Assessment of Existing Relevant Climate, Health, Poverty and Vulnerability Information
Background

ABOUT THE PROJECT

Climate change, including climate variability, has multiple influences on human health. Both direct and indirect impacts are expected. These include alterations in the geographic range and intensity of transmission of vector-, tick-, and rodent-borne diseases and food- and waterborne diseases, and changes in the prevalence of diseases associated with air pollutants and aeroallergens. Climate change could alter or disrupt natural systems, making it possible for diseases to spread or emerge in areas where they had been limited or had not existed, or for diseases to disappear by making areas less hospitable to the vector or the pathogen. The World Health Organization (WHO) estimates that climate change may already be causing over 150,000 deaths globally per year. While direct and immediate impacts such as deaths in heat waves and floods can often be dramatic and provoke immediate policy-responses, the most important long-term influences will likely act through changes in natural ecosystems and their impacts on disease vectors, waterborne pathogens, and contaminants.

Despite the increasing understanding of health risks associated with climate change, there has been limited identification and implementation of strategies, policies, and measures to protect the health of the most vulnerable populations. Reasons for this include the relatively recent appreciation of the links between climate change and health, which means that existing public health related policies and practices globally do not reflect needs with respect to managing likely climate change-related health impacts.

Recognizing the fact that Ghana experiences an extremely high burden of climate-sensitive diseases such as malaria, diarrhoeal, cerebrospinal meningitis and other infectious diseases and given the fact that Ghana is significantly vulnerable to climatic changes, The Ministry of Health (MOH), Ghana in partnership of United Nations Development Programme (UNDP) is implementing a Global Environment Facility (GEF) funded project to pilot climate change adaptation for health in Ghana.
Malaria, Cerebrospinal Meningitis and Diarrhoeal Diseases, were identified as climate sensitive diseases of interest for the pilot project. The pilot will cover three districts – Bongo in the Upper East Region, Keta in the Volta region and Gomoa West in the Central region.

The proposed project will develop systems and response mechanisms to strengthen the integration of climate change risks into the health sector. Critical barriers will be overcome to shift the current response capacity of the health sector from being reactive towards being more anticipatory, deliberate and systematic. Project actions will identify, implement, monitor, and evaluate adaptations to reduce likely future burdens of malaria, diarrhoeal diseases, and cerebrospinal meningitis (CSM), priority climate change-related health issues identified by national stakeholders.
The production of this report was facilitated by the Climate Change and Health Project Implementation Unit, Ministry of Health, led by Benjamin Yaw Manu, the Project Manager, with the support of Abena Nakawa, the Project Associate, and in consultation with Mr. Isaac Adams, Director, Research, Statistics, Information Management, Ghana.

The content of this report was developed, discussed and validated through extensive consultations led by the Ministry of Health with stakeholders from government agencies including Ghana Health Service, Ghana Meteorological Service, National Malaria Control Programme, National Development Planning Commission, National Disaster Management Organization, Ministry of Local Government and Rural Development, Environmental Protection Agency, Ministry of Environment Science and Technology, National Disease Control Programme, Health Promotion Unit, Ministry of Health, Ministry of Finance and Economic Planning (External Relations Unit).
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Assessment of Existing Relevant Climate, Health, Poverty and Vulnerability Information

Country Focus: Ghana

This consultancy report was prepared by;
Prof Asante and Dr Bawakyillenuo
## List of Acronyms

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<th>Description</th>
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<td>CMS</td>
<td>Cerebrospinal Meningitis</td>
</tr>
<tr>
<td>DALYs</td>
<td>Disability Adjusted Life Years</td>
</tr>
<tr>
<td>EEA</td>
<td>European Environment Agency</td>
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<td>GEF</td>
<td>Global Environment Facility</td>
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<td>GHS</td>
<td>Ghana Cedis</td>
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<td>GLSS</td>
<td>Ghana Living Standard Survey</td>
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<td>GMA</td>
<td>Meteorological Services Agency</td>
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<tr>
<td>GPRS</td>
<td>Ghana Poverty Reduction Strategy</td>
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<td>GSGDA</td>
<td>Ghana Shared Growth and Development Agenda</td>
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<tr>
<td>IFAD</td>
<td>International Fund for Agricultural Development</td>
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<tr>
<td>IFRC</td>
<td>International Federation of Red Cross</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<tr>
<td>IPCC TAR</td>
<td>Intergovernmental Panel on Climate Change Third Assessment Report</td>
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<tr>
<td>McM</td>
<td>Meningococcal Meningitis</td>
</tr>
<tr>
<td>MEST</td>
<td>Ministry of Environment, Science and Technology</td>
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<tr>
<td>MOH</td>
<td>Ministry of Health</td>
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<tr>
<td>NADMO</td>
<td>National Disaster Management Organisation</td>
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<tr>
<td>PPP</td>
<td>Purchasing Power Parity</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNDP</td>
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<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<td>VBD</td>
<td>Vector Borne Diseases</td>
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<td>WHO</td>
<td>World Health Organization</td>
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Executive Summary

