 4.2, the F-statistic in the model indicates that the model is a good fit at $p<0.05$. Extreme rainfall events in the Ashiedu-Keteke sub-Metropolitan Area Granger cause diarrhoeal disease. An increase in extreme rainfall, which is used as proxy for flooding in the research, leads to an increase in incidence of diarrhoeal disease in the Ashiedu-Keteke sub-Metropolitan Area of Accra.

**Table 4.2: Granger causality of the relationship between number of extreme rain days and incidence of diarrhoea in the study communities**

| Characteristics | Coefficient | S.E |
|---|---|---|
| Number of extreme rainy days | 0.0009 * | 0.00045 |
| Constant | -0.0005 | 0.00009 |
| Adjusted $R^2$ | 0.12000 | |
| F( 1, 23) | 4.21000 * | |

In Figure 4.9, very wet periods indicate high amount of rainfall that could cause flooding while dry periods indicate low amount of rainfall that could cause drought. It shows that there have been rapid increases in incidence of diarrhoeal disease in Ashiedu-Keteke sub-Metropolitan Area of Accra over periods 1985-1995. However, within the same period, diarrhoeal disease incidence decreases anytime there is high rainfall. The explanation that could be given for this relationship is that the lag time in disease outbreak after flooding could be influencing the shift in the occurrence of the disease. Flooding per se occurs as a result of excess water from runoff usually due to heavy rainfall. The development of diseases may begin during this period but the epidemic may occur later. As a result, diarrhoeal disease may occur more during the dry periods when there is no rain with some few cases occurring in the years that flooding occurred.

The first five years of the second decade of Figure 4.9 shows a decrease in incidence of diarrhoeal disease with very wet rainfall and dry periods respectively. However, the last five years of the second decade of the graph indicates an increase in incidence of diarrhoeal disease as a result of very wet rains. The last six years of the graph witnessed more of very wet years but recorded lower incidence of diarrhoeal disease. The last decade of the graph recorded more of very wet years than the previous 15 year period. The incidence of diarrhoeal disease was fluctuating in both periods but was slightly higher in the previous 15 year period than in the last decade, which may be as a result of improvement in water and sanitation systems or public health educational campaign. This trend of event is an indication that the relationship between flooding and diarrhoeal disease is confounded by a host of intervening factors that could be social or environmental. The social triggers of the relationship which include the risk perception of the affected population have not been motivated in research over the years.

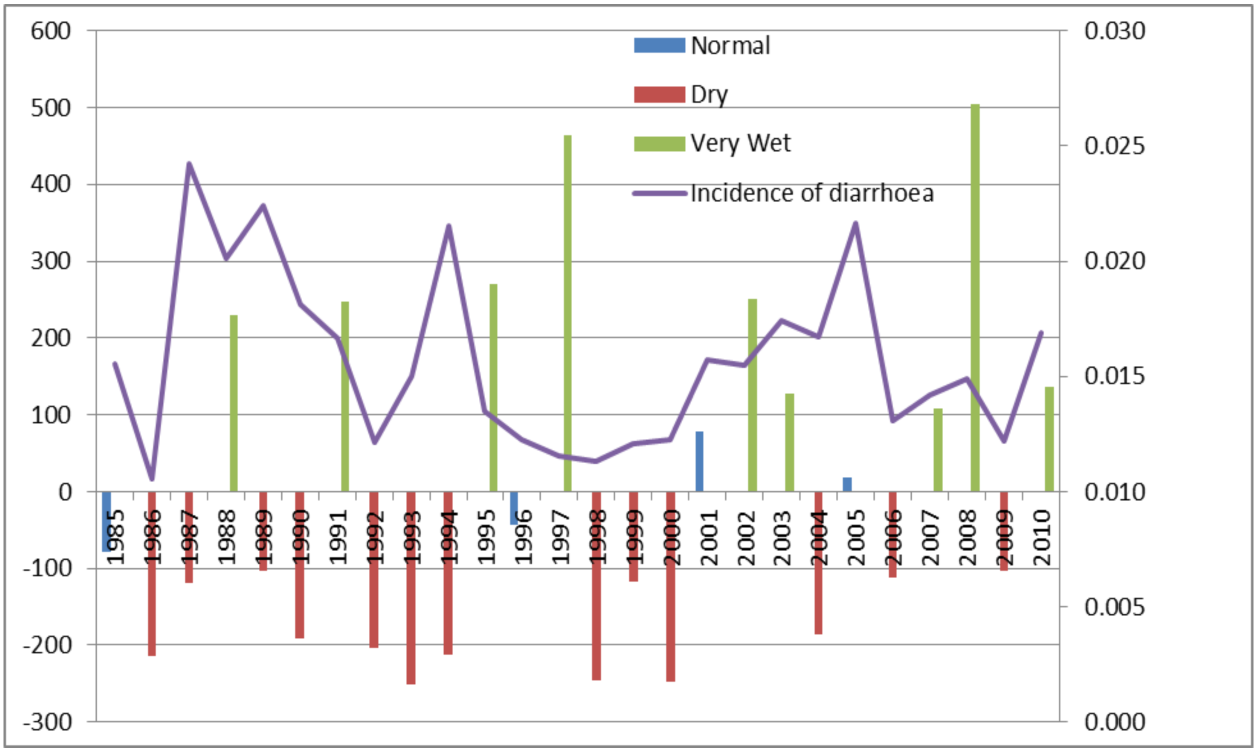


Figure 4.9 Average annual rainfall variation and incidence of diarrhoeal disease in Ashiedu-Keteke sub-Metropolitan Area of Accra – 1985-2010

In conclusion, flooding and diarrhoea are critical issues in the Ashiedu-Keteke sub-Metropolitan area of Accra. Flooding in the research area is as a result of changes in the trend of rainfall in the sub-Metropolitan Area. Of the 10 annual mean rainfall values that exceeded the mean annual rainfall in the sub-Metropolitan area over the last 26 years under investigation, six of these occurred in the last decade. The bi-modal pattern of rainfall in the research area has not changed over the years with the months of June and October recording the highest amount of rainfall. There is also an increase in the volume of rainfall in these months over the last decade resulting in the increase in flooding frequency. The trend of diarrhoeal disease in the research area has been fluctuating, possibly due to public health interventions like washing of hands with soap before eating, which helped in reducing diarrhoea incidence or increased poor sanitation, which contributed to increased diarrhoea incidence in some communities. Finally, this chapter revealed that flooding is a period when the bacteria that causes diarrhoea become active. There are more incidences of diarrhoea during the first four weeks after flooding. The chapter revealed that flooding predicts diarrhoea incidence in the Ashiedu-Keteke sub-Metropolitan Area of Accra.

# Chapter Five

## Household characteristics and preventive strategies

### 5.1 Introduction

Research has shown that there exist some statistical associations between flooding and diarrhoeal disease (Stoler et al. 2012; Hashizume et al. 2007). Yet, this association may be affected by a lot of intermediate variables such as, demographic, social, economic, household water and sanitation condition, environmental risk factors, and household preventive strategies. This chapter provides univariate description of these variables in the study.

### 5.2 Demographic, social and economic characteristics of households

The results from the household survey in Table 5.1 indicate that more than half (56.6%) of the household heads are males while the remaining 43.4% are females. Even though male household heads are in the majority, the proportion of female-headed households is quite high compared to the national figure of 33.7%. Given the fact that women are amongst the poorest in urban places in Ghana and are also more likely to be found in the informal sector (Taylor et al. 2002), women-headed households are more likely to suffer most in the event of an environmental hazard. Also, ILGS & IWMI (2012) noted that the socially constructed norms that give men more power and access to resources than women will further increase the vulnerability of households headed by women. There is a high proportion of male-headed households than female headed households in both study communities. The James Town community has a higher proportion of female headed households (45.5%) than the Agbogbloshie community (41.2%). On the other hand, the composition of households and resources available to them determine the level of vulnerability of members irrespective of whether it is headed by a male or female. The most critical resource a household requires to prepare towards environmental events is prompt and accurate information about the event. The capacity of households to have access to such information will help it to adequately prepare for such events.

**Table 5.1: Percentage distribution of demographic, social and economic characteristics of study population**

| Household Characteristics | Agbogbloshie (N=199) | James Town (N=202) | Total (N=401) |
|---|---|---|---|
| **Sex of household head** | | | |
| Male | 58.8 | 54.5 | 56.6 |
| Female | 41.2 | 45.5 | 43.4 |
| **Proportion of household members with Some education** | | | |
| No member had education | 2.0 | 2.0 | 2.0 |
| Less than 50% had education | 0.5 | 1.0 | 0.7 |
| 50% and above had education | 26.6 | 25.2 | 25.9 |
| All members had education | 70.9 | 71.8 | 71.3 |
| **Age group of household members** | | | |
| <15 | 6.5 | 5.0 | 5.7 |
| 15-19 | 23.6 | 11.4 | 17.5 |
| 20-24 | 21.6 | 19.8 | 20.7 |
| 25-29 | 25.1 | 16.8 | 20.9 |
| 30-34 | 11.6 | 11.4 | 11.5 |
| 35-39 | 6.0 | 8.4 | 7.2 |
| 40-44 | 1.5 | 6.9 | 4.2 |
| 45-49 | 2.0 | 5.4 | 3.7 |
| 50+ | 2.0 | 14.9 | 8.5 |
| **Mean age of household members** | 25.2 | 32.7 | 29.0 |
| **Household size** | | | |
| 1 | 21.1 | 31.7 | 26.4 |
| 2-3 | 41.7 | 28.2 | 34.9 |
| 4-6 | 31.2 | 29.7 | 30.4 |
| 7+ | 6.0 | 10.4 | 8.2 |
| **Mean household size** | 3.2 | 3.3 | 3,2 |
| **Wealth quintile** | | | |
| Poorest | 26.6 | 18.8 | 22.7 |
| Poor | 24.6 | 16.8 | 20.7 |
| Middle | 20.1 | 14.9 | 17.5 |
| Rich | 15.6 | 23.8 | 19.7 |
| Richest | 13.1 | 25.7 | 19.5 |

Table 5.1 shows that the proportion of household members with some form of education is not different in the study communities. There is a high proportion (71.3%) of households with

all members having had some form of education. Households that had more than 50% of the members getting some form of education is 26.6% in Agbogbloshie and 25.2% in James Town. The proportion of households without any member attaining some level of education is 2% in both communities. The high proportions of household members who have had some form of education are expected to influence the way things are done in the household. The educational level of household members, therefore, plays an important role in decisions that are taken which could have implications for the health of individual household members. It is expected that people who are educated are likely to be financially stable and also more knowledgeable on variety of issues that will benefit the household. It is, therefore, not just the level of education of the household head that may influence decisions in the household but the proportion of household members with some form of education. Thus, in a household where the head is illiterate but majority of the members have some form of education, the educational levels of the other members will influence decision making in the household and not just that of the head.

The mean age of households in the study communities is 29 years. Households in *Agbogbloshie* and *James Town* recorded a mean age of 25 years and 33 years respectively. On average, majority of the households (70.6 percent) could be described as youthful households who may have the capacity to contribute to the development of the household. There was a higher proportion (81.9%) of youthful households in *Agbogbloshie* than *James Town* (59.4%). However, less than one-tenth (5.7%) of households had members with an average age of less than 15 years with *Agbobloshie* recording the highest proportion of 6.5% and *James Town* 5.0%. These are young households and the dependency levels in such households are high. It is also expected that these households will be more vulnerable in times of environmental hazards because of the higher vulnerability of children and women in a disaster (UNICEF 2011;

Yavinsky 2012*)*. There are also ageing households in the study communities (8.5%) with an average age of 50 years and above. There were more ageing households in *James Town* (14.9%) than in *Agbogbloshie* (2.0%). This may be attributed to the poor housing condition of *Agbogbloshie* which is more suitable for young migrants than for the ageing population. Households with ageing members are equally vulnerable in the event of an environmental hazard because of their inability to quickly move out of the hazard zone. These are households that will require emergency response services in times of disaster. The ability of households to respond to disaster, however, depends on the composition and the size of households.

More than one-third (34.9%) of households have total membership of 2-3 members and a little over one-quarter (26.4%) are single-member households. Thus, more than half of households have less than four members and less than 10 percent of households have seven or more members. There is a higher proportion of single households in *James Town* (31.7%) than in *Agbogbloshie* (21.1%). Also, households with seven or more members are higher in *James Town* (10.4%) than *Agbogbloshie* (6.0%). Even though household size may seem not to be large in the study communities, most households have single room accommodation inhabiting all its members. The total number of persons per room in the communities is high, increasing their predisposition to the spread of diseases in the event of a disaster (Hashizume et al. 2007: Songsore et al. 2005). The mean household size in the study communities is 3.2. This is lower than the figure of 3.9 for the Greater Accra Region (Ghana Statistical Service, 2012). The household size in *James Town* is a little higher than that of *Agbogloshie*, but household size in each of the communities is lower than the national figure for poor urban areas (4.4).

The distribution of wealth status of households from Table 5.1 indicates an approximately proportional distribution of wealth in the study communities. An examination of wealth status in the two communities, however, showed that households in *James Town* are relatively richer than those in *Agbogbloshie*. There are about 27% of those in the poorest wealth quintile in *Agbogbloshie* and about 19% in *James Town*. Also, in the richest wealth quintile, about 26% of households in *James Town* and 13% in *Agbogbloshie* are in this category. The wealth status of households has influence on other factors such as household water quality, sanitation facilities that will be used, location of households in the community and their capacity to respond to disaster.

### 5.3 Household Water, Sanitation and hygiene condition

Table 5.2 shows that a little less than two-thirds (64.6%) of households use treated water sold in sachets as their main source of drinking water while the remaining households use pipe borne water. The proportion of households that depend on pipe borne water is higher in *James Town* (44.5%) than in *Agbogbloshie* (26.1%). There are, however, more households in *Agbogbloshie* (73.9%) that use "sachet" water as against 55.4% of households in *James Town*. Even though "sachet" water is presumed to be treated water, there is literature that shows that "sachet" water has serious health implications for people (Stoler et al, 2012). A lot of households believe that "sachet" water is clean and safe for drinking but recent studies have shown otherwise (Stoler et al. 2012; Dodoo et al. 2007). Evidence from these researches revealed particles of feacal matter and some harmful chemicals in some of the "sachet" water which is harmful to human health.

**Table 5.2: Percentage distribution of household water, sanitation and hygiene condition of study population**

| Characteristics | Agbogbloshie (N=199) | James Town (N=202) | Total (N=401) |
|---|---|---|---|
| **Main source of drinking water** | | | |
| Piped into dwelling | 0.5 | 10.9 | 5.7 |
| Piped into yard | 3.0 | 8.4 | 5.7 |
| Public tap/stand pipe | 22.6 | 25.2 | 23.9 |
| Sachet water/bottled water | 73.9 | 55.4 | 64.6 |
| **Type of toilet facility** | | | |
| Bucket pan/pit latrine | 0.5 | 5.0 | 2.7 |
| WC/Flush toilet | 0.0 | 9.9 | 5.0 |
| KVIP | 10.1 | 5.0 | 7.5 |
| Public toilet | 89.4 | 80.2 | 84.8 |
| **Method of solid waste disposal** | | | |
| Collected at home by a private company | 0.5 | 29.7 | 15.2 |
| Collected at home by a government agency | 1.0 | 15.8 | 8.5 |
| Refuse container | 57.8 | 37.1 | 47.4 |
| Community drain | 0.5 | 2.5 | 1.5 |
| Truck pushers (kaya bola) | 39.2 | 8.4 | 23.7 |
| Other | 1.0 | 6.5 | 3.7 |
| **Method of liquid waste disposal** | | | |
| Septic tank | 1.0 | 0.5 | 0.7 |
| Community drain | 92.5 | 76.7 | 84.5 |
| Backyard | 3.0 | 12.9 | 8.0 |
| Other | 3.5 | 9.9 | 6.7 |

Empirical evidence from literature suggests a strong correlation between sanitation and diarrhoeal disease (Songsore 2005; Hashizume et al 2007). The type of household source of drinking water and the sanitation facilities determine how vulnerable a household is to the impact of flooding. In Table 5.2, more than 80% of the sample population utilizes public toilet facility. Even though about 95% of the public toilet facilities in the study communities have been upgraded from the "Kumasi Ventilated Improved Pit" (KVIP) to water closet flush toilet, the pressure on the use of the same facility by several households facilitates disease transmission. A small proportion of the households still uses KVIP (7.5%) and some use bucket pan and pit latrines (2.7%). The proportion of households that use KVIP in *Agbogbloshie* (10.1%) is higher than *James Town* (5.0%). However, the percentage of households that uses bucket pan/pit latrines is higher in *James Town* (5.0%) than in *Agbogbloshie* (0.5%). Bucket pans/pit latrines have been classified by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) in 2006 as unimproved sanitation facility because it facilitates disease transmission.

In terms of solid waste disposal, more than two-fifth (47.4%) dispose waste into refuse containers provided at vantage points in the community while a little over one-fifth (23.7%) depend on the services of local/traditional waste collectors known as "*kaya bola*". Households in *Agbogbloshie* had a higher proportion of households disposing their solid waste via "*Kaya bola*". The proportion of the sample of the population that used the services of modern private waste collectors was 15.2%. There are more households in *James Town* (29.7%) that had their refuse collected by the modern private waste collection companies compared with less than one percent of households in *Agbogbloshie*. Even though these companies collect waste on time from households and also do it professionally, some households still prefer to use the "*kaya bola*" because it is cheaper. However, due to lack of supervision, the "*Kaya bola*" service providers often dispose the waste at places closer to the communities (Osei and Duker 2008).