The effects of climate change and climate variability on human health have gained great importance in the 21st Century due to their devastating nature. Despite the possible effect of climate change on human health, little has been done in the Ghanaian context to examine the linkages between climate change, poverty, health and vulnerability. Consequently, this study sought to document the existing relevant climate, health, poverty and vulnerability information in Keta, Bongo and Gomoa West districts. Using secondary (documents) and primary (stakeholder focus group discussions) data sources, findings showed certain linkages among the aforementioned variables (climate change, health, poverty and vulnerability) in these three districts. The directions of linkages, however, differ depending on the characteristics and other influencing factors that prevail in the various districts. For instance, the quantitative and qualitative results differ to some extent due to gaps in the data set. As a result, it is recommended that stakeholders should invest in yearly or biennial robust surveys on district level poverty and vulnerability in the pilot districts. Also, non-functional weather stations at the three districts should be revamped, while the districts should compile accurate health statistics on the three diseases and any other diseases including background information of the patience.
Introduction
ASSESSMENT OF EXISTING RELEVANT CLIMATE HEALTH, POVERTY AND VULNERABILITY INFORMATION
1.0 Introduction

Climate change, including climate variability, has multiple influences on human health and these are expected to be either direct or indirect. The impacts of climate change on human health include intensity of transmission of vector-, tick-, and rodent-borne diseases; food- and water water-borne diseases, and changes in the prevalence of diseases associated with air pollutants and aeroallergens. Climate change could alter or disrupt natural systems, making it possible for diseases to spread or emerge in areas where they had been limited or had not existed, or for diseases to disappear by making areas less hospitable to the vector or the pathogen. While direct and immediate impacts such as deaths in heat waves and floods can often be dramatic and provoke immediate policy-responses, the most important long-term influences will likely act through changes in natural ecosystems and their impacts of disease vectors, waterborne pathogens, and contaminants.

Despite the increasing understanding of health risks associated with climate change, there has been limited identification and implementation of strategies, policies, and measures to protect the health of the most vulnerable populations. Reasons for this include the relatively recent appreciation of the links between climate change and health. Hence, a lot of the existing public health related policies and practices globally, tend to neglect the needs apropos managing likely climate change-related health impacts.

In Ghana, the continuing high burden of malaria and other tropical diseases like buruli ulcer, diarrhoeal diseases and the recurrence of seasonal epidemics such as CMS and cholera symptomatic of the vulnerability of the health system and the possible effect of climate change on the health status on Ghanaians. Although these issues have attracted the attention of planners and policy makers in the health sector, the lack of empirical evidence and perhaps the inability to draw the linkages between climate, health, poverty and vulnerability has led to the lack of emphasis on climate change resilient policies and plans. Thus, the need for a very robust assessment of the linkages between climate, health, poverty and vulnerability in selected districts in Ghana in order to inform effective climate change resilient policies and plans cannot be overemphasized.

Against this backdrop, the Ministry of Health (MOH), Ghana in partnership with the United Nations Development Programme (UNDP), commissioned this pilot research project with funding from the Global Environment Facility (GEF) to examine the linkages between climate, malaria, diarrhoea, cerebrospinal meningitis, poverty and vulnerability in Bongo, Keta and Gomoa West districts.
2.0 Objectives
2.1 Objectives

The main objective of this baseline study is to document the existing relevant climate, health, poverty and vulnerability information in the three pilot districts. Specifically, it seeks to achieve the following objectives:

- The collection of baseline information against which the performance of the three project districts will be measured;
- The identification of gaps in the information and possible sources of necessary information;
- The establishment of baseline on the status of the three diseases (CSM, malaria, diarrhoea diseases) in terms of burden, risk factors and capacity to institute control measures;
- The development of a robust methodology for conducting such baseline assessment at the district level in future.
3.0 Background information on Keta, Bongo and Gomoa West Districts
This section provides a brief overview of the three pilot districts (Keta, Bongo and Gomoa West). This encompasses discussion on the populations of the districts, their locations, environmental conditions and other relevant background information.

### 3.1 Keta District

The Keta district lies at the south-eastern corner of the Volta Region, between longitude 0°30E and 1°05E. It is located east of the Volta estuary, about 160km to the east of Accra, off the Accra-Aflao main road. In the North the district shares common borders with Akatsi District, Gulf of Guinea to the South, South Tongu District to the west and Ketu District to the east. The total land area of the Keta district is about 1,086km², out of which about one-third is covered with water bodies (362km²). The other two-third, which is not covered by water creates a situation of severe constraint on access to land for development in the district, hence making the area densely populated.

Geographically, the district can be divided into belts namely, southern, middle and northern belts. In relation to the southern belt, it consists of a narrow strip of land along the coast, stretching from Anyanui to Havedzi, characterized by sandbars. This belt has been prone to sea erosion for several years. For instance, it is estimated that about five miles of Keta coastal land has been washed away by the sea, leading to the destruction of properties, including schools, roads, private houses, historical edifices, etc. This disaster is responsible for the significant out-migration from the area. Likewise, the middle belt (also known as the lagoon basin) is below sea level. It is made up of islands and lagoons and covers Shime and Kome areas. The middle belt is generally marshy as a result of sandy-clay geological formation. Due to this, the area gets flooded during the rainy season making access very difficult or impossible. The northern belt covers the whole of Anyako Sub-municipality and Anlo-Afiadenyigba. Unlike the other belts, the northern belt has a relatively higher elevation of 50 meters above sea level.

In relation to the climatic conditions, the Keta district lies within the Dry Coastal Equatorial Climate with an annual average rainfall of less than 1,000mm. As one travels from the north to the coastal parts the amount of rainfall reduces, with annual amount of rainfall of about 800mm at the coastal part. The district is considered to be one of the driest along the coast of Ghana. High temperatures are experienced all the year round in this district with an average temperature of about 30°C. According to the Municipal Health Directorate Keta, the population of the Keta district as at the year 2011 is about 164,407.

### 3.2 Gomoa West District

The Gomoa District is one of the 12 districts in the Central Region of Ghana. It lies within latitude 5°14 north and 5°35 north and longitude 0°22 west and 0°54 west on the eastern part of the Central Region of Ghana. It is bounded on the north by Agona District, on the northeast by Awutu Effutu Senya District, on the west and northwest by Mfantseman and Ajumako-Enyan-Essiam Districts respectively, and on the south by the Atlantic Ocean and larger part of the dissected Awutu-Effutu-Senya District. The Gomoa District covers an area of 1,022.0 sq km and a total population 194,792. (i.e. 12.23% of the Central Region’s population). In consequence, it is the district with the highest population and surface area next to Assin District in the Central Region.

The district abounds with numerous natural resources, which when tapped will contribute to its development. These include rivers, streams, lagoons, beaches, forest reserves, quarry stones and traces of mineral deposits. The district experiences two rainfall patterns - major rainy season (April - July) and minor rainy season (September - November). The mean annual rainfall ranges between 70cm and 90cm in the southern coastal belt and 90cm to 110 cm in the northern and north western
semi-deciduous forest areas. Its mean annual maximum and minimum temperatures of 29°C and 26°C occur in February to March and August respectively. Its relative humidity is influenced by the presence of large water bodies like the ocean, rivers, lagoons and streams.

3.3 Bongo District

Bongo District is one of the nine districts in the Upper East Region. It shares boundaries with Burkina Faso to the north and east, Kassena-Nankana District to the West and Bolgatanga Municipal. The settlement pattern of the district exhibits rural characteristics. Apart from the district capital, Bongo, all the other communities are made up of small farm settlements scattered around the district. According to the projected population for 2006, Bongo district as a population of about 95,000. The district lies within the Northern Savannah Zone with one rainy season in a year and the amount of rainfall in the district is offset by the intense drought that precedes the rain and by the very high rate of evaporation that is estimated at 168 cm per annum. The vegetation is that of the Guinea Savannah type. Rivers and streams dry up and the vegetation withers due to the high temperature.
Literature Review on Impacts of Climate Change
Climate change in the past two decades has become a topical issue at the global level. This is because the physical and biological systems on all continents are already being affected by recent changes in climatic conditions. There is overwhelming scientific evidence and consensus that climate change is largely human induced (Rosenzweig, 2007; Sach, 2008). Atmospheric concentration of carbon dioxide increased from a pre-industrial revolution value of 278 parts per million to 387 parts per million in 2008 (Maslin, 2008). Work by Keeling and Whorf (2005) reveals that since the industrial revolution, annual variations in the concentration of carbon dioxide have been occurring but the overall trend shows a rise in concentration. Greenhouse gas emissions have further increased over the last two decades. From 1.3% per annum in the 1990’s, the rate of green house emission increased to 3.3% per annum between 2000 and 2006 (Canadell et al., 2007).

The occurrence of climate change is unequivocal. The IPCC estimates that there has been an average increase in temperature of 0.6 degrees Celsius over the past century. Atmospheric temperature has been unprecedented in the past 25 years with eleven out of the twelve warmest years occurring between 1995 and 2006 (UNFCC, 2007). Countries are beginning to experience the consequences associated with global warming such as prolong drought in the African Sahel and the widening of the transmission belt of malaria within tropical Africa (Sachs, 2008). Globally, the number of reported weather-related natural disasters is mounting rapidly. Reports of natural catastrophes have more than tripled since the 1960s. In 2007, fourteen (14) out of fifteen (15) “flash appeals” for emergency humanitarian assistance were for floods, droughts and storms, five times higher than in any previous year (John 2008). In Ghana, climate change is being experienced through the rise in temperatures and unpredictable rainfall across all ecological zones (MEST, 2010).

Further, global warming is being predicted to result in changes in precipitation patterns, aridification and humidity (IPCC, 2007). Against this background, the overall impact of climate change on global life support systems remains uncertain. Some areas will experience extreme rainfalls leading to flooding; other areas such as the Mediterranean will experience a decrease which might lead to drought conditions (IPCC, 2007). According to IPCC (2001) global mean temperatures are expected to increase between 1.4 and 5.8 °C by the end of this century with a corresponding rise in sea level as glaciers melt. Recent observations, however, show that many predictions about aspects of climate change are near the upper boundary of IPCC’s estimates. Sea levels for instance have increased far above IPCC’s projected estimates to 30cm (Kearney, 2002).

### 4.1 Climate Change and Health

Being healthy is not only the absence of disease, but it encompasses the physical, social and psychological wellbeing of a person (Confalnieri et al, 2007). The health of a population has an impact on the pace of development in a nation. Globally, a lot of progress has been made in reducing morbidity and mortality from disease among populations in the last fifty (50) years but the benefits of improved public health and technological advancement has not been evenly distributed across countries (McMichael et al, 2004). The average life expectancy of an African is forty-six (46) years, roughly thirty-three (33) years lower than those living in high income countries (Sach, 2008).