Household liquid waste disposal is equally a problem in the neigbourhoods. Table 5.2 shows that more than 80% households dispose their liquid waste into the open drains. These open drains are a source of disease transmission point in the communities. About 10% of households dispose liquid waste in their backyard which could pre-dispose the majority of children who play around to diseases. The probability of humans coming into contact with household liquid waste is greater in the neighbourhood because of the poor sanitary conditions. Household water and food could easily be contaminated with liquid waste because water channels in the communities are open and they are also constructed in such a way that they go through people's homes. Such practice may be responsible for poor health conditions such as malaria, diarrhoea and skin diseases in the communities.

### 5.4 Household environmental risk factors

There are health risk factors that affect households, which emanate from their immediate environment. Most important is the way public sanitation facilities are located and managed. Public sanitation facilities in urban poor communities are not kept clean and this predisposes households who reside closer to these facilities to diseases. According to the WHO (2006), households that reside less than 50 metres away from public sanitation facilities that are not kept clean are more vulnerable to diseases than households that reside 50 metres or more away from public sanitation facilities. Table 5.3 shows that more than two-thirds (66.8%) of households in the study communities reside in locations that are 50 metres or more away from the nearest public toilet. In the Agbogbloshie community, more than one-third (34.7%) of the households reside in places that are less than 50 metres away from a public toilet. In terms of the proximity of households to the nearest refuse collection point, 75.8% of them reside in places that are less than 50 metres away from a public refuse collection point. Almost all the households (98.5%) in James Town are located in places that are less than 50 metres away from public refuse collection points while in Agbogbloshie, it is 52.8%..

**Table 5.3: Percentage distribution of environmental risk factors**

| **Distance to the nearest public toilet** | Agbogbloshie (N=199) | James Town (N=202) | Total (N=401) |
|---|---|---|---|
| Less than 50 metres | 34.7 | 31.7 | 33.2 |
| 50 metres and above | 65.3 | 68.3 | 66.8 |
| **Distance to the nearest refuse collection point** | | | |
| Less than 50 metres | 52.8 | 98.5 | 75.8 |
| 50 metres and above | 47.2 | 1.5 | 42.2 |

### 5.5 Household preventive strategies

Hygiene is an important determinant of health outcomes in households in urban poor communities. With regard to creating awareness towards good hygiene, the donor community promoted a programme on hand washing with soap after defecation and before eating (World Bank 2002; Saade et al. 2001). Table 5.4 shows that more than a quarter (26%) of households in the study communities wash their hands with soap before eating whilst more than one-third (39%) wash their hands with soap after coming from the wash room. Few households in the study communities purify their water before drinking. Less than 10% of households in the study communities purify their drinking water. In Agbogbloshie, 5% of the households purify their water whilst about 13% of households in James Town purify their water.

Also, cockroaches and livestock like sheep and goats are known to be carriers of the bacteria that cause diarrhoea. The presence of them in household is likely to lead to diarrhoea incidence. The results indicate that 31.7% of households had seen cockroaches for four or more times in their household in the last seven days preceding the survey. The frequency of cockroaches in household is an indication of poor sanitation in the household which could facilitate disease transmission. The proportion of households that had seen cockroaches for four or more times is higher in *Agbogbloshie* (63.3%) than in *James Town* (47.4%). There are generally few households that keep livestock in the study communities. Only 5% of households keep livestock in the study communities.

**Table 5.4: Percentage distribution of household preventive strategies against diarrhoea incidence**

| Household preventive strategies | Agbogbloshie (N=199) | James Town (N=202) | Total (N=401) |
|---|---|---|---|
| **Wash hands with soap before eating food** | | | |
| Yes | 23.1 | 28.2 | 25.7 |
| No | 76.9 | 71.8 | 74.3 |
| **Wash hands with soap after coming from wash room** | | | |
| Yes | 43.2 | 35.1 | 39.2 |
| No | 56.8 | 64.9 | 60.8 |
| **Purify water before drinking** | | | |
| Yes | 5.0 | 12.9 | 9.0 |
| No | 95.0 | 87.1 | 91.0 |
| **Number of times seen cockroaches in household in the past 7 days** | | | |
| Never | 18.1 | 22.2 | 26.2 |
| 1-3 times | 18.1 | 27.9 | 37.6 |
| 4 or more times | 63.3 | 47.4 | 31.7 |
| Don't know | 0.5 | 2.5 | 4.5 |
| **Presence of livestock in household** | | | |
| Yes | 2.0 | 3.7 | 5.4 |
| No | 98.0 | 96.3 | 94.6 |

In conclusion, a significant proportion of household heads in the research area are females who do not have the resources to stand the challenge of environmental hazards. About two-thirds of household members have some form of education, which is expected to influence decision making in households. Majority of households in the research area drink "sachet" water as their main source of drinking water because it is perceived to be treated water. In terms of sanitation, most households are located 50 metres away from public toilet facilities, which can trigger indiscriminate disposal of human excreta in an environment where there are few households with access to toilet facilities in their homes. Also, most of the households live close to refuse collection points, which, are not managed properly and pose a health threat to the people. The poor sanitation condition in the study area and the high patronage of “sachet” water, which has been shown in other studies not to be safe are major determinants of diarrhoeal disease in the study area.

# Chapter Six

# Risk Perception Measures, Flooding and Incidence of Diarrhoea in Agbogbloshie and James Town

## 6.1 Introduction

Risk perceptions of populations influence the way they react to hazards and help in the development of risk management policies (Cutter et al. 2008; Schanze et al. 2006). Assessment of risk perceptions of people is, therefore, critical in population science and demography. This chapter provides univariate description of household's experience of flooding and diarrhoea in the study area with specific reference to the October 26, 2011 flooding in Accra. It also, examines households risk perception measures of diarrhoea as a result of flooding and the validation of each of the risk perception measures.

## 6.2 Household experience of flooding and diarrhoeal disease incidence

Table 6.1 shows that more than two-fifth (45.4 %) of households experienced the October 26th, 2011 flooding in the study communities. Approximately, three quarters (75.4%) of households in Agbogbloshie and less than two-fifth (15.8%) of households in *James Town* experienced the October 26, 2011 flooding in Accra. In terms of diarrhoeal disease, a little less than half (48.6%) of households had members diagnosed with diarrhoeal disease in the first four weeks after the October 26, 2011 flooding. There is a higher proportion of reported diarrhoea in *Agbogbloshie* (65.3%) compared with *James Town* (32.2%). This is because the factors that predispose households in the study communities to diarrhoea are more pronounced in *Agbogbloshie* than in *James Town*. The proportion of households that experienced the October 26th, 2011 flooding was higher in *Agbogbloshie* than *James Town*.

**Table 6.1: Percentage distribution of household experience of October 26th, 2011 flooding and diarrhoeal disease incidence**

| Characteristics | Agbogbloshie (N=199) | James Town (N=202) | Total (N=401) |
|---|---|---|---|
| **Experienced October 26th, 2011 flooding** | | | |
| Yes | 75.4 | 15.8 | 45.4 |
| No | 24.6 | 84.2 | 54.6 |
| **At least one member of household was diagnosed with diarrhoea within 4 weeks after October 26th, 2011 floods** | | | |
| Yes | 65.3 | 32.2 | 48.6 |
| No | 34.7 | 67.8 | 51.4 |

## 6.3 Household's risk perceptions of diarrhoeal disease as a result of flooding

The October 26th, 2011 flooding and previous flooding experiences in the study communities triggered some perceptions among households in the area. Such perceptions are measured by a numeric, verbal or a comparative scale to determine the actions that people take to reduce the consequences of their exposure to floods. Each risk perception measure has its strengths and weaknesses but a critical assessment of the effectiveness of each of them is important to government risk reduction policies. In this instance, household risk perceptions of diarrhoeal disease are measured based on their experience of the October 26th, 2011 floods and previous flooding experiences in the study communities.

### *6.3.1 Numeric Measure*

Numeric risk perception measures are good to detect changes in how people perceive their risk to an event. Households in the study communities numerically rated their risk of diarrhoea resulting from floods. It is a percentage measure where households scored their risk of diarrhoea resulting from flooding on a 0% to 100% scale. As shown in Table 6.2, about three-quarters (75.3%) of households in the study communities rate their numeric risk of being diagnosed with diarrhoea from flooding as 0-19% probability. In the *Agbogbloshie* community, 13.6% of the respondents indicated that members of their households had a 40%-59% risk of exposure with diarrhoeal disease as a result of flooding. There were also households in *Agbogbloshie* that perceived that they have 60%-79% (3.5%) and 80%-100% (3.0%) risk of exposure with diarrhoea as a result of flooding. The situation in *James Town* is different from what pertained in *Agbogbloshie*. Numerically, about 91% of households in *James Town* scored the probability of a member of their household being diagnosed with diarrhoea resulting from flooding as 0-19% while the remaining 9% scored the chance of members being diagnosed with diarrhoea 20%-39%. There were no households in *James Town* that scored the probability of members being diagnosed with diarrhoea resulting from flooding, above 39% probability. The low probability scores in *James Town* is as a result of the numerous sanitation interventions in the area including distribution of refuse bins and construction of ally pavements in the community to facilitate free flow of rain water. The *Agbogbloshie* community has received less attention from government in terms of sanitation facilities and drainage construction because inhabitants of the area are seen as illegal settlers. Also the *Agbogbloshie* community is prone to flooding than the *James Town* community. The fact that there is some support from external sources in the *James Town* community is enough justification for households in such areas to see themselves at low risk whilst those who receive no external support will rate their risk high.

**Table 6.2: Percentage distribution of household perceptions of diarrhoeal disease**

| **Perceptions of diarrhoeal disease** | Agbogbloshie (N=199) | James Town (N=202) | Total (N=401) |
|---|---|---|---|
| **Numeric measure (%)** | | | |
| 0-19 | 59.8 | 90.6 | 75.3 |
| 20-39 | 20.1 | 9.4 | 14.7 |
| 40-59 | 13.6 | 0.0 | 6.7 |
| 60-79 | 3.5 | 0.0 | 1.7 |
| 80-100 | 3.0 | 0.0 | 1.5 |
| **Verbal measure** | | | |
| Very low | 33.7 | 58.9 | 46.4 |
| Moderately low | 37.2 | 33.7 | 35.4 |
| Neither high nor low | 18.1 | 7.4 | 12.7 |
| Moderately high | 10.1 | 0.0 | 5.0 |
| Very high | 1.0 | 0.0 | 0.5 |
| **Comparative measure** | | | |
| Much lower | 26.1 | 45.5 | 35.9 |
| Lower | 40.7 | 53.0 | 46.9 |
| About the same | 23.1 | 0.5 | 11.7 |
| Higher | 9.5 | 1.0 | 5.2 |
| Much higher | 0.5 | 0.0 | 0.2 |

### *6.3.2 Verbal Measure*

Verbal risk perception measures are known to be good measures of instantaneous perception of a given risk (Levy et al. 2006). This kind of perception is usually developed by people residing in hazard locations. Table 6.2 shows that almost half (46.4%) of households in the study communities perceived that they were at very low risk of diarrhoea as a result of flooding. Also, 12.7% perceived that they were neither at high nor low risk of diarrhoea while 5% perceived that they were moderately at high risk. In *Agbogbloshie*, 10% of the households perceived that they were at moderately high risk while none of the households in *James Town* has a similar perception. The risk of flooding is high in *Agbogbloshie* than in *James Town* and as such, households in *Agbogbloshie* are likely to develop high verbal risk perceptions of diarrhoea resulting from flooding than those who reside in *James Town*. Generally, households have the perception that the risk of diarrhoeal disease is low among their members and this is a common belief among households in the *James Town* community. Households in *Agbogbloshie*, however, expressed concern about members being affected with diarrhoea as result of heavy rainfall.

### *6.3.3 Comparative measure*

The comparative risk perception measure helps to understand the behaviour of different groups of people in a hazard location and the various interventions that could be applied to each group to achieve risk reduction. A high proportion of the households (35.9% and 46.9%) considered themselves to be at a much lower or lower risk of diarrhoea compared to other households in their neighbourhood. More than one-fifth (23.1%) of the households in *Agbogbloshie* considered themselves to be about the same risk as others in their neighbourhood while only 0.5% of households in *James Town* were of a similar view (Table 6.2).

## 6.4 Measures of Diarrhoeal Disease Risk after floods

Diarrhoea is a major public health problem in Ghana. There are several ways diarrhoeal disease risk can be measured in a community depending on the predisposing factors. However, three measures of risk that have been found to be useful in other epidemiological studies were adopted for this study. This section is dedicated to examining household risk perception measures of diarrhoea resulting from flooding. Each risk perception measure of diarrhoeal disease was evaluated and the correlation between risk perception measures and incidence of diarrhoeal disease by some households and environmental risk factors were examined in this chapter. The aim of this section is to validate the risk perception measures and also to identify the strengths and weaknesses of each of the measures in urban poor settings.

### *6.4.1 Household Risk Perceptions of Diarrhoea as a result of flooding*

Floods have a repetitive behaviour pattern and as a result, most floods are 'known risk'. It is, therefore, possible to relate such risk to other consequences that might result from being exposed to the risk. Populations vulnerable to 'known risks' develop some perceptions that guide their actions towards reducing their risk (Wisner et al. 2004). These risks have been examined in the cognitive sense (Leiserowitz 2006) but could be translated into quantitative, verbal and comparative measures to see how each influences human behaviour (Levy et al. 2006). Table 6.3 has assessment of the normality and the validity of risk perception measures employed in the study using convergent, discriminant and predictive validity tests. The Shapiro-Wilks test indicates that none of the risk perception measures are normally distributed. Each risk perception measure was significantly correlated with each other ($r \geq 0.48$ for all) and also correlated with a measure of diarrhoeal disease risk as a result of flooding ($r \geq 0.47$ for all). Also, each risk perception measure was significantly correlated with actual diarrhoeal disease occurrence in household within four weeks after the October 26$^{th}$, 2011 flooding in Accra ($r \geq 0.23$ for all).

The correlation of risk perception measures with incidence of diarrhoeal disease within four weeks after the October 26$^{th}$, 2011 flooding in Accra by socio-demographic and other risk factors of diarrhoeal disease indicated that the correlation was not affected by sex for both verbal and comparative measures and also not affected by age for verbal measures. Numerically, the correlation was stronger for women than for men. With regard to the age composition of the households, the correlation was stronger for households with younger and older households than other households for both numeric and comparative measures.

**Table 6.3: Normality and convergent, discriminant and predictive validity of the risk-perception measures (n=401)**

| Criteria | Risk Perception measures | | | | | |
|---|---|---|---|---|---|---|
| | Numeric | | Verbal | | Comparative | |
| **Normality** | | | | | | |
| - Shapiro Wilks test (W) | 0.674 | *** | 0.7888 | *** | 0.808 | *** |
| **Convergent validity (correlation with other risk perception measures)** | | | | | | |
| - Verbal | 0.476 | *** | - | | - | |
| - Comparative | 0.492 | *** | 0.516 | *** | - | |
| **Discriminant and predictive validity** | | | | | | |
| - Correlation with diarrhoeal disease worry | 0.531 | *** | 0.474 | *** | 0.561 | *** |
| **Correlation with actual diarrhoeal disease** | | | | | | |
| -Household member experiencing diarrhoea in the last 4 weeks after the October 2011 flooding | 0.478 | *** | 0.345 | *** | 0.230 | *** |
| **Association with actual diarrhoeal disease by:** | | | | | | |
| - Sex of household head *(Males vs female)* | 0.187 | ** | 0.076 | | 0.172 | |
| - Mean age of household members *(young or aged vs youth)* | 0.214 | ** | 0.088 | | 0.279 | *** |
| - Household size *(<4 vs 4+)* | 0.134 | | 0.070 | | 0.159 | * |
| - Proportion of household members with some form of education *(<50% vs 50% and above)* | 0.099 | | 0.070 | | 0.159 | * |
| - Wealth quintile of household *(poor vs rich)* | 0.122 | | 0.075 | | 0.111 | |
| - Type of toilet facility *(improved vs unimproved)* | 0.008 | | 0.018 | | 0.038 | |
| - Main source of drinking water *(improved vs unimproved)* | 0.401 | *** | 0.345 | *** | 0.230 | *** |
| - Distance from house to nearest toilet facility *(<50m vs 50+)* | 0.011 | | 0.038 | | 0.125 | |
| - Distance from house to nearest refuse collection point *(<50m vs 50+)* | 0.231 | *** | 0.185 | *** | 0.209 | *** |
| - Experience of October 2011 flooding *(yes vs no)* | 0.203 | ** | 0.219 | ** | 0.299 | *** |
| - Mode of disposing solid waste *(improved vs unimproved)* | 0.055 | | 0.251 | *** | 0.209 | *** |
| - Mode of disposing liquid waste *(improved vs unimproved)* | 0.010 | | 0.067 | | 0.033 | |
| - Purification of water *(yes vs no)* | 0.111 | | 0.144 | * | 0.108 | |
| - Used soap to wash hand before eating *(yes vs no)* | 0.060 | | 0.001 | | 0.030 | |
| - Used soap to wash hand after coming from washroom *(yes vs no)* | 0.030 | | 0.109 | | 0.002 | |
| - Presence of livestock in household *(yes vs no)* | 0.113 | | 0.076 | | 0.048 | |
| - Presence of cockroaches in house *(yes vs no)* | 0.251 | *** | 0.179 | *** | 0.194 | ** |

*p<0.05; **p<0.01; ***p<0.001

Other indicators that influenced the relationship with incidence of diarrhoeal disease are distance from house to the nearest refuse collection point, experience of October 2011 flooding, household source of drinking water, mode of disposing household solid waste and presence of cockroaches in household which was used to measure the level of sanitation in the household. Even though, the numeric measure was stronger for distance from house to the nearest refuse collection point and presence of cockroaches in house, the comparative measure was lower among the three risk perception measures in terms of their experience of the October 26, 2011 flooding (Table 6.3). Also, all the three risk perception measures are influenced by household source of drinking water in predicting incidence of diarrhoea. The numeric risk perception measure was the strongest, followed by the verbal and the comparative risk perception measures in relation to how they predict incidence of diarrhoea through household source of drinking water. However, it is only the comparative measure that significantly predicts diarrhoeal disease in households by the proportion of household members with some form of education and the size of the household.