Until recently, the climate change-health nexus did not feature prominently in the climate change discourse. In the past, discussions on climate change focused on the effects of the phenomenon on the global economic outlook and eco-systems sustainability (McMichael, 2009). Conspicuously missing from the preparatory submissions of countries for the United Nations Framework Convention on Climate Change (UNFCCC) negotiations...
in Copenhagen in December, 2009 was the effects of climate change on human health. In addition, only four (4) out of forty seven (47) countries that made preparatory submissions mentioned human health as an area of concern (McMichael et al, 2009). This notwithstanding, it has long been known, at least since the Hippocrates, that climate has wide ranging impacts on health (Haines et. al, 2006).

Increasingly, scientists have become interested in the potential effects of global climate change on health. According to McMichael et al (2006), climate change already has and will continue to have a negative impact on the health of human populations. Evidence already exists that climate change will affect rates of malnutrition, diarrhoeal diseases, malaria and deaths as a result of changing precipitation and high temperatures (McMichael, 2004). This is because there is ample evidence that links most of the world’s killer diseases to climatic variations (Campbell-Lendrum et al, 2003).

Climate change according to Costello (2009) was responsible for 5·5 million disability adjusted life years (DALYs) lost in 2000. These initial assessments and figures of the disease burden attributable to climate change were conservative and relate only to deaths caused by cardiovascular diseases, diarrhoeal diseases, malaria, accidental injuries during coastal and inland floods, landslides and malnutrition. Studies show that small increases in the risk for climate-sensitive disease conditions such as diarrhoea diseases and malnutrition can result in very large increases in the total disease burden (Haines et.al, 2006).

Not all of the effects of climate change will be harmful to human health but the damages are projected to outweigh the benefits. A warmer climate is expected to bring benefits to some populations, including reduced mortality and morbidity in winter and greater local food production, particularly in northern high latitudes. Against this background, the negative effects of climate change on health are likely to be greater and are more strongly supported by evidence than are the possible benefits. In addition, the negative effects are concentrated on poor populations that already have compromised health prospects, thus widening the inequality gap between the most and the least privileged (World Health Organization, 2009). The likely effects and outcomes of climate change on human health as summarized by Confalniera (2007) are presented in Figure 1.

- **Figure 1: Direction and Magnitude of Change of Selected Health Impacts of Climate Change**

```markdown
<table>
<thead>
<tr>
<th>Negative impact</th>
<th>Positive impact</th>
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<tr>
<td><strong>Very high confidence</strong></td>
<td></td>
</tr>
<tr>
<td>Malaria: contraction and expansion, changes in transmission season</td>
<td></td>
</tr>
<tr>
<td><strong>High confidence</strong></td>
<td></td>
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<tr>
<td>Increase in malnutrition</td>
<td></td>
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<tr>
<td>Increase in the number of people suffering from deaths, disease and injuries from extreme weather events</td>
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<td>Increase in the frequency of cardio-respiratory diseases from changes in air quality</td>
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<td>Change in the range of infectious disease vectors</td>
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<tr>
<td>Reduction of cold-related deaths</td>
<td></td>
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<tr>
<td><strong>Medium confidence</strong></td>
<td></td>
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<tr>
<td>Increase in the burden of diarrhoeal diseases</td>
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*Source: Confalniera, 2007*
Figure 1 shows that there will be both positive and negative health outcomes of climate change but the negative effects are likely to outweigh the positive effects. Woodward et al. (2011) observe that the risk of climate change to health results mainly from the effects of the phenomenon on local food production, severity and frequency of storms and floods, threats to water supplies and the direct effect of the heat on people. Confalnieri et al (2007) also classifies human exposure to the effects of climate change into two, that is, direct and indirect. People are affected directly through changing weather patterns and indirectly through food and water quality and quantity, agriculture among others. Exposure to any of these conditions can cause morbidity and even death. What most literature on the implications of climate change suggest is that climate change affects human health through three pathways: directly, indirectly and through social and economic disruptions (IPCC, 2007). These are discussed further below;

4.1.1 Health Effects Due to Direct Exposure To Changes in Climatic Variables

Changes in climatic conditions are expected to affect the distribution of morbidity and mortality through the physical effects of exposure to high or low temperature (Campbell-Lendrum et al, 2003). Several studies have concluded on the impact of atmospheric temperature on the health status of a given population. Human beings are able to cope well with mid-range temperatures and are only stressed by temperatures that are ‘uncommonly’ high or low (Woodward, 2011). What constitutes uncommon heat or cold differs from one region to the other. According to Parsons (2003), human beings are only able to tolerate body temperature of about 37 degrees Celsius. Significant increase or reduction in temperature adversely affects body temperature and metabolism processes within the body.

Climate change projections show that, heat waves will become more frequent, intense and will last longer in the twenty-first century (Tebaldi, 2004). This scenario is not expected to happen only in the Mediterranean regions, but also in the temperate regions which are currently not experiencing heat wave events (D’Ippoliti et al, 2010). The early effect of high temperature usually is reduced physical and mental work capacity; and further sustained exposure leads to exhaustion and heat stroke (Kovats, 2006). These have direct effects on productivity (IPCC, 2007 and Nerlander, 2009).

Heat waves are defined as temperature extremes of short duration (IPCC, 2007). There has been a lot of research on heat waves and its effect on human health since the Third Assessment Report of the IPCC especially, in Europe and the United States (Basu and Samet, 2002; Koppe et al, 2004). According to Robine et al (2008), the heat wave in Europe in 2003 caused about 70,000 deaths principally from cardiovascular diseases. Other studies in California by Knowlton et al (2009) found similar results. In urban areas of developing countries, urban sprawl and sub-standard housing is increasing the vulnerability of poor urban households to heatstroke and weaves through the ‘heat island effect’, hence, putting an estimated 4 billion people in developing country cities at risk (Castello et al, 2009).

Another direct impact of climate is cold waves, which usually affect people that spend a lot of time outdoors such as the homeless. In the polar and temperate regions, cold waves can still increase mortality when electricity and heating systems malfunction (Confalnieri et al, 2007). Cold related mortality has declined in most European countries since 1950 (Carson et al, 2003). Many attribute the reduction in winter time mortality to decline in cold days and nights. Carson et al (2006), however, report that the reduction in cold temperature accounts for a small proportion of the reduction in winter time mortality. Rather, improvements in domestic heating and public health systems as well as housing improvement have contributed more to the observed reduction in winter time mortality.
IPCC (2007) indicated that the increase in temperature will lead to a reduction in the number of deaths that are associated with cold weather, but this will be outweighed by the deaths that will occur from exposure to extreme heat. Campbell-Lendrum et al (2003) are, however, of the view that the reduction in winter time mortality will be countered by increased mortality in summer time, thus, the impact of changes in thermal regimes on the global disease burden will be neutral. Campell-Lendrum et al (2003) probably came to this conclusion because there is an indication that populations have become less sensitive to hyper thermal conditions. For instance, there has been a reduction in the mortality arising from heat related illness in the United States since the 1970’s (Donaldson et al, 2003; IPCC, 2007).

Schwarts (2005) also found in his study that socio-demographic characteristics and medical conditions can increase the risk of death associated with extreme temperatures. He indicated that while patients with diabetes had a higher risk of dying on hot days, women had higher risk of dying on cold days. Studies by D’Ippoliti et al (2010) confirmed the results of an earlier study by Schwarts (2005) that, the effect of heat waves was highest among people with respiratory diseases and women aged between 75 and 84 years.

Floods are the most frequent natural disasters (Confalnieri et al, 2007). The effects of floods, storms and wind are usually influenced by existing water management practices, urbanization trend, intensified land use and forestry (EEA, 2005). The impact of floods ranges from death through drowning, injuries, the outbreak of epidemics of infectious disease among others (Greenough et. al, 2001). Major storms and floods’ disasters have occurred within the past twenty years (IPCC, 2007). Deaths recorded from these disasters occur usually through drowning and severe injuries. Floods in Bangladesh and Mozambique have been cited as having been caused by climate change. About 1, 813 people were estimated to have died from the 2000/2001 floods in Mozambique (IFRC, 2002). All of these illustrations show how climate change directly affects human health.