Personal hygiene practices such as the use of soap in hand washing was not significant across all the risk perception measures in predicting incidence of diarrhoea in households. Also, the purification of water before drinking significantly influences the relationship between verbal risk perception and incidence of diarrhoea in household.

### *6.4.2 Estimation of Households at Very High or Low Risk of Diarrhoeal Disease*

The sensitivity and specificity test was used to identify households with very high or very low risk perception as indicated in Table 6.4. The numeric and the verbal measures have the highest sensitivity (0.86 and 0.85 respectively) and the comparative measure has the lowest sensitivity (0.80) for identifying households at higher risk of diarrhoea as a result of flooding.

The numeric and the verbal measure had the highest measure of specificity (0.64 and 0.60 respectively) for excluding households who do not have high risk perception. The comparative measure had the lowest specificity measure (0.58). In all, for identifying households with very high risk perceptions, the numeric and verbal measures had higher sensitivity and specificity than the comparative measure. However, to determine the likelihood of the various risk perception measures to predict high or low risk of diarrhoea, the calculation of predictive values of the tests were done.

**Table 6.4: Sensitivity and specificity of risk perception measures**

| | Numeric | Verbal | Comparative |
|---|---|---|---|
| Sensitivity scores | 0.86 | 0.85 | 0.80 |
| Specificity scores | 0.64 | 0.60 | 0.58 |

The predictive values of test results are useful because it helps to determine the likelihood that the test finding will actually happen. Two main predictive values (positive and negative predictive values) were examined in this study. The positive predictive value of a test result is the likelihood that a person with a positive test finding actually has the predictive attributes. A negative predictive value of test result is the likelihood that a person with a negative test sign does not have the attribute. Table 6.5 shows that, of the 195 households identified with incidence of diarrhoea, 85 of them expressed high numeric risk perception of diarrhoea as a result of flooding. The positive predictive value of the test is, therefore, 44%. Similarly, of the 206 households that were not identified with incidence of diarrhoea, 192 were classified correctly. The negative predictive value of the test is 93%. In sum, positive predictive test from the numeric risk perception measure yielded a 44% probability of being correct, while a negative test recorded a 93% likelihood of being correct. Thus, predicting the likelihood of households not being infected with diarrhoea as a result of flooding using the numeric risk perception measure warrant more confidence than predicting for households that are more likely to report of incidence of diarrhoea.

In terms of verbal risk perception measure, positive predictive test yielded a 32% probability of being correct while the negative test yielded 95% likelihood of being correct. The comparative risk perception measure on the other hand recorded a positive predictive score of 25% probability of being correct and a negative predictive score of 93% likelihood of being correct. All the three risk perception measures predicted the probability of households not reporting incidence of diarrhoea as a result of flooding at a high confidence level than predicting the likelihood of households reporting incidence of diarrhoea as a result of flooding. The verbal measure predicted the highest in terms of predicating the probability of households not reporting incidence of diarrhoea as a result of flooding while the numeric measure predicted the highest in terms of the probability of households reporting incidence of diarrhoea as a result of flooding. Overall, the three risk perception measures did well in predicting households at low risk of diarrhoea as a result of flooding. The numeric measure, however, was the best in terms of predicting the probability of households reporting incidence of diarrhoea as a result of flooding (Table 6.5).

**Table 6.5: Calculation of predictive values for various risk perception measures**

| **Numeric** | | | |
|---|---|---|---|
| Incidence of diarrhoea in household | Risk perception of diarrhoea | | Predictive values |
| | High risk (+) | Low Risk (-) | |
| Yes (+) | 85 | 110 | 85/195 = 43.6% |
| No (-) | 14 | 192 | 192/206 = 93.2% |
| Total | 99 | 302 | |
| **Verbal** | | | |
| Incidence of diarrhoea in household | Risk perception of diarrhoea | | Predictive values |
| | High risk (+) | Low Risk (-) | |
| Yes (+) | 62 | 133 | 62/195 = 31.8% |
| No (-) | 11 | 195 | 195/206 = 94.7% |
| Total | 73 | 328 | |
| **Comparative** | | | |
| Incidence of diarrhoea in household | Risk perception of diarrhoea | | Predictive values |
| | High risk (+) | Low Risk (-) | |
| Yes (+) | 55 | 140 | 55/195 = 28.2% |
| No (-) | 14 | 192 | 192/206 = 93.2% |
| Total | 69 | 332 | |

In conclusion, households in the study area are exposed to flooding and diarrhoeal disease. A little less than half of them experienced the October, 26, 2011 flooding in Accra, while about the same percentage had members of their households reporting incidence of diarrhoea over the period under investigation. Risk perception of diarrhoea as a result of flooding is more pronounced in Agbogbloshie than in *James Town*, because of the ecological differences in the communities and the presence of interventions in the *James Town* community. Households in the research area expressed numeric risk perceptions of diarrhoea than verbal and comparative risk perceptions. They assess their risk based on their experiences without necessarily being mindful of what other neighbours do. They appreciate things that are related to their household than those that they have to relate or compare their household to.

# Chapter Seven

## Bivariate analysis of flooding, risk perceptions, controls and diarrhoeal disease incidence

## 7.1 Introduction

This chapter has been structured into several parts to reflect the contribution of the different factors that affect diarrhoeal disease in urban poor settings. A bivariate analysis between all the factors and diarrhoeal disease incidence is examined in this chapter. Also, a chi-square test is performed on each of the bivariate analyses to establish the statistical associations between incidence of diarrhoea and the factors.

## 7.2 Factors associated with diarrhoeal disease

### *7.2.1 Flooding and diarrhoea*

Households in the study communities are made of different groups of people with different demographic and socio-economic background characteristics that determine how they are affected by environmental hazards. They are exposed to different environmental risks depending on their location in the community and the composition of the household. Table 7.1 indicates that there is a statistically significant association between households' exposure to the October 26, 2011 flooding and incidence of diarrhoeal disease. More than three-fifths (64.3%) of households that experienced the flooding reported an incident of diarrhoeal disease. In *Agbogbloshie*, more than two-thirds (69.3%) of households that experienced the flooding reported incidence of diarrhoea while a little over two-fifths (40.6) of households in *James Town* that experienced the flooding reported incidence of diarrhoea. The experience of flooding influences households to develop some risk perceptions of flooding and other associated consequences that might arise from that, including health consequences.

**Table 7.1 Percentage distribution of household experience of flooding, risk perceptions and incidence of diarrhoeal disease**

| Experience of October 26th, 2011 flooding | Agbogbloshie | | | James Town | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Incidence of diarrhoeal disease | | | | | | | | |
| | Yes | No | N | Yes | No | N | Yes | No | N |
| | | P<0.05 | | | P=(0.181) | | | P<0.001 | |
| Yes | 69.3 | 30.7 | 150 | 40.6 | 59.4 | 32 | 64.3 | 35.7 | 182 |
| No | 53.1 | 46.9 | 49 | 30.6 | 69.4 | 170 | 35.6 | 64.4 | 219 |
| **Numeric risk perception (%)** | | | | | | | | | |
| | | P<0.001 | | | P=(0.136) | | | P<0.001 | |
| 0-19 | 45.4 | 54.6 | 119 | 30.6 | 69.4 | 183 | 36.4 | 63.6 | 302 |
| 20-39 | 95.0 | 5.0 | 40 | 47.4 | 52.6 | 19 | 79.7 | 20.3 | 59 |
| 40-59 | 92.6 | 7.4 | 27 | 0.0 | 0.0 | 0.0 | 92.6 | 7.4 | 27 |
| 60-79 | 100.0 | 0.0 | 7 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 7 |
| 80-100 | 100.0 | 0.0 | 6 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 6 |
| **Verbal risk perception (%)** | | | | | | | | | |
| | | P<0.001 | | | P=(0.702) | | | P<0.001 | |
| Very slow | 46.3 | 53.7 | 67 | 30.3 | 67.7 | 119 | 36.0 | 64.0 | 186 |
| Moderately slow | 58.1 | 41.9 | 74 | 38.8 | 66.2 | 68 | 46.5 | 53.5 | 142 |
| Neither high nor low | 97.2 | 2.8 | 36 | 40.0 | 60.0 | 15 | 80.4 | 19.6 | 51 |
| Moderately high | 95.0 | 5.0 | 20 | 0.0 | 0.0 | 0.0 | 95.0 | 5.0 | 20 |
| Very high | 100.0 | 0.0 | 2 | 0.0 | 0.0 | 0.0 | 100.0 | 0.0 | 2 |
| **Comparative risk perception** | | | | | | | | | |
| | | P<0.001 | | | P<0.001 | | | P<0.000 | |
| Much lower | 48.1 | 51.9 | 52 | 43.5 | 56.5 | 92 | 45.1 | 54.9 | 144 |
| Low | 64.2 | 35.8 | 81 | 21.5 | 78.5 | 107 | 39.9 | 60.1 | 188 |
| About the same | 71.7 | 28.3 | 46 | 0.0 | 100.0 | 1 | 70.2 | 29.8 | 47 |
| High | 100.0 | 0.0 | 19 | 100.0 | 0.0 | 2 | 100.0 | 0.0 | 21 |
| Much higher | 100.0 | 0.0 | 1 | 0.0 | 0.0 | 0 | 100.0 | 0.0 | 1 |
| **Total %** | 65.3 | 34.7 | 199 | 32.2 | 67.8 | 202 | 48.6 | 51.4 | 401 |

### *7.2.2 Risk perceptions and diarrhoea*

In terms of household perception of diarrhoea and how this is related to incidence of diarrhoeal disease in the event of flooding, three risk perception measures (numeric, verbal, comparative) of diarrhoea were examined. There is statistically significant association between household numeric risk perception measure and incidence of diarrhoea in the *Agbogbloshie* community, but this is not statistically significant for *James Town*. Numerically, the percentage of household members that reported diarrhoeal disease increases with an increase in the percentage risk of the households. The higher the percentage risks the more likely that there will be incidence of diarrhoea in the household. All the households that reported higher percentage risks of 40% and above in *Agbogbloshie* reported high incidence of diarrhoeal disease.

Households' verbal risk perception measure was also statistically associated significantly with incidence of diarrhoeal disease in *Agbogbloshie*, but not statistically significant in *James Town*. Table 7.1 shows that a little over 5 out of 10 (58.1%) of households that mentioned that they were moderately low of being at risk with diarrhoea in *Agbogbloshie* reported diarrhoeal disease in their households. At every level of verbal measurement, over two-fifths of households reported diarrhoeal disease. This is an indication that diarrhoeal disease affects everybody in the community because the mode of transmission seems to emanate from a common good that is shared in the community.

Another interesting indicator in examining households' risk of diarrhoea is a comparative measure and its relationship with incidence of diarrhoeal disease. Most households saw themselves to be at either much lower or low risk of diarrhoea; but over one-third of these households reported incidence of diarrhoeal disease. In *Agbogbloshie* for instance, 6 out of 10 (64.2%) of households that reported that their households were at low risk of diarrhoea compared to other households reported diarrhoeal disease. With regard to households that rated their risk of diarrhoea as a result of flooding as being about the same as other people in their community, 70.2% of them reported diarrhoeal disease in their households. Household comparative risk perception measure was statistically significant with diarrhoeal disease in households in both study communities (Table 7.1). The comparative risk perception measure is the only measure that was statistically significant for the *James Town* community. This is because the *James Town* community has received a lot of intervention as part of the national development agenda to up-grade Old Accra (especially *James Town* and *Ussher Town*) since 2004. This has led to the construction of some drainage systems and public places of convenience for the people of *James Town*. The community has also benefited from the distribution of households waste containers from some private non-governmental organisations in Accra to help in the management of waste at the household level. The *Agbogbloshie* community has not had such interventions because of the perceptions people have that the inhabitants of the place are squatters. People in James Town, therefore, examine issues in a collective form while those in Agbogbloshie are based on self-assessment.

### *7.2.3 Household preventive strategies and diarrhoea*

Personal hygiene behaviour in household is linked to incidence of disease because of the likelihood of food or water contamination through poor hygiene. Table 7.2 shows that there is a statistically significant association between washing of hands with soap before eating and incidence of diarrhoea in *James Town,* but not in *Agbogbloshie*. However, there is no statistically significant association between washing of hands with soap after coming from wash room and incidence of diarrhoea in households in the study communities. With regard to the households that do not wash their hands with soap before eating, 47.3% reported incidence of diarrhoea. There is equally higher proportion of households in *Agbogbloshie* (58.7%) that reported incidence of diarrhoea as a result of not washing their hands with soap before eating compared to those in *James Town* (47.4%). Also, 45.4% of households in the study communities who do not wash their hands after coming from the wash room reported incidence of diarrhoea.

In terms of water purification, only a few households that drink pipe borne water purify it. Less than two-fifths (39%) of households that purify their water reported incidence of diarrhoea within four weeks after the October 26$^{th}$, 2011 flooding in the study communities. This association was, however, not statistically significant. Furthermore, the presence of livestock such as sheep and goats in a household has been found to have significant relationship with disease transmission (Pathela et al. 2005). In Table 7.2, there is a statistically significant association between the presence of livestock in households and diarrhoeal disease. One-fifth (20%) of households that had livestock reported diarrhoeal disease. These livestock could contaminate household food and water with diseases through their droppings. Also, the presence of cockroaches in households has been established to be scientifically associated with the spread of diarrhoeal disease (Tachbele et al. 2006; Agbodaze & Owusu 1989).

Furthermore, there is a statistically significant association between the presence of cockroaches in household and diarrhoeal disease incidence in the *Agbogbloshie* community. More than three-fifth (63.2%) of households that reported to have seen cockroaches in their homes for four or more times in the last seven days preceding the survey had members diagnosed with diarrhoeal disease. It is difficult to control the movement of cockroaches under the kind of living arrangement that pertains in urban poor communities. The transmission of diarrhoeal disease through cockroaches will, therefore, be more pronounced in the study area.

**Table 7.2: Percentage distribution of hygiene practices, water purification and diarrhoeal disease incidence**

| Occasion washed hand with soap | Agbogbloshie | | | James Town | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Diarrhoeal disease incidence | | | | | | | | |
| | Yes | No (P=0.281) | N | Yes | No P<0.010 | N | Yes | No (P=0.371) | N |
| **Before eating** | | | | | | | | | |
| Yes | 58.7 | 41.3 | 46 | 47.4 | 52.6 | 57 | 52.4 | 47.6 | 103 |
| No | 67.3 | 32.7 | 153 | 26.2 | 73.8 | 145 | 47.3 | 52.7 | 298 |
| **After coming from wash room** | | | | | | | | | |
| | | (0.805) | | | (0.190) | | | (0.117) | |
| Yes | 66.3 | 33.7 | 86 | 38.0 | 62.0 | 71 | 53.5 | 46.5 | 157 |
| No | 64.6 | 35.4 | 113 | 29.0 | 71.0 | 131 | 45.4 | 54.5 | 244 |
| **Purify water before drinking** | | | | | | | | | |
| | | P=(0.750) | | | P=(0.294) | | | P=(0.283) | |
| Yes | 70.0 | 30.0 | 10 | 26.9 | 73.1 | 26 | 38.9 | 61.1 | 36 |
| No | 65.1 | 34.9 | 189 | 32.6 | 67.4 | 176 | 49.5 | 50.5 | 365 |
| **Presence of livestock in household** | | | | | | | | | |
| | | P=(0.087) | | | P=(0.307) | | | P<0.050 | |
| Yes | 25.0 | 75.0 | 4 | 18.2 | 81.8 | 11 | 20.0 | 80.0 | 15 |
| No | 66.2 | 33.8 | 195 | 33.0 | 67.0 | 191 | 49.7 | 50.3 | 386 |
| **Number of times seen cockroaches in household in the last 7 days** | | | | | | | | | |
| | | | P<0.001 | | P=(0.749) | | | | P<0.001 |
| Never | 36.1 | 63.9 | 36 | 34.0 | 66.0 | 53 | 34.8 | 65.2 | 89 |
| 1 - 3 Times | 55.6 | 44.4 | 36 | 27.6 | 72.4 | 76 | 36.6 | 63.4 | 112 |
| 4 or more Times | 77.0 | 23.0 | 126 | 35.96 | 64.1 | 64 | 63.2 | 36.8 | 190 |
| Don't Know | 0.0 | 100.0 | 1 | 33.3 | 66.7 | 9 | 30.0 | 70.0 | 10 |
| **Total %** | 65.3 | 34.7 | 199 | 32.2 | 67.8 | 202 | 48.6 | 51.4 | 401 |

### *7.2.4 Socio-demographic characteristics and diarrhoea*

The findings of this study show that the sex of the head of household is not statistically associated with incidence of diarrhoeal disease in household (Table 7.3) even though the literature suggests in general that female-headed households in sub-Saharan Africa (SSA) tend to be organised and protected from illnesses than male headed households (Yavinsky 2012). This is because the health care needs of households in SSA are mostly provided by women and having a female head implies that attention would be given to individual health needs of household members. There is not much difference between male and female headed households in Agbogbloshie pertaining to members who reported diarrhoeal disease during the first four weeks after the October 26, 2011 flooding in Accra. In *James Town*, however, a high proportion of male-headed households reported diarrhoeal disease than female-headed households.