4.1.2 Climate Change and Indirect Exposure to Disease Pathogens

Indirectly, climate change affects human health through air, food and water quality and quantity, agriculture and the ecology of vectors (IPCC, 2007). Malnutrition and food insecurity are also affected indirectly by climate change as high temperatures and erratic rainfall reduce crop yields (Costello et al, 2009). Contact between food and pest species, especially flies, rodents and cockroaches, is also temperature-sensitive. Fly activity is largely driven by temperature rather than by biotic factors (Goulson et al, 2005). Muamba and Ulimwengu (2010) indicate that agriculture is one of the sectors that is extremely vulnerable to climate change and will be adversely impacted directly by the phenomenon.

The impact of climate change on agriculture and food security could be through drought, destruction of crops during floods, destruction of food logistics and an increase in plant diseases and pest (Confalnieri et al, 2007). Lobell and Ashner (2003) found that corn and soya beans yields in the United States of America fell by 17% for every degree rise in average temperatures during the planting season. Lobell et Al, (2008) also point out that without sufficient adaptation strategies, people in Southern Africa and Asia will suffer from the negative outcomes as a result of a reduction in the production of major staples such as maize, wheat and rice. In developing countries, climate change will cause a reduction in the output of most staples including rice, wheat, maize and soybeans (Nelson et al, 2009). These climate change impacts will intensify food insecurity among the world’s poorest populations leading to malnutrition.

Drought does not only reduce the overall food availability but also, dietary diversity. Malnutrition is therefore likely to worsen as climate change affects crops, forestry, fisheries and water resources that serve as food and dietary supplements (Costello, 2009). Malnutrition according to IPCC (2007) increases the risk of morbidity and mortality.
from infectious diseases. Azziz et al (1990) confirmed this in his study in Bangladesh. In Bangladesh, drought and lack of food were linked to an increasing possibility of dying from a diarrhoeal disease.

Having access to safe and regular supply of water is an important health requirement (Costello, 2009). Climate extremes according to IPCC (2007) can cause both physical and managerial stress on water supply systems. The IPCC (2007) classified the route of transmission of water related diseases into two: water-borne (ingested) and water-washed routes (caused by lack of hygiene). They also reported four main considerations to be addressed when evaluating the relationship between health outcomes and rainfall, water availability and quality. These are:

i. Linkages between water availability, household access to improved water and the health burden attributable to gastrointestinal/diarrhoeal diseases;

ii. The role of extreme intense rainfall and drought in facilitating outbreak and spread of water related diseases through piped water supplies or surface water;

iii. Effects of temperature and run-off on microbiological and chemical contamination of coastal, recreational and surface water resources; and

iv. Direct effects of temperature on availability of water and hence the incidence of diarrhoeal diseases, rodent and vector borne diseases.

Getting access to safe drinking water especially in underdeveloped countries has a huge influence on the health of populations. According to the World Health Organisation (2005), over two billion people live in the dry regions of the world and suffer diseases related to contaminated and insufficient water. Though currently, a small amount of this disease burden is attributed to climate change variability by IPCC (2007) global warming will play a major role in the distribution and spread of these diseases in the foreseeable future.

Changes in rainfall patterns affect surface water flow. Reduction in rainfall will lead to reduced river flows and increased water temperature leading to declining water quality because the dilution of contaminants in the water is reduced. Less oxygen is therefore dissolved in the water and microbiological activity is enhanced (Confalnieri et al, 2007 and Bates et al, 2008). This notwithstanding, several studies document the linkage between microbial load in water as a result of extreme rainfall events and runoff and cases of human disease is not very clear (Aramin et al, 2000; Schwartz et al, 2000; Lim et al, 2002).

Work by Senhorst and Zwolsman, (2005) in the Netherlands associated the low quality of water during the 2003 period to low river flows during the dry summer of 2003. The marked seasonal outbreak of cholera in the Amazon and sub-Saharan Africa are often associated with reductions in rainfall, floods and the faecal contamination of water supplies (Gerolomo and Pema, 1999; Confalnieri et al, 2007). In the United States of America, Curriro et al, (2003) found an association between extreme rainfall events and monthly reports of outbreak of water-borne diseases. Common forms of food contamination such as salmonellosis have been found to be associated with high temperatures (IPCC, 2007). Studies by D’Souza et al, (2004), Kovats et al, (2004) and Fleury et al, (2006) concluded that an increase in the reported cases of salmonellosis corresponds with every degree increase in temperature. Work by Trærup et al, (2010) on the health impacts of climate change in Tanzania also concluded that a unit increase in temperature induces a 23 to 51% increase in cholera cases.

Vector borne diseases are also climate sensitive. Vector borne diseases (VBD) are infections transitions through the bite or contact with infected arthropod species such as mosquitoes, ticks, triatomine bugs, sandflies and blackflies (IPCC, 2007). Vector Borne Diseases include, malaria, dune fever, schistosomiasis, fascioliasis, alveolar echinococcosis, leishmaniasis, lyme borreliosis, tick-borne encephalitis, and hantavirus infections (Costello, 2009).

Rising temperature within a certain range affects rate of pathogen maturation and replication within mosquitoes. Temperature also moderates vector and rodent densities thereby increasing the likelihood of infections.
The reproduction of vectors, parasite development and frequency of blood meals generally rises with temperature. Diseases such as malaria, tick-borne encephalitis and dengue fever will therefore become increasingly widespread as temperature rises as result of global warming. Currently, no transmission zones for malaria for instance could become malaria endemic areas as a result of the changes in temperature (Kovats et al., 2005).