In addition to the sex of the head of household, the age of household members helped in determining the vulnerability of the household to diarrhoeal disease. Households that are composed of members in economically active ages are less likely to report diarrhoeal disease than those with higher proportion of children and ageing population. There is a statistically significant association between age of household members and incidence of diarrhoeal disease in urban poor settings ($P<0.05$). Overall, experience of diarrhoeal disease in urban poor households decreases with an increase in the age of household members (Table 7.3). However, the percentage of household members reporting incidence of diarrhoeal disease in *Agbogbloshie* is high among households with an average age of less than 30 years, low among those with an average age of 30-39 years and rises again among those with an average age of 40 years and above. In *James Town* on the other hand, incidence of diarrhoeal disease in household seems to increase with an increase in average age of household members. There is no statistically significant association between household size and incidence of diarrhoeal disease in the study communities. The percentage of households that reported members with diarrhoeal disease, however, decreases with an increase in household size. The incidence of diarrhoea in households relates more with the composition of the household than the size (Agbodadze and owusu 1989).

**Table 7.3: Percentage distribution of demographic, social and economic characteristics and diarrhoeal disease incidence**

| | Agbogbloshie | | | James Town | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Incidence of diarrhoea | | | | | | | | |
| **Socio-demographic characteristics** | Yes | No | N | Yes | No | N | Yes | No | N |
| **Sex** | | (P= 0.864) | | | (P=0.431) | | | (P= 0.352) | |
| Male | 65.8 | 34.2 | 117 | 34.5 | 65.5 | 110 | 50.7 | 49.3 | 227 |
| Female | 64.6 | 35.4 | 82 | 29.3 | 70.7 | 92 | 46 | 54 | 174 |
| **Age of household members** | | (P<0.01) | | | (P=0.831) | | | P< 0.050) | |
| <15 | 92.3 | 7.7 | 13 | 20 | 80 | 10 | 60.9 | 39.1 | 23 |
| 15-19 | 74.5 | 25.5 | 47 | 39.1 | 60.9 | 23 | 62.9 | 37.1 | 70 |
| 20-24 | 65.1 | 34.9 | 43 | 27.5 | 72.5 | 40 | 47.0 | 53.0 | 83 |
| 25-29 | 66 | 34 | 50 | 32.4 | 67.6 | 34 | 52.4 | 47.6 | 84 |
| 30-34 | 56.5 | 43.5 | 23 | 34.8 | 65.2 | 23 | 45.7 | 54.3 | 46 |
| 35-39 | 16.7 | 83.3 | 12 | 47.1 | 52.9 | 17 | 34.5 | 65.5 | 29 |
| 40-44 | 66.7 | 33.3 | 3 | 21.4 | 78.6 | 14 | 29.4 | 70.6 | 17 |
| 45-49 | 25 | 75.0 | 4 | 36.4 | 63.6 | 11 | 33.3 | 66.7 | 15 |
| 50+ | 100 | 0.0 | 4 | 30.0 | 70.0 | 30 | 38.2 | 61.8 | 34 |
| **Household size** | | (P=0.952) | | | (P=0.617) | | | (P=0.256) | |
| 1 | 66.7 | 33.3 | 42 | 34.4 | 65.6 | 64 | 47.2 | 52.8 | 106 |
| 2-3 | 66.3 | 33.7 | 83 | 36.8 | 63.2 | 57 | 54.3 | 45.7 | 140 |
| 4-6 | 64.5 | 35.5 | 62 | 28.3 | 71.7 | 60 | 46.7 | 53.3 | 122 |
| 7+ | 58.3 | 41.7 | 12 | 23.8 | 76.2 | 21 | 36.4 | 63.6 | 33 |
| **Proportion of household members with some education** | | P=(0.767) | | | P=(0.297) | | | P=(0.766) | |
| No member had education | 50 | 50 | 4 | 25 | 75 | 4 | 37.5 | 62.5 | 8 |
| Less than 50% had education | 100 | - | 1 | - | 100 | 2 | 33.3 | 66.7 | 3 |
| More than 50% had education | 67.9 | 32.1 | 53 | 23.5 | 76.5 | 51 | 46.2 | 53.8 | 104 |
| All members had education | 64.5 | 35.5 | 141 | 35.9 | 64.1 | 145 | 50 | 50 | 286 |
| **Wealth quintile** | | (P=0.803) | | | (P=0.082) | | | (P=0.392) | |
| Poorest | 69.8 | 30.2 | 53 | 23.7 | 76.3 | 38 | 50.5 | 49.5 | 91 |
| Poor | 65.3 | 34.7 | 49 | 41.2 | 58.8 | 34 | 55.4 | 44.6 | 83 |
| Middle | 57.5 | 42.5 | 40 | 16.7 | 83.3 | 30 | 40 | 60 | 70 |
| Rich | 67.7 | 32.3 | 31 | 31.3 | 68.8 | 48 | 45.6 | 54.4 | 79 |
| Richest | 65.4 | 34.6 | 26 | 42.3 | 57.7 | 52 | 50 | 50 | 78 |
| **Total** | 65.3 | 34.7 | 199 | 32.2 | 67.8 | 202 | 48.6 | 51.4 | 401 |

Another significant household characteristic is the level of education of household members. Education plays a critical role in helping individuals to access more information and also be able to make informed decisions that will benefit them and their household. Any form of education by household members is important in helping them to take decisions on health-related matters. In this regard, the proportion of household members with some form of education was examined in relation to diarrhoeal disease incidence in households. Table 7.3 shows that there is no statistically significant association between the proportion of household members with some form of education and diarrhoeal disease incidence in households. Diarrhoeal disease occurs in households with no member having some form of education and also in households where all members have some form of education. This is an indication that diarrhoea as a health challenge is a community problem and individual efforts alone may not be enough to address it.

Wealth status of households also plays an important role in determining the choice of neighbourhood for households and the kind of environmental hazards they may be exposed to. In urban poor neighbourhoods, there is not much variation in income among households. Table 7.3 indicates that the wealth status of the households did not show any statistically significant association with incidence of diarrhoeal disease in households. There is not much difference in the percentage of household in the poorest and poor wealth quintiles compared to those in the rich and richest wealth quintiles and household incidence of diarrhoeal disease.

### *7.2.5 Household water, sanitation and diarrhoea*

Household water and sanitation are strong mediating predictors of flooding and diarrhoeal disease relationship. The state of water and sanitation situation in the households determine the risk of members of households contracting diarrhoeal disease in the event of flooding. There is no statistically significant association between the type of toilet used by households and experience of diarrhoeal disease in households at p-value of 0.05 (Table 7.4). Approximately half (49.7%) and more than half (53.3%) of households that use public toilets and KVIP respectively reported diarrhoeal disease within the first four weeks of the October 26, 2011 flooding. In *Agbogbloshie* for instance, almost every household uses either KVIP or public toilet. The sanitary conditions in some of the public toilet facilities and household KVIPs are appalling and this could facilitate disease transmission in the communities. In *James Town*, there are few households that continue to use bucket pan and pit latrines. There are equally some households in the community that use water closet toilets in their homes. Generally, households in the study area share toilet facilities. Earlier qualitative interviews in the communities revealed that, lack of space in housing structures is responsible for the non-provision of toilet facilities for individual households. Also, house owners do not make any effort to provide toilet facilities for tenants. In some 'compound houses', rooms that were originally designed for toilet facilities have been converted into single bed rooms because of the high demand for accommodation in the communities.

Table 7.4 shows that in terms of main source of drinking water, majority of the households mentioned "sachet"/bottled water as their main source of drinking water. More than half (55.2%) of households that use "sachet"/bottled water reported diarrhoeal disease while amongst those who use other forms of pipe borne water, a low percentage reported diarrhoeal disease. Among households that have pipe in their dwelling, less than one out of ten (8.7%) reported diarrhoeal disease within the first four weeks of the October 26, 2011 flooding. The general perception that "sachet"/bottled water is very hygienic compared to other sources of water need to be looked at again. The quality of "sachet" water in urban places in Africa has been found to be of poor quality but this is the water that is mostly patronised by rich households (Stoler et al. 2012).

**Table 7.4: Percentage distribution of water, sanitation and incidence of diarrhoeal disease**

| | Agbogbloshie | | | James Town | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Incidence of diarrhoea | | | | | | | | |
| **Water and sanitation** | Yes | No | N | Yes | No | N | Yes | No | N |
| **Main source of drinking water** | | (P=0.354) | | | (P=0.795) | | | (P=0.276) | |
| Piped into dwelling | 0.0 | 100 | 1 | 9.1 | 90.9 | 22 | 8.7 | 91.3 | 23 |
| Piped into yard | 33.3 | 66.7 | 6 | 41.2 | 58.8 | 17 | 39.1 | 60.9 | 23 |
| Public tap/stand pipe | 62.2 | 37.8 | 45 | 25.5 | 74.5 | 51 | 42.7 | 57.3 | 96 |
| Sachet water/bottled water | 68 | 32 | 147 | 38.4 | 61.6 | 112 | 55.2 | 44.8 | 259 |
| **Type of toilet facility** | | (P=0.154) | | | (P<0.050) | | | (P<0.001) | |
| No facility/bucket pan/pit latrine | 0.0 | 100.0 | 1 | 40 | 60 | 10 | 36.4 | 63.6 | 11 |
| WC/Flush toilet | 0.0 | 0.0 | 0 | 30 | 70 | 20 | 30 | 70 | 20 |
| KVIP | 70.0 | 30.0 | 20 | 20 | 80 | 10 | 53.3 | 46.7 | 30 |
| Public toilet | 65.2 | 34.8 | 178 | 32.7 | 67.3 | 162 | 49.7 | 50.3 | 340 |
| **Mode of household solid waste disposal** | | (p=0.398) | | | (p=0.252) | | | (p=0.212) | |
| Collected at home by a private company | 0.0 | 100 | 1 | 35 | 65 | 60 | 34.4 | 65.6 | 61 |
| Collected at home by a government agency | 50 | 50 | 2 | 25 | 75 | 32 | 26.5 | 73.5 | 34 |
| Refuse container | 68.7 | 31.3 | 115 | 30.7 | 69.3 | 75 | 53.7 | 46.3 | 190 |
| Community drain | 100 | 0.0 | 1 | 80 | 20 | 5 | 83.3 | 16.7 | 6 |
| Truck pushers (kaya bola) | 60.3 | 39.7 | 78 | 35.3 | 64.7 | 17 | 55.8 | 44.2 | 95 |
| Other | 100 | 0.0 | 13 | 30 | 70 | 13 | 41.7 | 58.3 | 15 |
| **Mode of household liquid waste disposal** | | (P=0.148) | | | (P=0.688) | | | (P=0.816) | |
| Septic tank | 0.0 | 100 | 2 | 100 | 0.0 | 1 | 33.3 | 66.7 | 3 |
| Community drain | 64.7 | 35.3 | 184 | 32.3 | 67.7 | 155 | 49.9 | 50.1 | 339 |
| Back of house | 83.3 | 16.7 | 6 | 30.8 | 69.2 | 26 | 40.6 | 59.4 | 32 |
| Other | 83.3 | 16.7 | 7 | 30.3 | 69.7 | 20 | 44.2 | 55.8 | 27 |
| Total | 65.3 | 34.7 | 199 | 32.2 | 67.8 | 202 | 48.6 | 51.4 | 401 |

Apart from the quality of household drinking water in urban poor places there is the issue of household waste management. The management of household solid and liquid waste has become a major challenge in urban places in Africa especially in poor neighbourhoods

(WHO/UNICEF 2006). In many instances, refuse containers are provided at strategic locations in communities for people to dispose their solid waste while liquid waste is disposed in the drains in the community. In places where there are no drains, liquid waste is disposed indiscriminately. The details of the mode of disposal of solid and liquid waste are indicated in Table 7.4. There is, however, no statistically significant association between place of disposal of solid waste and experience of diarrhoeal disease in household at p-value of 0.05.

### *7.2.6 Household environmental risk factors and diarrhoea*

There are other household environmental factors that determine the risk of diarrhoeal disease in the households. These are: distance of house to the nearest refuse collection point and public toilet facility, and the presence of livestock and cockroaches in households. These environmental factors facilitate disease transmission in the household.

The location of sanitary facilities such as public toilets and refuse containers creates sanitation problems in urban poor places. In most instances, these public toilets are not kept clean and households that live close to these facilities are at high risk of disease infections. With regard to refuse containers, the collection is irregular and is often left in the community for days when it is full and this creates inconveniences for households that live closer to these containers. Also, because the containers are not emptied on time, people from the community dump their waste around the container creating a lot of health challenges for people who live close-by.

Table 7.5 shows that there is statistically significant association between the distance of a household to the nearest refuse container and incidence of diarrrhoeal disease in household. Among households that live within 50 metres from a community refuse container, a little over two-fifth (41.1%) of them reported diarrhoeal disease in their households while more than two-thirds (72.2%) of those who live 50 metres or more away from community refuse containers reported household members with incidence of diarrhoeal disease within the first four weeks after the October 26, 2011 flooding in Accra. The delay in collecting waste from homes in poor communities could lead to improper disposal of waste. Households that live far away from refuse containers in poor communities may resort to indiscriminate disposal of waste because they have no other options. This practice has health consequences which include diarrhoea, typhoid and worm infections (Yaqout 2003). It is expected that households who live 50 metres or more away from community refuse containers will report less diarrhoea, but that is not the case in the research communities. Generally, the sanitation condition in the area is poor and so distance to public refuse containers does not differentiate incidence of diarrhoea among households. Also, the distance of households to the nearest public water closet toilet is not statistically associated significantly with diarrhoeal disease. These toilets are managed by private individuals for profit making, thereby improving on the hygiene condition of these toilets.

**Table 7.5: Percentage distribution of environmental risk factors and diarrhoeal disease**

| **Environmental risk factors** | Agbogbloshie | | | James Town | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Incidence of diarrhoeal disease | | | | | | | | |
| | Yes | No | N | Yes | No | N | Yes | No | N |
| | | p=(0.736) | | | p=(0.070) | | | p=(0.228) | |
| **Distance to the nearest public toilet** | | | | | | | | | |
| Less than 50 metres | 63.8 | 36.2 | 69 | 23.4 | 76.6 | 64 | 44.4 | 55.6 | 133 |
| 50 metres or more | 66.2 | 33.8 | 130 | 36.2 | 63.8 | 138 | 50.7 | 49.3 | 268 |
| **Distance to the nearest Refuse collection point** | | | | | | | | | |
| | | p=(0.095) | | | P<0.050 | | | P<0.001 | |
| Less than 50 metres | 60.0 | 40.0 | 105 | 31.2 | 68.8 | 199 | 41.1 | 58.9 | 304 |
| 50 metres or more | 71.3 | 28.7 | 94 | 100.0 | 0.0 | 3 | 72.2 | 27.8 | 97 |
| **Total %** | 65.3 | 34.7 | 199 | 32.2 | 67.8 | 202 | 48.6 | 51.4 | 401 |

In conclusion, there is a statistically significant association between flooding and incidence of diarrhoea and also, between risk perception measures of diarrhoea and incidence of diarrhoea. Households that experienced the October 26, 2011 flooding reported more incidence of diarrhoea than those who did not experience the flooding. Also, households that expressed high risk of diarrhoea across all the three risk perception measures are those who reported more diarrhoea incidence than their counterparts who expressed low risk. Other demographic and environmental risk factors that showed statistically significant association with incidence of diarrhoea are, distance to the nearest refuse collection points, source of drinking water, age of household members, type of toilet facility and the number of times that cockroaches had been seen in household in the past seven days preceding the survey. There is a statistically significant association between poor environmental condition in the research communities and incidence of diarrhoeal disease. Flooding and risk perception measures are important factors that affect diarrhoeal disease in the research communities.

# Chapter Eight

## Multivariate Analysis of Flooding, Risk perceptions, Controls and incidence of diarrhoeal disease

### 8.1 Introduction

This chapter focuses on multivariate analyses of the relationship that exists among the variables under investigation. In all, four models were run to examine the robustness of the relationship between diarrhoeal disease incidence and flood, risk perception measures, household preventive strategies, socio-demographic characteristics of households, water, sanitation, and environmental risk factors. In particular, the relationship between risk perception of diarrhoeal disease and incidence of diarrhoea was examined to see the contribution of each of the measures to incidence of diarrhoea in urban poor communities by controlling for the other risk factors.

### 8.2 Factor affecting diarrhoeal disease in household

Household experience of flooding predisposes members to diarrhoeal disease. Table 8.1 shows the relationship between household experience of October 26$^{th}$, 2011 flooding in the study communities and incidence of diarrhoeal disease. The model shows that about 6% of the variation in diarrhoeal disease in households in urban poor settings is explained by households' experience of flooding in the study communities. This relationship assumes that no other factors affect diarrhoeal disease in households with the exception of their experience of flooding. The Wald $\chi 2$ of the model is significant at 99% confidence interval indicating that the model is a good fit. Households that experienced flooding were 3.254 as likely as their counterparts who did not experience flooding over the period to report incidence of diarrhoeal disease. It is assumed in this analysis that households that are very vulnerable to the health impacts of flooding are those who live in fragile areas of the community where water and sanitation infrastructure are affected by flooding during heavy rainfall. Empirically, the duration of floods on diarrhoea has not been clearly established but the effect of flooding on water and sanitation infrastructure has been estimated to last up to six months (McCluskey 2001).

**Table 8.1: Binary logistic regression results for the relationship between household experience of flooding, measures of diarrhoeal disease risk and incidence of diarrhoea in the study communities (N=401)**

| | Model 1 | | | | Model 2 | | | |
|---|---|---|---|---|---|---|---|---|
| Characteristics | Coef. | Robust S.E | | Odds Ratio | coef. | Robust S.E | | Odds ratio |
| *Household experience of flood (RC=No)* | | | | | | | | |
| Yes | 1.180 | 0.210 | *** | 3.254 | 0.789 | 0.242 | *** | 2.201 |
| *Numeric risk perception (%) (RC=0-19)* | | | | | | | | |
| 20-39 | | | | | 2.085 | 0.352 | *** | 8.045 |
| 40+ | | | | | 2.194 | 0.818 | ** | 8.971 |
| *Verbal risk perception (RC=Very Low)* | | | | | | | | |
| Moderately low | | | | | 0.239 | 0.274 | | 1.270 |
| Neither high nor low | | | | | 1.803 | 0.417 | *** | 6.068 |
| [2]Moderately high | | | | | 1.968 | 1.039 | ** | 7.156 |
| *Comparative risk perception (RC=Much low)* | | | | | | | | |
| Low | | | | | -0.547 | 0.268 | ** | 0.579 |
| [3]About the same | | | | | -0.390 | 0.424 | | 0.677 |
| Constant | -0.592 | 0.141 | *** | | -0.950 | 0.260 | *** | 0.387 |
| Model $R^2$ | 0.060 | | | | 0.191 | | | |
| Wald $\chi 2$ | (1) | 31.67 | *** | | (8) | 85.54 | *** | |

** p<0.05; ** p<0.01; ***P<0.001*

[2] Moderately high includes very high categories because of fewer cases in very high category

[3] About the same includes higher and much higher categories because of fewer cases in them

The effects of risk perception measures on diarrhoeal disease were examined in Model 2. Table 8.1 (model 2) shows that about 19% of the variation in incidence of diarrhoea in the study communities is explained by households' experience of flooding and the various risk perceptions households have about diarrhoea as a result of their experience of flooding. The Wald $\chi 2$ of the model is significant at 99% confidence interval indicating that the model is a good fit. The numeric and verbal risk perception measures had more likelihood effect on incidence of diarrhoea while the comparative measure had less likelihood effect on incidence of diarrhoea. Experience of the October 26$^{th}$, 2011 flooding in the study communities also had a more likelihood effect on diarrhoeal disease. Households that scored their risk of diarrhoea between 20-39% were 8.045 times as likely as those who scored their risk between 0-19% to report incidence of diarrhoea. Also, households who scored their risk 40% and over were 8.971 times as likely as those who scored their risk 0-19% to report incidence of diarrhoea. The increase in the percentage of the risk score of households is associated with an increase in incidence of diarrhoea in households. In terms of the verbal risk measure, households that had neither high nor low risk were 6.068 times as likely as those who said they are at very low risk to report incidence of diarrhoea. In addition, households that reported to be moderately high at risk of diarrhoea were 7.156 as likely as those who indicated that they were at very low risk to report incidence of diarrhoea. The comparative measure on the other hand indicates that households that mentioned that they were at low risk of diarrhoea were 0.579 times less likely as those who said they were at much low risk to report incidence of diarrhoea.

In order to test the robustness of the associations that were established between flooding and incidence of diarrhoea in Model 1, and risk perception measures and incidence of diarrhoea in Model 2, a third Model was examined where all other factors that also affect incidence of diarrhoea were controlled. In Model 3, about 27% of the variation in household diarrhoeal disease in study communities is explained by household experience of flooding, risk perceptions of households, household socio-demographic characteristics, water and sanitation and other environmental risk factors (Table 8.2). This is an increase in the Model R Square over what pertained in models 1 and 2 where only household experience of flooding was considered. Thus, household environmental risk factors play a crucial role in diarrhoeal disease incidence at the household level. In sum, the coefficient of predictor variables (experience of flooding, risk perceptions of diarrhoea, distance of households to the nearest refuse collection point, presence of cockroaches in household and source of drinking water) were all significant at 95% or higher in predicting incidence of diarrhoeal disease. Households' experience of flooding, numeric and verbal risk perception measures, presence of cockroaches in household and source of drinking water have a more likelihood effect on incidence of diarrhoeal disease, while comparative risk perception measure, distance of households to the nearest refuse collection point have a less likelihood effect on incidence of diarrhoeal disease.

Table 8.2, Model 3 indicates that households that were exposed to flooding in the study communities were 1.459 times as likely as those who were not exposed to flooding to report of incidence of diarrhoeal disease. In terms of risk perceptions, households that reported high numeric risk scores (20-39% and 40+) were 7.776 and 9.412 times respectively as likely as those who reported low numeric risk scores (0-19%) to report incidence of diarrhoea. Also, households with neither high nor low verbal risk measure were 7.576 times as likely as those with very low verbal risk perception scores to report incidence of diarrhoea. The comparative risk perception measures indicates that households with low comparative risk measure were 0.542 times as likely as those with very low comparative risk perception measure to report incidence of diarrhoea. Generally, while verbal and numeric risk perception measures predicted the likelihood of incidence of diarrhoeal disease in households the comparative measure predicted less likelihood. The results indicate that risk perceptions are important factors in determining factors affecting diarrhoeal disease in flood prone communities.

**Table 8.2: Binary logistic regression results for the effects of flooding, measures of diarrhoeal disease risk and other control factors on incidence of diarrhoea in the study communities (N=401)**

| Model 3 | | | | |
|---|---|---|---|---|
| Characteristics | Coef. | Robust S.E | | Odd Ratio |
| *Household experience of flood (RC=No)* | | | | |
| Yes | 0.378 | 0.290 | * | 1.459 |
| *Numeric risk perception (%) (RC=0-19%)* | | | | |
| 20-39 | 2.051 | 0.391 | *** | 7.776 |
| 40-59 | 2.242 | 0.775 | ** | 9.412 |
| *Verbal risk perception (RC=Very slow)* | | | | |
| Moderately slow | 0.220 | 0.313 | | 1.246 |
| Neither high nor low | 2.025 | 0.468 | *** | 7.576 |
| [4]Moderately high | 1.607 | 1.208 | | 4.988 |
| *Comparative risk perception (RC=Much low)* | | | | |
| Low | -0.612 | 0.291 | * | 0.542 |
| [5]About the same | -0.572 | 0.516 | | 0.564 |
| *Wash hand with soap before eating (RC=Yes)* | | | | |
| No | -0.545 | 0.332 | | 0.580 |
| *Wash hand with soap after visiting wash room (RC=Yes)* | | | | |
| No | -0.100 | 0.296 | | 0.905 |
| *Do you purify your water before drinking (Yes)* | | | | |
| No | 0.025 | 0.561 | | 1.025 |

[4] Moderately high categories includes very high because of fewer cases in very high category

[5] About the same include higher and much higher categories because of fewer cases in them

| Model 3 – Continuation | | | | |
|---|---|---|---|---|
| Characteristics | Coef. | Robust S.E | | Odd Ratio |
| *Do you have livestock (RC=No)* | | | | |
| Yes | 1.743 | 1.142 | | 5.714 |
| *Number of times seen cockroaches in household in past 7 days (RC=Never)* | | | | |
| 1-3 times | 0.071 | 0.386 | | 1.074 |
| 4 or more times | 0.765 | 0.338 | * | 2.149 |
| Don't know | 0.595 | 0.975 | | 1.813 |
| *Mean age of household members* | -0.007 | 0.009 | | 0.993 |
| *Mean education of household members* | 0.205 | 0.184 | | 1.228 |
| *Sex of household head (Male)* | | | | |
| Female | 0.150 | 0.286 | | 1.162 |
| *Wealth quintile (RC=Poorer)* | | | | |
| Poor | 0.497 | 0.401 | | 1.644 |
| Middle | -0.354 | 0.441 | | 0.702 |
| Rich | 0.160 | 0.413 | | 1.174 |
| Richest | 0.675 | 0.427 | | 1.964 |
| *Household size* | -0.039 | 0.065 | | 0.962 |
| *Distance to the nearest public toilet (RC=<50 metres)* | | | | |
| 50 metres and above | -0.155 | 0.307 | | 0.856 |
| *Distance to nearest refuse collection point (RC=<50 metres)* | | | | |
| 50 metres and above | 0.787 | 0.400 | * | 2.197 |
| *Type of toilet facility (RC=Bucket pan/pit latrine)* | | | | |
| WC/Flush toilet | -0.315 | 0.943 | | 0.730 |
| KVIP | -0.815 | 0.894 | | 0.443 |
| Public toilet | -0.579 | 0.638 | | 0.560 |
| *Mode of disposing solid waste (RC=Unimproved)* | | | | |
| Improved | -0.105 | 0.337 | | 0.900 |
| *Mode of disposing liquid waste (RC=Unimproved)* | | | | |
| Improved | 0.105 | 0.380 | | 1.111 |
| *Source of drinking water (RC=Piped into dwelling)* | | | | |
| Piped into yard | 1.608 | 1.061 | | 4.993 |
| Public tap/stand pipe | 1.154 | 0.907 | | 3.171 |
| Sachet water/bottled water | 1.817 | 0.865 | * | 6.153 |
| Constant | -3.758 | 1.865 | * | |
| Model $R^2$ | 0.271 | | | |
| Wald $\chi 2$ | (33) | 105.91 | *** | |

** $p<0.05$; ** $p<0.01$; ***$P<0.001$*

In addition, the results in Model 3 show that distance of household to the nearest refuse collection point is a significant predictor of diarrhoeal disease in household. Households that live 50 metres or more away from a public refuse collection point were 2.197 times as likely as those who live less than 50 metres away from public refuse collection points to report incidence of diarrhoea. It has been found in other studies that the sanitary conditions around public refuse collection points pose a lot of health challenges to people that live closer to it (Hashizume et al. 2008; Hashizume et al. 2007; Boadi & Kuitune 2005). However, in the study setting, diarrhoeal disease affects households that live far away from public refuse collection points than those who live closer to it. The general sanitation in the study communities is poor and this puts every household in the area at risk of diarrhoea. Those who live far away from a public refuse collection points are more likely dispose their waste indiscriminately because of lack of refuse containers, which could result in pollution and disease outbreak during flooding. Also, it could be that the WHO standard of 50 metres threshold from a public refuse collection point does not apply to these settings. In addition, households that had seen cockroaches four or more times in their home were 2.149 times as likely as those who have not seen cockroaches in their in past seven days preceding the survey to report incidence of diarrhoea. This is a very important indicator of sanitation at the household level and some studies have shown that cockroaches are carriers of the bacteria that cause diarrhoea (Agbodaze and Owusu 1989).

Furthermore, households' source of drinking water was a significant predictor of diarrhoeal disease. Households that drink "sachet"/bottled water were 6.153 times as likely as those who had pipe borne water in their dwelling to report incidence of diarrhoea. A higher proportion of households in the study communities drink "sachet" water (also known as "pure water") because it is believed to be clean and is of good quality. There are a number of 'sachet' water in the market with different prices depending on the quality of bagging and the taste of it. This research is not able to tell the type of "sachet" water that triggers diarrhoea, because analysis on various types of "sachet" water was not done.

In conclusion, the main predictors of diarrhoeal disease in urban poor communities in the Ashiedu-Keteke sub-Metropoliatan Area of Accra are flooding, risk perception measures of diarrhoea, distance to the nearest refuse collection points, number of times that cockroaches have been seen in household in the past seven days preceding the survey, and source of drinking water. Households that experience flooding in the study area were more likely to report incidence of diarrhoea than those who did not experience flooding. The numeric and verbal risk perception measures predict the likelihood of households reporting incidence of diarrhoea while the comparative risk perception measure predict the less likelihood of households reporting incidence of diarrhoea. Thus, comparatively, every household in the study community perceive that they are better than other households and so rate their risk lower compared to others. The numeric and verbal risk perception measures are the best in targeting households at higher risk of diarrhoea for interventions. Also, the use of "sachet" water as the main source of drinking water by majority of the households in the area should be a critical concern to public health practitioners. Even though this research does not indicate the type of "sachet" water that triggers diarrhoeal disease in the research communities, the belief that people have about the quality of "sachet" water needs further investigation and education.

# Chapter Nine

## Summary, Conclusions and Recommendations

### 9.1 Summary

Diarrhoeal disease is affected by environmental, demographic and socio-economic factors. In this thesis, experience of flooding is an important climatic factor in the flooding and diarrhoea nexus. Flooding destroys household property; pollute household water and food, which has potential adverse health effects on households including diarrhoea. Despite the evidence to the effect that flood will increase in Accra with attendant adverse effects on human health, few researches in the past decade have demonstrated the association between flooding and diarrhoea but none of these researches has incorporated the risk perceptions of diarrhoea people develop as a result of their experience of flooding. It has also been a problem examining the relationship between flooding and diarrhoea because of the lack of time series data on the number of factors that mediate this relationship. The complexity in establishing these relationships demands a thorough investigation of the environmental, demographic and socio-economic predictors of diarrhoeal disease. To understand how households measure the risk of diarrhoea considering other factors that predict the incidence of diarrhoea, this study considered three measures of diarrhoeal disease risk in the study communities, the demographic and socio-economic situation of households, and the environmental condition of the study area that increases their susceptibility to diarrhoeal disease.

The results indicate that flooding predicts diarrhoeal disease in the Ashiedu-Keteke sub-Metropolitan Area of Accra. It revealed that the period of flooding is the disease development stage with few reported cases and the epidemic occurs within the first four weeks after the flood. Findings from Hashizume et al. (2008) on the impact of climate variability on diarrhoeal disease in Bangladesh and UNEP and OCHA Report (2011) on the 26th October 2011 flooding of Accra revealed some lag periods in the flooding-diarrhoeal disease nexus. The study also found that majority of the households in the study communities perceived diarrhoeal disease as a stressor of flooding. This is so because both communities are located in flood-prone areas, which increases their vulnerability to flooding and its attendant effects on human health. The frequent flooding of the study communities with little amount of rainfall, coupled with frequent outbreaks of diarrhoeal-related diseases in the area explains the high perceptions people in the area have about their susceptibility to diarrhoeal disease as a result of flooding. In addition, experience of flooding in the study communities predicts incidence of diarrhoea in households after controlling for demographic, environmental and socio-economic factors. These findings are consistent with other studies in urban poor communities that indicate that flooding has become a critical predictor of diarrhoea in urban poor areas (Rain et al. 2012; ILG and IWMI 2012; Songsore et al. 2008).

Risk perception measures are critical indicators in the relationship between flooding and diarrhoea in the study communities. The socio-demographic and environmental risk factors affect the relationship between each risk perception measure and diarrhoeal disease differently. Generally, all the risk perception measures have a high probability of being able to predict low incidence of diarrhoea in the study communities as a result of flooding than predicting high incidence of diarrhoea. Flooding is a 'known risk' in the study communities and as such households have adapted a number of strategies to avert the health consequences of it. The study revealed that the poor environmental condition in the study communities exposes households to the risk of diseases, which is usually exacerbated by flood. It is easy to predict the health consequences of poor environmental sanitation and take some action on it than when the situation is complicated with a climatic hazard like flooding, which is difficult to predict. Recent outbreaks of cholera and non-cholera diarrhoea in the study communities are related to flood events. This finding supports the argument that 'known risks' are easy to address than 'unknown risks (Wisner et al. 2004). The difficulty in predicting flooding in the study communities makes the situation more complex.