Lindsay and Martens (1998) estimated that 260-320 million people will be affected by malaria by 2080 as a result of both latitudinal and altitudinal expansion of the malaria belt. Projections for Africa suggest that 170 million people will be at risk of malaria by 2030 (Hay et al., 2006). Studies in the East African highlands provided similar estimates (Hay et al., 2006; Pascal et al., 2006; Tanser et al., 2003). Ye et al., (2007) studied the effect of meteorological factors on clinical malaria in children and provided empirical evidence supporting the fact that temperature had the highest effect on the incidence of malaria among the survey population. Other studies, for instance, that of Reiter et al. (2004) and Hay et al., (2002) caution against attributing malaria dynamics solely to global warming and point to the uncertainties associated with predicting malaria epidemics nationally and locally.

Dengue fever is the most lethal viral vector borne disease. Approximately, one (1) out of every three (3) persons in the world live in areas where climatic conditions are suitable for the transmission of Dengue. The global population at risk from dengue is put at about 2 billion by the 2080s (Hales et al., 2002). Several studies including Cazelles et al., (2005) and Gagnon et al., (2001) have associated dengue with temperature. However, the associations were modified by other competing factors.

4.1.3 Climate Induced Social and Economic Disruptions and the Disease Burden

Global warming will indirectly influence human health through social and economic disruptions. Extreme weather events such as floods, storms, drought due to climate change explain why a large number of people, especially in Africa are living under economic stress and food scarcity, with the likely result of conflict. It has been proven by Miguel et al., (2004) that the exploratory power of economic variables in accounting for the incidence and location of ethnic conflicts and civil strife within countries in Africa was stronger than institutional and political factors. Africa’s economy is driven by agriculture which is largely rain-fed and labour intensive. A reduction in rainfall causes a shrink in the economy through a number of chain effects such as low harvest and food supply causing inflation, low foreign exchange earnings and hunger. These trigger conflicts within countries on the continent. The conflict in Darfur is a point in case. A reduction in rainfall over past thirty years, water shortage and migration in search grazing land (increase in population in the region) have led to extreme poverty, which is fuelling the war (Confalnieriet al., 2007). The disease burden is higher during conflicts as health services are disrupted and food shortages are rampant compared to peace time leading to malnutrition. More importantly, combatants, women and children sustain injuries or are maimed during war which contributes to the global disease burden. While the War in Darfur has claimed about 300,000 lives, Waldeman (2001) reports that in Guinea-Bissau mortality from tuberculosis was three (3) times higher in people affected by war. This was mainly as a result of their inability to access or continue treatment.

Population movement through rural-urban migration due to crop failure and other climatic induced shocks can cause health problems through overcrowding, psychological stress and the increase pressure on health and social services in urban centres (Toole and Walderman, 1990). The effects of climate change on water stress, agriculture among others will affect the rural dealers more reinforcing recent trends in rural urban migration. Peasant farmers are expected to be badly hit by reduction in rainfall because of the low use of and availability of irrigation facilities. This will lead to higher incidence of poverty especially among vulnerable groups like food crop farmers and women mostly
in rural areas. Rural-urban migration as a result of climate change could also lead to an increase in the number of urban poor, a group described by many including Agyeman-Bonsu et al., (2008) and Nelson and Agbey (2005) as being vulnerable to the adverse effects of climate change on health impacts. This is because migrants from the rural areas mostly do not have the skills required to enter and participate in the formal urban wage labour market that guarantees higher earnings.

Climate change factors like water stress and erratic rainfall will induce conflicts and/or shocks which will trigger mass movements and migration within and across nation territories. The disease burden of both migrant/immigrants/climate refugees and hosts are at risk as there is the possibility of cross infecting with disease that were previous not associated with each group.

The effects of climate change on health have been discussed broadly so far through the three pathways suggested by the IPCC (2007). The next section explores the links between malaria, diarrhoeal diseases and meningitis and climatic variables.

4.2 Effects of Climate Change on Malaria, Diarrhoeal Diseases and Meningitis

This section examines literature that border on how climate change could affect the incidence of malaria, diarrhoea land meningitis.

4.2.1 Malaria

The widespread occurrence of malaria has made it one of the most important vector borne diseases in the World (Hales et al., 2001). The World Health Organization reports that 1.5 to 2.7 million people die from malaria yearly and out of this number, 90% are young children (Asante et al., 2005). Sub-Saharan Africa alone accounts for 90% of the global malaria burden (WHO, 1999; Asante et al., 2005). The economic burden of malaria is estimated as an average annual reduction in economic growth of 1.3% for those African countries with the highest burden (Gallup and Sachs, 2001). The symptoms of malaria include fever (70% of all fevers are diagnosed as malaria), hypoglycaemia (severe cases) and convulsion among children (Lankinen et al., 1994). The disease is the number one cause of morbidity in Ghana (Asenso-Okyere and Asante, 2003). It accounts for between 40%-60% and 30%-36% of all out patients’ visits and admissions respectively (Government of Ghana, 2004).

The anopheles mosquito carries the malaria parasite. Asante et al., (2005) report that four species of the parasite cause malaria in humans. These are plasmodium falciparum, plasmodium vivax, plasmodiumovale and plasmodium malariae. Malaria is transmitted by mosquitoes of the genus Anopheles. There are about seventy (70) species that are vectors of malaria under natural conditions. The main vector species in Africa is the Anophelesgambiae complex. This is the most dangerous vector in the World (van Lieshout et al., 2004).

Mosquito-borne diseases are climate sensitive. This is because mosquitoes require clean stagnant water to breed. In addition, the survival of mosquitoes depends on prevailing temperature (warm temperature). More importantly, gonotrophic cycle as well as life expectancy of both the vector and the parasite depends on warm temperature (Hales et al., 2002; Martens et al., 1997). Temperature is also important to larvae development and the speed at which the parasite is able to replicate itself (Focks et al., 1993; Patz et al., 1998).

Rainfall also supports vector and parasite growth and survival. Rainfall provides habitats for mosquitoes to lay their eggs and the minimum humidity threshold required to sustain the life of mosquitoes. It has been shown that the soil moisture (rainfall) predicts 45% and 56% of the variability of human biting rate and entomological inoculation rate, respectively (Grosso et al., 2010). It has been correlated positively with the incidence of malaria in several endemic zones in most parts of the tropics. Analyses of time series clinical data in India showed that there was about a fivefold increase in the risk of malaria