The correlation between risk perception measures and incidence of diarrhoea in households was stronger for households that reside in locations that flood often than their counterparts who reside in places that do not flood often for the numeric and comparative measures. Generally, all the three risk perception measures were validated using discriminant, convergent and predictive validity tests. The numeric measure was strongly correlated with incidence of diarrhoea while the verbal and comparative measures were moderately correlated with incidence of diarrhoea. The numeric measure was the best of the three measures in estimating households at high or low risk of diarrhoea as a result of flooding. The high correlation among the three measures could be an indication that the three measures represent one construct. However, as indicated by Levy et al. (2006), the differential association of each risk perception measure with other variables may represent different aspects of risk perception, which may have implications for health behaviour.

Households that are at high or low risk of diarrhoeal disease were estimated using sensitivity and specificity tests for each of the risk perception measures. The numerical and the comparative measures had the highest sensitivity (0.95-0.98) and the verbal measure had the lowest (0.49) for identifying households with very high risk perception. Each of the measures did well in identifying households at low risk of diarrhoeal disease. On the other hand, the verbal and the numeric risk measures exhibited the highest specificity (0.60-0.64) for excluding households who did not have very high risk perception measure. The comparative measure had the lowest specificity (0.58) for excluding households that did not have very high risk perception measure. In all, the numeric measure was the best in identifying households at high or low risk of diarrhoea than the verbal and the comparative measures. The differences in the impact of various risk perception measures on diarrhoeal disease is not different from what has been found in similar studies that indicate that risk perception measures impact on people differently (Levy et al., 2006).

There were other factors that also predicted incidence of diarrhoea in the study communities. Water and sanitation are significant predictors of diarrhoeal disease. The source of water to the households significantly predicts incidence of diarrhoeal disease. Majority of urban dwellers consume 'sachet' water which is considered as hygienic but the results show otherwise. Households that consumed 'sachet' water were significantly more likely to report incidence of diarrhoea than those whose main source of drinking water is piped into their dwellings. Thus, the quality of water is critical in the flooding-diarrhoea nexus. This finding is similar to other studies that showed that 'sachet' water is of low quality and access to piped water in dwelling is crucial to addressing water related diseases in households (Stoler et al. 2012). However, the correlation between the three risk perception measures and diarrhoeal disease was not affected by the household source of drinking water. Thus, the households develop their risks of diarrhoea independent of the source of drinking water available to them in the study communities. But the correlation between verbal risk perception and diarrhoeal disease was influenced by the household water purification. Verbal risk perception measures trigger water purification behaviour among households in urban poor settings because risks associated with water are easily measureable verbally than in a numeric or comparative measure.

With regard to sanitation, the distance of household to the nearest refuse collection point and mode of disposal of solid waste were strong predictors of the relationship between risk perception of diarrhoea and incidence of diarrhoeal disease. All the three risk perception measures were strongly influenced by the distance of the household to the nearest refuse collection points. The numeric and the comparative measures had stronger correlation coefficients than the verbal measure. On the other hand, the verbal measure was strongly correlated with the mode of solid waste disposal in the households compared to the other measures. The differences in the measures in relation to the other variables are indications of how people's behaviour could be influenced differently. People believe in what they hear around them and there are a number of perceptions people in urban poor communities have about climatic impacts (Codjoe et al. 2014). Perceptions per se may not trigger actions in communities but the risk associated with these perceptions is what triggers behaviour change in communities. For instance, a household may have the perception that cockroaches are carriers of diarrhoeal disease without necessarily residing in cockroach infested area. As a result, no action may be taken on this because the object of perception is not closer to the household. However, if the households reside in cockroach infested area, then there will be that urgent measure to ensure that members do not get infected with diarrhoea because of the risk associated with it.

## 9.2 Conclusions

Flood hazards are considered as one of the most significant natural disasters in terms of human capital and economic losses (Jonkman 2005). The impact of floods on health has become a major global concern because recent studies have linked flooding to the outbreak of diarrhoeal disease in some parts of the world (Hashizume et al. 2008). The increasing frequency of floods in some countries in West Africa will, therefore, not result in only infrastructure cost but also health. This will affect efforts made in these countries in achieving the United Nations Millennium Development Goals 4 and 5 of reducing child mortality rate and combating HIV/AIDS, Malaria and other diseases.

The study revealed that rainfall has become more variable in Accra and the last decade has experienced more erratic rainfalls with their attendant floods. These findings are consistent with other studies that found that flooding in Accra over the last two decades does not occur in only the major rainy seasons but also in the minor season (ILGS & IWMI 2012; Songsore 2008). Flooding can lead to the outbreak of epidemics, which usually happens weeks after the flooding event (Hashizume et al. 2007 & 2008) and the impact of flooding on water in particular could last up to six months (McCluskey 2001). It was evident from the study that the relationship between flooding and diarrhoea is complex because of a number of factors that affect diarrhoea at both the community and household levels. At the community level, the study revealed that poor sanitation and increasing frequency of floods in the study communities are major causes of high incidence of diarrhoea in the area. At the household level, risk perceptions of diarrhoea, personal hygiene and sources of drinking water for the household are major triggers of diarrhoea.

Urban poor communities have a number of problems including environmental, social and economic problems. Results from the study show that these problems can be tackled by understanding the kind of risk perceptions urban poor dwellers have about their challenges. This is because, the kinds of risk perceptions people have about their problems determine the actions they will take to address the situation. Also, policies aimed at addressing the problems of urban poor communities may not be successful if the risk perceptions of the people are not well understood to help in designing the right type of information for the people. The study has shown that numeric risk perception measures are good for identifying households at high risk of diarrhoeal disease and this is crucial for effective policy intervention. By so doing, the cost of intervention could be reduced because it is not everybody who would be targeted and also the right people who need the information are those who will be provided with the service. In addition, the verbal measure is a good risk measure for identifying households at low risk of diarrhoeal disease while the numeric risk measure is the best in estimating households at high risk of diarrhoeal disease. All the three risk perception measures had a high probability of being able to estimate households at low risk of diarrhoea as a result of flooding. However, it is only the numeric risk perception measure that has about 44% probability to accurately estimate households at high risk of diarrhoea as a result of flooding. The method of choice will depend on the objective of the programme. If the objective of the programme is to identify households at high risk of diarrhoeal disease in the event of flooding for policy intervention then the numeric or the verbal measure will be the best option but all the three risk perception measures are good at estimating households at low risk of diarrhoea as a result of flooding.

### 9.3 Recommendations

Flooding-diarrhoeal disease nexus is a critical area of research in the 21st Century because of the high frequency of flooding globally and its impact on human health. There are few population researches in this area because of differences in methodology and the problem of linking demographic data to climatic data. The study employed methods from epidemiology, psychology and demography to examine this relationship by focusing on the risk perceptions households develop as a result of their experience of flooding. Risk perception measures are new in population studies but common in clinical, psychology and environmental studies. Most often in risk perception studies, there is uncertainty in the choice of a risk perception measure but the study applied multiple techniques to examine the strengths and weaknesses of three risk perception measures of diarrhoeal disease as a result of flooding. The study makes the following recommendations based on the findings:

Addressing the health effects of floods is critical to supporting poor countries to address recent challenges with floods. Programmes aimed at addressing the health effects of floods should involve community members from the beginning so that they can associate themselves with the final outcomes. Involving people requires critical understanding of how they perceive and associate themselves with the risk of the issues being discussed. In addressing most global situations, risk perceptions are usually the last option policy implementers consider because of the difficulty in costing perceptions. However, global problems like HIV and AIDS and breast cancer saw positive trends in addressing these issues after series of research on the risk perceptions of people on the diseases. The relationship between flooding and health is a complex issue affecting people globally. Therefore, employing risk perception measures in flood and diarrhoea studies will help to identify populations at high or low risk to its impact. In so doing, populations at high risk could be targeted with adaptation programmes that will enable them to cope with the situation while those at low risk could be encouraged to embark on some mitigation programmes to further reduce their risk.

Also, there is the need to address the increasing rate of the incidence of diarrhoeal disease in the study communities. The current approach which focuses on the curative aspect by introducing ZINC tablets in addition to oral re-hydration salts (ORS) for people diagnosed with diarrhoea may help to reduce diarrhoea mortality but not the incidence. To reduce the incidence of diarrhoeal disease in the study communities will require adequate education on sanitation and water treatment in the communities. Floods may continue to occur because the communities are located in flood-prone areas in Accra but the conditions that predispose the population to diseases in the event of flooding is water quality and sanitation. It is critical to address the water and sanitation problems in urban poor areas by educating the people on good sanitation and hygiene because predictions of climate change impacts indicate increase flooding in urban areas with attendant impacts on human health.

Recent flooding in urban poor communities is an additional stressor to the stressors impacting on the wellbeing of the population residing in these areas while diarrhoeal diseases are just one of the stressors of flooding that households in urban poor places have to address. The construction of new drainage systems and the maintenance of old ones could help in the free flow of storm water in the study communities. The study results showed that, there is a strong association between, risk perceptions, water, sanitation, flooding, and incidence of diarrhoeal disease in the study communities. It is, however, not clear in this study as to the causal relationships that exist between the variables. It is recommended that a further study in the form of a case control will be appropriate to help establish the causal link between risk perceptions resulting from flooding and diarrhoeal disease.

Finally, on the basis of the fact that several instances of strong associations were established between risk perception measures resulting from flooding and diarrhoeal disease incidence in urban poor communities in the Ashiedu-Keteke sub-Metropolitan Area of Accra, it is recommended that the study be repeated using data from other urban poor communities to validate these associations. Also, in addition to floods, risk perception measures could also be tested on other disasters such as fires and pollution from refuse dumps. This will help to critically evaluate risk perception measures among various hazards in communities and also to establish whether all hazards trigger the same kind of risk perceptions or not. Doing this kind of research has become necessary because of the recent increase in disasters in major cities in

Ghana. The findings will help in providing the appropriate measures to addressing issues in communities since interventions will be designed along the way the people perceive things.

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## List of Appendices

### Appendix A: Household survey instrument

**IDENTIFICATION**

| | |
|---|---|
| LOCALITY NAME* ______ | ☐ |
| E.A. BASE ______ | |
| NAME OF HOUSEHOLD HEAD ______ | |
| E.A. /EDL NUMBER ........ | ☐☐ |
| STRUCTURE NUMBER........ | ☐☐☐ |
| HOUSEHOLD NUMBER ........ | ☐☐ |
| GREATER ACCRA........ | 0 3 |
| ROUND........ | 0 2 |
| * **CODES FOR LOCALITY NAME:** 1=AGBOGBLOSHIE 2=JAMES TOWN 3=USSHER TOWN | |

**INTERVIEWER VISITS**

| | 1 | 2 | 3 | FINAL VISIT | |
|---|---|---|---|---|---|
| DATE | ______ | ______ | ______ | DAY | ☐☐ |
| | | | | MONTH | ☐☐ |
| | | | | YEAR | 2 0 1 2 |
| INTERVIEWER'S NAME | ______ | ______ | ______ | INT. CODE | ☐☐ |
| RESULT* | ______ | ______ | ______ | RESULT | ☐ |
| Next visit: Date | ______ | ______ | | | |
| Time | ______ | ______ | | TOTAL NO. OF VISITS | ☐ |

| | | |
|---|---|---|
| ***RESULT CODES:** | TOTAL PERSONS IN HOUSEHOLD | ☐☐ |
| 1 COMPLETED | | |
| 2 PARTLY COMPLETED | | |
| 3 NO HOUSEHOLD MEMBER AT HOME OR NO COMPETENT RESPONDENT AT HOME AT THE TIME OF VISIT | TOTAL ELIGIBLE WOMEN | ☐☐ |
| 4 ENTIRE HOUSEHOLD ABSENT FOR EXTENDED PERIOD OF TIME | | |
| 5 POSTPONED | TOTAL ELIGIBLE MEN | ☐☐ |
| 6 REFUSED | | |
| 7 DWELLING VACANT OR ADDRESS NOT A DWELLING | LINE NO. OF RESP. TO HOUSEHOLD QUEST. | ☐☐ |
| 8 DWELLING DESTROYED | | |
| 9 DWELLING NOT FOUND | | |
| 10 OTHER (SPECIFY) ______ | HH INT. IN ROUND 1 | 1=YES 2=NO |

**LANGUAGE**

| | |
|---|---|
| LANGUAGE OF QUESTIONNAIRE: **ENGLISH** | 1 |
| LANGUAGE OF INTERVIEW** ______ | ☐ |
| NATIVE LANGUAGE OF RESPONDENT** ______ | |
| WAS TRANSLATOR USED? (YES=1, NO=2) .......... | ☐ |
| ****LANGUAGE CODES**: | |
| 1= ENGLISH 2 =AKAN 3= GA 4 =EWE 5 =DAGBANI | |
| 6= HAUSA 7= OTHER (SPECIFY) ______ | |

| SUPERVISOR ☐☐ | FIELD EDITOR ☐☐ | KEYED BY |
|---|---|---|
| NAME ______ | NAME ______ | ☐☐ |
| DATE ______ | DATE ______ | |

# INFORMED CONSENT HOUSEHOLD

Title: Association between flooding and diarrhoeal disease in urban poor settings in Ghana: effects and vulnerable population.

Principal Investigator: Mumuni Abu

Address: Regional Institute for Population studies
University of Ghana
P.O. Box LG 96
Legon – Accra, Ghana

**General Information about Research**

My name is ................................................ from the Regional Institute for Population Studies (RIPS) at the University of Ghana. We are conducting a research in your community. This study aims at investigating the association between flooding and diarrhoeal disease in this community. We will ask you questions about the general characteristics of your household and members of your household including the composition (age and sex of the members of your household) and their ethnicity, religious affiliation, educational attainment, assets owned by your household, experience of flooding, experience of diarrhoeal disease etc). If you agree to be part of the study, the interview will last approximately 30 minutes and the responses you provide will be recorded in this questionnaire. The information will then be later captured and analysed.

**Possible Risks and Discomforts**

There are no known physical, social and financial risks or discomforts associated with participating in this study.

**Confidentiality**

All information you provide for this study will be treated with strict confidentiality. We will protect all information about you to the best of our ability. You will not be named in any reports. Only academic advisers may have access to this research records.

**Voluntary Participation and Right to Leave the Research**

Participation in this research is voluntary, you have the right to withdraw at any point without penalty to you, and all information provided will be deleted from the study. Have I explained everything well enough to you? Do you have any questions for me?

**Contacts for Additional Information**

For additional information or any concern about this research after the interview, please contact the principal investigator Mumuni Abu on 0277385249 or 0302500274 at the Regional Institute for Population Studies, University of Ghana, Legon.

**Your rights as a Participant**

This research has been reviewed and approved by the Institutional Review Board of Noguchi Memorial Institute for Medical Research (NMIMR-IRB). If you have any questions about your rights as a research participant you can contact the IRB Office between the hours of 8am-5pm through the landline 0302916438 or email addresses: nirb@noguchi.mimcom.org or HBaidoo@noguchi.mimcom.org . You may also contact the chairman, Rev. Dr. Ayete-Nyampong through mobile number 0208152360 when necessary.

**VOLUNTEER AGREEMENT**

The above document describing the benefits, risks and procedures for the research title ***(Association between flooding and diarrhoeal disease in urban poor settings: effects and vulnerable population)*** has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

________________________ ____________________________________________

Date Name and signature or mark of volunteer

Thumb print

**If volunteers cannot read the form themselves, a witness must sign here:**

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

________________________

______________________________________________

Date Name and Signature of Witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

________________________ ______________________________________________

Date Name and Signature of Person Who Obtained Consent

START TIME FOR INTERVIEW HOURS MINS

| | | | |
|---|---|---|---|
| | | | |

# HOUSEHOLD SCHEDULE

I would like some information about the people who usually live in your household or who are staying with you now.

| **LINE NO.** | **USUAL RESIDENTS AND VISITORS** | **RELATION-SHIP TO HEAD OF HH** | **SEX** | **RESIDENCE** | | | **AGE** | **ELIGIBILITY** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Please give me the names of the persons who usually live in your household and guests of the household who stayed here last night, starting with the head of the household. | What is the relationship of (NAME) to the head of the household?* | Is (NAME) male or female? | Does (NAME) usually live here? (6months or more) | Did (NAME) sleep here last night? YES→8 | Why did (NAME) not sleep here last night?** | How old is (NAME)? | CIRCLE LINE NUMBER OF ALL CHILDREN UNDER AGE 5 | CIRCLE LINE NUMBER OF ALL WOMEN AGE 12- 49 | CIRCLE LINE NUMBER OF ALL MEN AGE 12-59 |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| 01 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 01 | 01 | 01 |
| 02 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 02 | 02 | 02 |
| 03 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 03 | 03 | 03 |
| 04 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 04 | 04 | 04 |
| 05 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 05 | 05 | 05 |
| 06 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 06 | 06 | 06 |
| 07 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 07 | 07 | 07 |
| 08 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 08 | 08 | 08 |
| 09 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 09 | 09 | 09 |
| 10 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 10 | 10 | 10 |
| 11 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 11 | 11 | 11 |
| 12 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 12 | 12 | 12 |
| 13 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 13 | 13 | 13 |
| 14 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 14 | 14 | 14 |
| 15 | | | M F 1 2 | YES NO 1 2 | YES NO 1 2 | | IN YEARS | 15 | 15 | 15 |
| **TICK HERE IF CONTINUATION SHEET USED** | | | **NUMBER OF ELIGIBLE CAREGIVERS** | | | | **NUMBER OF PERSONS IN HH** | | | |

*** CODES FOR Q3**

**RELATIONSHIP TO HEAD OF HOUSEHOLD:**

01 = HEAD
02 = SPOUSE
03 = SON OR DAUGHTER
04 = SON-IN-LAW/DAUGHTER-IN-LAW
05 = GRANDCHILD
06 = PARENT
07 = PARENT-IN-LAW
08 = BROTHER/SISTER
09 = CO-WIFE
10 = ADOPTED/FOSTER/STEP-CHILD
11= OTHER RELATIVE (AFFINAL)
12= OTHER RELATIVE (CONSANGUINE)
13= NOT RELATED
98=DON'T KNOW

****CODES FOR Q7**

01=AT WORK
02=NO SPACE FOR SLEEPING
03=TRAVELLED
04=BOARDING HOUSE
06=OTHER (SPECIFY)..........
98=DON'T KNOW

| LINE NO. | | EDUCATION (IF AGE 3 OR OLDER & IF ATTENDED SCHOOL) | | | IF AGE 15 OR OLDER MARITAL STATUS | ETHNICITY | RELIGION |
|---|---|---|---|---|---|---|---|
| | Has (NAME) ever attended school? **NO→ 16** | What is the highest level of education (NAME) attended?* | What is the highest grade (NAME) completed at that level?** | **IF AGE IS LESS THAN 25 YEARS** Is (NAME) still in school? | What is the marital status of (NAME)? *** | What is the ethnic group of (NAME)? **** | What is the religion of (NAME)? ***** |
| | (12) | (13) | (14) | (15) | (16) | (17) | (18) |
| 01 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 02 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 03 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 04 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 05 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 06 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 07 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 08 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 09 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 10 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 11 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 12 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 13 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 14 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |
| 15 | YES NO 1 2 | | | YES NO 1 2 | | 96=OTHER SPECIFY ……………………… | |

Just to make sure that I have a complete listing:

1) Are there any other persons such a small children or infants that we have not listed? YES → ENTER EACH IN TABLE NO
2) In addition, are there any other people who may not be members of your HH, such as domestic servants, lodgers or friends who usually live here? YES → ENTER EACH IN TABLE NO
3) Are there any guests or temporary visitors staying here, or anyone else who slept here last night that I have not listed? YES → ENTER EACH IN TABLE NO (SKIP ONE ROW)
4) Are there any persons who used to live in your household but have moved out in the past 1 year? YES → ENTER EACH IN TABLE NO HOW MANY?

| *CODES FOR Q13 | **EDUCATION GRADE Q14 | ***CODES FOR Q16 | ****CODES FOR Q17 | |
|---|---|---|---|---|
| 0=PRE-SCHOOL | 00=LESS THAN 1 YEAR | 0=NEVER MARRIED | 01=AKAN | 07=GRUSI |
| 1=PRIMARY | 98=DON'T KNOW | 1= LIVING TOGETHER | 02=GA-DANGME | 08=MANDE |
| 2=JHS/MIDDLE | | 2= MARRIED | 03=EWE | 96=OTHER (SPECIFY) |
| 3=SHS/SECONDARY | | 3= SEPARATED | 04=GUAN | **RECORD ADJACENT TO** |
| 4=HIGHER | | 4=DIVORCED | 05=GURMA | **TO THE CODE** |
| 8=DON'T KNOW | | 5= WIDOWED | 06=MOLE-DAGBANI | **ABOVE.** |

*****CODES FOR Q18

01= NO RELIGION 05=OTHER CHRISTIAN
02= CATHOLIC 06=ISLAM
03= PROTESTANTS 07=TRADITIONAL/SPIRITUALIST
04= PENTECOSTAL/CHARISMATIC 08=EASTERN RELIGIONS
96=OTHER (SPECIFY)……………………………………………………………………………………………

## DIARRHOEAL DISEASE CONDITIONS

| LINE NO. | Has (Name) had diarrhoea in the last 2 weeks?<br>1. YES<br>2. NO | Has (Name) had diarrhoea just after the heavy rain that flooded some areas in Accra in Oct. 2011?<br>1. YES<br>2. NO | When exactly did this happen?<br>1. Weeks<br>2. Months | Was (Name) given any medications or other treatment for diarrhoea?<br>1. YES<br>2. NO | On average, how many times does name experience diarrhoea in a year? | On average, how much does it cost to treat (Name) of diarrhoea?<br><br>**GH ₵** |
|---|---|---|---|---|---|---|
| | **(32)** | **(33)** | **(34)** | **(35)** | **(36)** | **(37)** |
| 01 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 02 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 03 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 04 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 05 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 06 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 07 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 08 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 09 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 10 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 11 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 12 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 13 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 14 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |
| 15 | ☐ | ☐ | ☐ ………… | ☐ | ☐ | |

## HOUSEHOLD CHARACTERISTICS

| NO. | QUESTION | RESPONSE | SKIP |
|---|---|---|---|
| 45. | What is the main source of drinking water for members of your household?<br>**PIPED WATER**<br>11=PIPED INTO DWELLING/INDOOR 12=PIPED TO YARD/PLOT<br>13=PUBLIC TAP/STANDPIPE 21=TUBE WELL OR BOREHOLE<br>**DUG WELL**<br>31=PROTECTED WELL 32=UNPROTECTED WELL<br>**WATER FROM SPRING**<br>41=PROTECTED SPRING 42=UNPROTECTED SPRING<br>51=RAINWATER 61=TANKER TRUCK<br>71=CART WITH SMALL TANK<br>81=SURFACE WATER (RIVER/DAM/LAKE/POND/STREAM)<br>91=BOTTLED WATER<br>92=SACHET WATER<br>96=OTHER (SPECIFY)............................................................... | | IF CODE 11 or 12, SKIP TO Q47 |
| 46. | Who usually goes to this source to fetch water for your household? (Probe: Is this person under age 15 years? What sex? Circle the code that best describe the person.<br>1=ADULT WOMAN 2=ADULT MAN 3=FEMALE CHILD (UNDER 15 YEARS)<br>4=MALE CHILD (UNDER 15 YEARS) | | |
| 47. | Do you store water in your house so as to use it for more than one day?<br>1=YES 2=NO | | IF CODE 2 SKIP TO Q51 |
| 48. | How do you store your drinking water?<br>1=OVERHEAD TANK 2=PLASTIC/STEEL CONTAINER WITH LID<br>3=PLASTIC/STEEL CONTAINER WITHOUT LID 4=EARTHEN WARE POT WITH LID<br>5=EARTHEN WARE POT WITHOUT LID 6=ALUMINIUM BUCKET WITH LID<br>7=ALUMINIUM BUCKET WITHOUT LID 8=PLASTIC/ALUMINIUM/ENAMEL BASIN<br>9=OTHER.................................................. | | IF CODE , 1,3,5,7,8 SKIP TO Q50 |
| 49. | If container has a lid, does the lid screw on or attach tightly to the container?<br>1=YES 2=NO | | |
| 50. | Does the container have a spigot or small mouth or tap for dispensing water?<br>1=YES 2=NO | | |
| 51. | Do you do anything to make this water safe to drink?<br>1=YES 2=NO 8=DON'T KNOW | | IF CODE 2 OR 8, SKIP TO Q53 |
| 52. | What do you usually do to make the water safe to drink?<br>1=BOIL 2=ADD BLEACH, CHLORINE, OR ALLOY 3=STRAIN THROUGH A CLOTH<br>4=SOLAR DISINFECTION 5=LET IT STAND TO SETTLE 6=WATER TABLETS<br>7=ALUM 8=CAMPHOR 9= OTHER (SPECIFY)...................................................<br>11= DON'T KNOW | | |

| NO. | QUESTION | YES | NO | SKIP |
|---|---|---|---|---|
| 53. | Who manages sanitation resources in your community? | | | |
| | a. AMA/SUB-METRO | 1 | 2 | |
| | b. UNIT COMMITTEE | 1 | 2 | |
| | c. LOCAL WATER/SANITATION COMMITTEE | 1 | 2 | |
| | d. COMMUNITY DEVELOPMENT COMMITTEE | 1 | 2 | |
| | e. NGO | 1 | 2 | |
| | f. TRADITIONAL LEADER(S) | 1 | 2 | |
| | g. RELIGIOUS ORGANISATION(S) | 1 | 2 | |
| | h. RIVATE INDIVIDUAL(S) | 1 | 2 | |
| | i. OTHER.................................................. | 1 | 2 | |
| | j. DON'T KNOW | 1 | 2 | |

| NO. | QUESTION | RESPONSE | SKIP |
|---|---|---|---|
| 54. | What kind of toilet facility does your household use?<br>1=NO FACILITY (BUSH/BEACH/FIELD)<br>2=WATER CLOSET (W.C)/FLUSH TOILET<br>3= KVIP<br>4= PIT LATRINE<br>5=BUCKET/PAN<br>6=PUBLIC TOILET (W.C,KVIP, PIT LATRINE,BUCKET/PAN)<br>8=OTHER (SPECIFY).......................................................... | | IF CODE 1, 6 SKIP TO Q56 |

| | | | | |
|---|---|---|---|---|
| 55. | Do you share this facility with other households?<br>1=YES 2=NO | | | |
| 56. | The last time the youngest child (under 5 years) passed stool, what was done to dispose of the stool? CHECK HH ROSTER IF THERE IS A CHILD UNDER 5 YEARS<br>1=CHILD USED TOILET/LATRINE 2=PUT/RINSED INTO TOILET OR LATRINE<br>3=PUT/RINSED INTO DRAIN OR DITCH 3=THROWN INTO GARBAGE<br>4=BURIED 5=LEFT IN THE OPEN 6=OTHER (SPECIFY)………………………………<br>8=DON'T KNOW | | | |
| 57. | Do you have a refuse bin in your household?<br>1=YES 2=NO | | | |
| 58. | Who usually disposes of the household solid waste?<br>1=ADULT WOMAN 2=ADULT MAN<br>3=FEMALE CHILD (UNDER 15 YEARS) 4=MALE CHILD (UNDER 15 YEARS) | | | |
| 59. | Where do you dispose of household solid waste?<br>1=COLLECTED AT HOME BY A PRIVATE COMPANY 4=COMMUNITY DRAIN<br>2=COLLECTED AT HOME BY A GOVERNMENT AGENCY 5=TRUCK PUSHERS (KAYA BOLA)<br>3=REFUSE CONTAINER 6=INDISCRIMINATELY<br>7=OTHER………………………………… | | | |
| 60. | Do you pay for disposing of household solid waste?<br>1=YES → **HOW MUCH DO YOU PAY MONTHLY (GH¢)**…………………………………**GH¢**<br>2=NO | | | |
| 61. | How do you dispose household liquid waste (waste water from bathing, preparation of food, cooking and other personal and domestic activities)?<br>1=SEPTIC TANK 2=COMMUNITY DRAIN 3=BACK OF HOUSE<br>4=INDISCRIMINATELY 5=OTHER (SPECIFY)…………………………………… | | | |
| 62. | What are the major environmental challenges that you face in this community? | **YES** | **NO** | **MOST CHALLENGING** |
| | a. FLOODING | 1 | 2 | |
| | b. POOR SANITATION | 1 | 2 | |
| | c. POLLUTION | 1 | 2 | |
| | d. HIGH TEMPERATURE (HEAT | 1 | 2 | |
| | e. OTHER (SPECIFY)………………………………… | 1 | 2 | |
| 63. | What are the most common diseases in this community that is associated with these environmental challenges? | **YES** | **NO** | **MOST COMMON** |
| | a. DIARRHOEA | 1 | 2 | |
| | b. MALARIA | 1 | 2 | |
| | c. CEREBRO-SPINAL MENINGITIS | 1 | 2 | |
| | d. SKIN RASH | 1 | 2 | |
| | e. COUGH/DIPHTHERIA | 1 | 2 | |
| | f. OTHER (SPECIFY)………………………………… | 1 | 2 | **IF 'a' IS YES (1) SKIP TO Q68** |
| 64. | If diarrhoea is not mentioned in **(Q63)**: Is diarrhoea one of the environmental health issues here?<br>1=YES 2=NO | | | **IF CODE 2 SKIP TO Q68** |
| 65. | Who are mostly affected by diarrhoea in your community?<br>1=CHILDREN UNDER 5 YEARS 2=5-9 YEARS 3=10-14 YEARS 4=15-24 YEARS<br>5=25 YEARS AND ABOVE 6=EVERYONE 7=NO ONE | | | |
| 66. | What do you think are the causes of diarrhoeal disease in your community?<br>1=Insanitary condition 2= Increased rainfall 5= Unhygienic food<br>3= Increased temperature 4= Poor quality of water 6= Other (specify)<br>…………………… | | | |
| 67. | How would you describe diarrhoea cases in this community over the past decade?<br>1=SAME 2=INCREASED 3=DECREASED 4=DON'T KNOW | | | |
| 68. | What is the main source of cooking fuel for this household?<br>01=NONE/NO COOKING 06=CHARCOAL<br>02= WOOD 07=CROP RESIDUE<br>03=GAS 08=SAW DUST<br>04=ELECTRICITY 09=ANIMAL WASTE<br>05=KEROSINE 10=OTHER (SPECIFY)………………………………… | | | |

| | | | |
|---|---|---|---|
| 69. | Does your household have: | YES | NO |
| | a. A CAR | 1 | 2 |
| | b. A MOTORCYCLE | 1 | 2 |
| | c. A BICYCLE | 1 | 2 |
| | d. A BOAT/CANOE | 1 | 2 |
| | e. A TRUCK | 1 | 2 |
| | f. AN OUTBOARD MOTOR | 1 | 2 |
| | g. A REFRIGERATOR | 1 | 2 |
| | h. A FREEZER | 1 | 2 |
| | i. A GENERATOR | 1 | 2 |
| | j. A WASHING MACHINE | 1 | 2 |
| | k. A TELEVISION | 1 | 2 |
| | l. A RADIO | 1 | 2 |
| | m. A TELEPHONE | 1 | 2 |
| | n. A CLOCK | 1 | 2 |
| | o. AN ELECTRIC/GAS STOVE | 1 | 2 |
| | p. A SOFA | 1 | 2 |
| | q. A SEWING MACHINE | 1 | 2 |
| | r. IRON | 1 | 2 |
| | s. AN ELECTRIC FAN | 1 | 2 |
| | t. A COMPUTER | 1 | 2 |
| | u. FISHING NET | 1 | 2 |
| 70. | In general, would you say that you/your household has:<br>1=MORE MONEY THAN YOU NEED 2=JUST ENOUGH MONEY<br>3=LESS MONEY THAN YOU NEED | | |
| 71. | Who is the primary source of income for this household?<br>1=HEAD OF HOUSEHOLD 3=BOTH SHARED EQUALLY (HEAD AND SPOUSE)<br>2=PARTNER 4= A DIFFERENT MEMBER OF THE HOUSEHOLD<br>8=OTHER(SPECIFY)........................................................................ | | |
| 72. | How much can you rely on relatives outside of your household or friends for financial support if you need it?<br>1=A LOT 2=SOMETIMES 3=A LITTLE 4=NOT AT ALL | | |
| 73. | What is the present holding/tenancy arrangement of this dwelling?<br>1=OWNING 2=RENTING 3=RENT FREE 4=PERCHING<br>5=SQUATTING 6=OTHER (SPECIFY)_______________ | | |
| 74. | Who owns this dwelling?<br>1=OWNED BY HH MEMBER 5=PRIVATE EMPLOYER<br>2=BEING PURCHASED (e.g., Mortgage) 6=OTHER PRIVATE AGENCY<br>3=RELATIVE NOT HH MEMBER 7=PUBLIC/GOVERNMENT OWNERSHIP<br>4=OTHER PRIVATE INDIVIDUAL 8=OTHER (SPECIFY)_______________ | | |
| 75. | How many rooms does this household occupy? **(COUNT LIVING, DINING, BEDROOMS BUT NOT BATHROOMS ,TOILET & KITHCEN)** | **NO. OF ROOMS** | |
| 76. | How many of the rooms are designed primarily for sleeping? | **NO.** | |
| 77. | How many household members sleep outside the designated sleeping rooms?<br>**CODE 00 IF NO HOUSEHOLD MEMBER SLEEPS OUTSIDE** | **NO.** | |
| 78. | What type of dwelling does this household occupy? **RECORD OBSERVATION**<br>01=SEPARATE HOUSE 04=ROOMS 07=KIOSK<br>02=SEMI-DETACHED HOUSE 05=SEVERAL HUTS/ BUILDING 08= CONTAINER<br>03=FLAT/APARTMENT 06=TENT 09= ATTACHED TO SHOP<br>10= COMPOUND HOUSE 96=OTHER (SPECIFY) _______________ | | |
| 79. | What is the main material of the floor? **RECORD OBSERVATION**<br>01=EARTH/SAND 04=WOOD 10=VINYL TILES 07=WOOLEN CARPET<br>02=BURNT BRICKS 05=WOOD PLANKS 08=LINOLEUM/RUBBER CARPET<br>03=CEMENT/CONCRETE 06=TERRAZO | | |

| | | | |
|---|---|---|---|
| | 09=CERAMIC TILES/PORCELAIN GRANITE/MARBLE 10=VINYL TILES 11=STONE<br>96=OTHER (Specify) ................................................................................................ | | |
| 80 | What is the main material of the roof? RECORD OBSERVATION<br>01=THATCH/PALM LEAF/SOD 06=ROOFING SHINGLES<br>02=RUSTIC MAT 07=ASBESTOS/SLATE ROOFING SHEETS<br>03=CARDBOARD 08=PALM/BAMBOO<br>04=METAL SHEETS 09=WOOD<br>05=BRICK TILES 10=CEMENT<br>96=OTHER (SPECIFY)...................................................................... | ☐☐ | |
| 81 | What is the main material of the wall? RECORD OBSERVATION<br>01=CANE/PALM/TRUNKS 08=MUD BRICKS<br>02=BAMBOO WITH MUD 09=STONE WITH MUD<br>03= WOOD 10= PLYWOOD<br>04=CARDBOARD 11=BAMBOO<br>05=LANDCRETE 12=CEMENT BLOCKS/CONCRETE<br>06=BURNT BRICKS<br>07=METAL SHEETS/SLATE/ASBESTOS<br>96=OTHER (SPECIFY)............................................................ | ☐☐ | |

| | | YES | NO |
|---|---|---|---|
| 82 | Do you have pets such as dogs and cats in your household? | 1 | 2 |
| | Do you have livestock such as goats in your household? | 1 | 2 |

| | | |
|---|---|---|
| 83 | 1=Never 2=1 - 3 times 3=4 or more times 4=Don't know | |
| | a. How many times have you seen cockroaches in your household in the past 7 days? | ☐ |
| | b. How many times have you seen mice/rats in your house hold in the past 7 days? | ☐ |
| | c. How often have you been exposed to pesticides (such as mosquito spray and coil) in your household or environment in the past 7 days? | ☐ |

## EXPOSURE TO FLOODING

| NO. | QUESTION | RESPONSE | SKIP |
|---|---|---|---|
| 101. | Have you ever experienced flooding in this community?<br>1=YES 2=NO | ☐ | **IF CODE 1 or SKIP TO Q105** |
| 102. | In which year(s) and month(s) did you experience flooding in this community? Year /month<br>Year /month<br>Year /month | ☐☐☐☐<br>☐☐☐☐<br>☐☐☐☐ | ---------------------------<br>--------------------------- |

| 103. | How do you cope during flooding situations ***Probe only once*** | MENTIONED | NOT MENTIONED |
|---|---|---|---|
| | 1 = MOVE TO LIVE WITH RELATIVE/FRIENDS | 1 | 2 |
| | 2 = CONSTRUCT WATER CHANNEL | 1 | 2 |
| | 3 = PURIFY DRINKING WATER | 1 | 2 |
| | 4 = RELY ON GOVERNMENT/NGO FOR SUPPORT | 1 | 2 |
| | 5 = CLEAN DRAINS | 1 | 2 |
| | 6 = CLEAR WATER FROM ROOMS | 1 | 2 |
| | 7 = DON'T DO ANYTHING | 1 | 2 |
| | 8 = OTHER:________________________ | 1 | 2 |

| | | | |
|---|---|---|---|
| 104. | How would you score the efficiency of these strategies if a similar event were to happen today? Note: A score of 1 means not efficient and 5 means very efficient<br>1 = MOVE TO LIVE WITH RELATIVE/FRIENDS<br>2 = CONSTRUCT WATER CHANNEL<br>3 = PURIFY DRINKING WATER<br>4 = RELY ON GOVERNMENT/NGO FOR SUPPORT<br>5 = CLEAN DRAINS<br>6 = CLEAR WATER FROM ROOMS<br>7 = DON'T DO ANYTHING<br>8 = OTHER:____________________ | SCORE | |
| 105. | Will you say you live in a part of the community that floods anytime it rains heavily?<br>1=YES 2=SOMETIMES 3=NO | | |
| 106. | Do you have problem sleeping in your room anytime it rains in this community?<br>1=YES 2=SOMETIMES 3=NO | | |
| 107. | What do you think is the chance of your house getting flooded due to increased rainfall?<br>**Answer in percentage:_______**<br>**Note: 0% = no chance;**<br>**100% = definitely** | PERCENT | |
| 108. | How would you rate the chance of your house getting flooded?<br>1 = VERY LOW 2 = MODERATELY LOW 3 = NEITHER HIGH NOR LOW<br>4 = MODERATELY HIGH 5 = VERY HIGH | | |
| 109. | Overall, how do you think is the chance of your house getting flooded due to increased rainfall compared to other houses in this community?<br>1 = VERY LOW 2 = MODERATELY LOW 3 = NEITHER HIGH NOR LOW<br>4 = MODERATELY HIGH 5 = VERY HIGH | | |
| 110. | How often do you worry about your house getting flooded anytime it rains?<br>1 = NOT AT ALL 2 = A LITTLE OF THE TIME 3 = SOME OF THE TIME<br>4 = MOST OF THE TIME 5 = ALL THE TIME | | |

| 111. | What month of the year does it rain in this community? ***Probe once*** | MENTIONED | NOT MENTIONED |
|---|---|---|---|
| | 1 = JANUARY | 1 | 2 |
| | 2 = FEBRUARY | 1 | 2 |
| | 3 = MARCH | 1 | 2 |
| | 4 = APRIL | 1 | 2 |
| | 5 = MAY | 1 | 2 |
| | 6 = JUNE | 1 | 2 |
| | 7 = JULY | 1 | 2 |
| | 8 = AUGUST | 1 | 2 |
| | 9 = SEPTEMBER | 1 | 2 |
| | 10 = OCTOBER | 1 | 2 |
| | 11 = NOVEMBER | 1 | 2 |
| | 12 = DECEMBER | 1 | 2 |
| | 13 = ALL YEAR ROUND | 1 | 2 |

| | | | |
|---|---|---|---|
| 112. | Has this been the same for the period you have been in this community?<br>1=YES 2=NO | | |
| 113. | How would you describe the current rainfall pattern compared to previous pattern?<br>1 = LESS THAN PREVIOUS 2 = MORE THAN PREVIOUS 3 = SAME AS PREVIOUS 4 = ERRATIC RAINFALL PATTERNS 5 = START EARLIER THAN PREVIOUS 6 = START LATER THAN PREVIOUS 7 = DON'T KNOW | | |

## EXPERIENCE OF DIARRHOEAL DISEASE

| NO. | QUESTION | RESPONSE | SKIP |
|---|---|---|---|
| 201. | What are the common diseases that affect members of your household? ***Probe only once*** | MENTIONED | NOT MENTIONED |
| | A =MALARIA | 1 | 2 |
| | B = DIARRHOEA | 1 | 2 |
| | C = CELERAL SPINAL MENINGISTIS | 1 | 2 |
| | D = SKIN RASH | 1 | 2 |
| | E = COUGH/DIPHTHERIA | 1 | 2 |
| | F = OTHER:________________ | 1 | 2 |

| | | | |
|---|---|---|---|
| 202. | Has any member of your household experience diarrhoea over the past 12 months?<br>1= YES 2=NO | ☐ | **IF Q202 AND Q201B ARE BOTH CODE 2 SKIP TO 301;**<br><br>**IF Q202 ONLY IS CODE 2 SKIP TO Q205** |
| 203. | When exactly did this happen? | **MONTH** / **YEARS** | |
| 204. | What is the age(s) of those who were affected? | AGE | |
| 205. | What do you think causes diarrhoea among members of your household? ***Probe only once***<br>1 = INSANITARY CONDITIONS<br>2 = INCREASED RAINFALL<br>3 = UNHYGIENIC FOOD<br>4 = INCREASED TEMPERATURE<br>5 = POOR QUALITY OF WATER<br>6 = TEETHING AMONG CHILDREN<br>7 = OTHER ___________________ | MENTIONED<br>1<br>1<br>1<br>1<br>1<br>1<br>1 | NOT MENTIONED<br>2<br>2<br>2<br>2<br>2<br>2<br>2 |
| 206. | How would you describe diarrhoea cases in your household over the past 5 years?<br>1 = SAME 2 = INCREASED 3 = DECREASED 4 = DON'T KNOW | ☐ | |
| 207. | What do you think is the chance of a member of your households getting diarrhoea due to flooding?<br>**Answer in percentage:________**<br>**Note: 0% = no chance;**<br>**100% = definitely** | PERCENT | |
| 208. | How would you rate the chance of children less than five years in your household getting diarrhoea as a result of flood?<br>1 = VERY LOW 2 = MODERATELY LOW 3 = NEITHER HIGH NOR LOW<br>4 = MODERATELY HIGH 5 = VERY HIGH 6=NO MEMBER OF THAT AGE | ☐ | |
| 209. | How would you rate the chance of your household member's age 5-17 years getting diarrhoea as a result of flood?<br>1 = VERY LOW 2 = MODERATELY LOW 3 = NEITHER HIGH NOR LOW<br>4 = MODERATELY HIGH 5 = VERY HIGH 6=NO MEMBER OF THAT AGE | ☐ | |
| 210. | How would you rate the chance of your household members getting diarrhoea as a result of flood?<br>1 = VERY LOW 2 = MODERATELY LOW 3 = NEITHER HIGH NOR LOW<br>4 = MODERATELY HIGH 5 = VERY HIGH | ☐ | |
| 211. | Overall, how do you think is the chance of a member of your household being diagnosed diarrhoea due to flooding compared to other households in this community?<br>1 = MUCH LOWER 2 = LOW 3 = ABOUT THE SAME 4 = HIGH 5 = MUCH HIGHER | ☐ | |
| 212. | How often do you worry about a member of your household getting diarrhoea anytime it rains?<br>1 = NOT AT ALL 2 = A LITTLE OF THE TIME 3 = SOME OF THE TIME<br>4 = MOST OF THE TIME 5 = ALL THE TIME | ☐ | |
| 213. | What do you do when a member of your household get diarrhoea? ***Probe only once***<br>1 = TAKE PERSON TO HOSPITAL<br>2 = GIVE PERSON ORS<br>3 = GIVE PERSON COCONUT JUICE<br>4 = GIVE PERSON SOME PILLS OR SYRUP | MENTIONED<br>1<br>1<br>1<br>1 | NOT MENTIONED<br>2<br>2<br>2<br>2 |

| NO. | QUESTION | RESPONSE | | SKIP |
|---|---|---|---|---|
| | 5 = GIVE PERSON SOME HERBAL MEDICINE | 1 | 2 | |
| | 6 = VISIT DRUG STORE/PHARMACY | 1 | 2 | |
| | 7 = OTHER ___________________ | 1 | 2 | |
| 214. | Overall, how would you score the severity of diarrhoea in your household?<br>***Note: A score of 1 means not severe and 5 means very severe*** | SCORE | | |
| 215. | Do you do anything to protect members of your household from getting diarrhoea?<br>1=YES 2=NO | | | **IF CODE 2 SKIP TO Q301** |
| 216. | What exactly do you do? ***Probe only once*** | MENTIONED | NOT MENTIONED | |
| | 1 = KEEP OUR SURROUNDING CLEAN | 1 | 2 | |
| | 2 = EAT WARM FOOD | 1 | 2 | |
| | 3 = DRINK SACHET WATER ONLY | 1 | 2 | |
| | 4 =WASH OUR HANDS WITH SOAP BEFORE EATING | 1 | 2 | |
| | 5 = OTHER ___________________ | 1 | 2 | |

## HYGEINE AND SANITATION

| NO. | QUESTION | RESPONSE | | SKIP |
|---|---|---|---|---|
| 301. | How long does it take you to go to the main source of drinking water for household?<br>1 = NO TIME, SOURCE IS IN HOME<br>2 = IF LESS THAN AN HOUR, MIN:________<br>3 = AN HOUR OR MORE, HOURS:________ | CODE | MIN/ HR | |
| 302. | On which of these occasions did you wash your hands yesterday? ***Probe only once*** | MENTIONED | NOT MENTIONED | |
| | 1 = DID NOT WASH HANDS YESTERDAY | 1 | 2 | |
| | 2 = BEFORE PREPARING FOOD | 1 | 2 | |
| | 3 = BEFORE EATING FOOD | 1 | 2 | |
| | 4 = BEFORE FEEDING CHILD | 1 | 2 | |
| | 5 = BEFORE PRAYER | 1 | 2 | |
| | 6 = AFTER CLEANING THE CHILD'S BOTTOMS | 1 | 2 | |
| | 7 = AFTER COMING FROM WASHROOM | 1 | 2 | |
| | 8 = AFTER EATING | 1 | 2 | |
| | 9 = AFTER FEEDING CHILD | 1 | 2 | |
| | 10 = AFTER PREPARING FOOD | 1 | 2 | |
| | 11 = AFTER CLEANING HOUSE | 1 | 2 | |
| | 12 = WASH HANDS AND FACE | 1 | 2 | |
| | 13 = HAVING/GIVING BATH | 1 | 2 | |
| | 14 = CLEAN UTENSILS | 1 | 2 | |
| | 15 = WASHING CLOTHS | 1 | 2 | |
| | 16 = OTHER:__________________ | 1 | 2 | |
| 303. | On which of these occasions did you use soap to wash your hands yesterday? ***Probe only once*** | MENTIONED | NOT MENTIONED | |
| | 1 = IN ALL OCCASIONS MENTIONED IN Q302 | 1 | 2 | |
| | 2 = BEFORE PREPARING FOOD | 1 | 2 | |
| | 3 = BEFORE EATING FOOD | 1 | 2 | |
| | 4 = BEFORE FEEDING CHILD | 1 | 2 | |
| | 5 = BEFORE PRAYER | 1 | 2 | |
| | 6 = AFTER CLEANING THE CHILD'S BOTTOMS | 1 | 2 | |
| | 7 = AFTER COMING FROM WASHROOM | 1 | 2 | |
| | 8 = AFTER EATING | 1 | 2 | |
| | 9 = AFTER FEEDING CHILD | 1 | 2 | |
| | 10 = AFTER PREPARING FOOD | 1 | 2 | |
| | 11 = AFTER CLEANING HOUSE | 1 | 2 | |
| | 12 = WASH HANDS AND FACE | 1 | 2 | |
| | 13 = HAVING/GIVING BATH | 1 | 2 | |
| | 14 = CLEAN UTENSILS | 1 | 2 | |
| | 15 = WASHING CLOTHS | 1 | 2 | |

| | | | |
|---|---|---|---|
| | 16 = DID NOT USE SOAP<br>17 = OTHER:_______________________ | 1 | 2 |
| | | 1 | 2 |
| 304. | Why did you wash your hands with soap at those times? ***Probe once*** | **mentioned** | **Not mentioned** |
| | 1 = TO REMOVE DIRT | **1** | **2** |
| | 2 = KILL/REMOVE GERMS | **1** | **2** |
| | 3 = CARE ABOUT FAMILY'S HEALTH | **1** | **2** |
| | 4 = CHILDREN DON'T GET SICK | **1** | **2** |
| | 5 = DON'T KNOW | **1** | **2** |
| | 6 = OTHER:_________________ | **1** | **2** |
| 305. | Do you have drains in this community that allow free passage of water anytime it rains?<br><br>1 = YES 2 =NO 3 = DON'T KNOW | | |
| 306. | Is your house closer to a major drain or a minor drain?<br>1 = CLOSE TO A MAJOR DRAIN 2 = CLOSE TO A MINOR DRAIN 3 = CLOSE TO NONE<br>4 = THERE ARE NO DRAINS IN COMMUNITY | | |
| 307. | What purpose do drains generally serve in this community? ***Probe once*** | **Mentioned** | **Not Mentioned** |
| | 1 = Easy passage of rain water | **1** | **2** |
| | 2 = Easy passage of household liquid waste | **1** | **2** |
| | 3 = Dumping place of solid waste | **1** | **2** |
| | 4 = Beautification of community | **1** | **2** |
| | 5 = Don't know | **1** | **2** |
| | 6 = Other:_________________ | **1** | **2** |
| 308. | What is the distance from your house to the nearest public toilet? | **Distance in metres** | |
| 309. | How long does it take you to go to the nearest public toilet in this community? | **Hours/Mins** | |
| 310. | What is the distance from your house to the nearest refuse collection point?<br><br>1. DISTANCE IN METRES<br>2. HOUSEHOLD COLLECTION | **Distance in metre** | |
| 311. | How long does it take you to go to the nearest refuse collection point?<br><br>1. DISTANCE IN METRES<br>2. HOUSEHOLD COLLECTION | **Distance in metre** | |
| 312. | How would you describe refuse collection in this community? | YES | NO |
| | 1 = REGULAR | 1 | 2 |
| | 2 = NOT REGULAR | 1 | 2 |
| | 3 = REFUSE IN NOT COLLECTED | 1 | 2 |
| | 4 = IT IS COLLECTED ONLY WHEN WE COMPLAIN | 1 | 2 |
| | 5 = IT IS A BAD SITUATION HERE | 1 | 2 |
| | 6 = OTHER:_________________ | 1 | 2 |

**END TIME FOR INTERVIEW** **HOURS** **MINS**

**Thank you very much we have come to the end of the interview. Do you have any questions for me?**
**RESPONDENT: Comments/Questions**

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**INTERVIEWER: Comments/observations**

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