the year after an El Niño (Bouma and van der Kaay, 1994).

A similar finding has been made in Venezuela, where, during the whole of the twentieth century, malaria rates increased on average by over one-third in the year immediately following an El Niño (Bouma and Dye, 1997). The 1958 malaria epidemic in Ethiopia was associated with unusually high amounts of rain. Similarly, in Nairobi, outbreaks of malaria occurred in 1940 after heavy rains (Lindsay and Martens, 1988). In the Ugandan highlands, rainfall anomalies because of El Niño were positively correlated with vector density one month later, and this may have started the resulting epidemic (Lindblade et al, 1999).

The link between climate and malaria distribution has long been established (Tanser, 2003). Climate change is likely to alter the distribution and seasonal transmission of malaria (McMichael, 2001). Studies based on the IPCC climate change scenarios for Africa, reveal that climate change will be associated with geographical expansion of the areas suitable for stable *Plasmodium falciparum* in most parts of Africa (Transer et al 2003; van Lieshout et al., 2004). The recent increase in the incidence of malaria transmission in the highland areas of East Africa has been attributed to climate change (Pascual et al, 2006; Alonso et al, 2011; Omumbo et al 2011). High malaria admissions have been occurring in the rainy season (rainfall) and unusually high temperatures in Kenya and Ghana (Gatheko and Ndegwa, 2001; Agyeman Bonsu et al, 2008).

Tanser (2003) for instance, quantitatively estimated current malaria exposure and assessed the potential effect of projected climate scenarios on malaria transmission in Africa. He found that, apart from the changes that can occur in geographical regions, the duration of the season will also affect the dynamics of transmission, with longer wet seasons allowing for heightened transmission and high levels of infection in the population. Also, a large proportion of the increase in transmission will occur in unstable endemic areas. Areas around Central America and the Amazon for instance are projected to experience a reduction in the incidence of malaria as a result of reduction in rainfall (Confalonieri et al, 2007).

Though studies have been able to establish the link between temperature and precipitation and malaria, results remain controversial. This is because many other factors can affect malaria and some may counter the effects of the climate (Confalonieri et al, 2007). Gething et al, (2010) used evidence-based malaria maps to show that despite global warming during the 20th century, a reduction in the incidence of malaria was observed globally. Other studies have refuted claims that the recent malaria resurgence in Africa has been driven by climate change. Work by Hay et Al, (2002) in the East African Highlands showed that temperature, rainfall, vapour pressure and the number of months suitable for *Plasmodium falciparum* transmission had not changed significantly during the period of reported malaria resurgence in the highland area. Pascual et al, (2008) reported that the incidence of the disease and meteorological factors such as temperature might complement each other and interact at different time scales. These contradictions inform Saugeon et al, (2009) conclusion that, the indirect effects of climate change on malaria might be more important than direct effects. For instance, the changes in agricultural productivity due to climate change could lead to migration with its resultant increase in urbanization, which results in lower transmission rates (Hay et al, 2005; Keiser et al, 2004). These observations make the link between climate change and malaria risk an important component in assessing the disease burden.

### 4.2.2 Diarrhoeal Diseases

The World Health Organization (2005) estimates show that about 4 billion episodes of diarrhoeal diseases occur annually around the world. Diarrhoeal diseases are one of the three main causes of child mortality in the world (Black et al, 2003; Bryce et al, 2005). One-and-a-half (1.5) million children under five (5) years die as a result of diarrhoeal diseases annually in developing countries (Prüss-Üstün and Corvalán, 2006). Diarrhoea in
early childhood can lead to impaired growth, physical fitness and cognitive development. This can in turn lead to a reduction in future school performance (BreyetteLorntz et al, 2006).

The enteric pathogens that cause diarrhoeal diseases include Rotavirus (watery diarrhoea), Shgellae (dysentery) and Vibrio Cholerae (cholera). These pathogens thrive under conditions of high rainfall, temperature, flooding, high population and housing densities and poor environmental and personal hygiene (Lankinen et al, 1994). These classes of diseases are transmitted through faecal-oral routes, which are particularly pervasive in conditions of poverty (Benneh et al, 1993). Two-thirds of all diarrhoeal diseases lead to dehydration through frequent passing of watery stools, causing poor absorption of nutrients especially in children. If not detected early and treated, diarrhoeal diseases can lead to mortality (Fricas and Matz, 2007). Diarrhoea morbidity accounts for between 4% and 5% of all morbidity in Ghana (Government of Ghana, 2004). A combination of Oral Rehydration Therapy, ameobicides and antibiotics have emerged as effective treatments for many diarrhoeal diseases in many regions of the world. This notwithstanding, morbidity and mortality from diarrhoeal diseases seems to be on the ascendancy in Africa (Benneh et al, 2006).

Rainfall and temperature variability impact the prevalence of diarrhoeal diseases through its effect on the various bacteria, protozoa, viruses and helmenthesis that cause the infections, leading to diarrhoeal diseases (Bandyopadhyay et al, 2011). For example, Vibrio Cholerae, the causative organism of cholera is found in brackish waters and among the estuarine ecology. The organism is also present in crustaceans such as shellfish as well as plankton which thrive in shallow ocean waters and estuaries. As climate change induces a rise in ocean temperature and salinity reduces as a result of increase in rainfall and/or melting of the polar ice sheets, conditions will become favourable for the growth of plankton and crustaceans within most shallow oceans and estuarine waters. This will increase the population of Vibrio Cholerae in these habitats. Historically, increase in oceanic temperature (surface temperature) on the Sea of Bengal and seasonal plankton abundance have been cited as possible reasons for the bimodal seasonal pattern of cholera in Coastal Bangladesh (Bouma and Pascal, 2001).

More frequent floods as a result of climate change have been noted as the main causes of increase in diarrhoeal cases in India, Bangladesh, and Mozambique and even in the United States of America (cited in IPCC, 2007; Curreiro, 2001). Kang et al (2001) have shown that the transmission of pathogens is higher during the rainy seasons. In Ghana, diarrhoeal diseases have been associated with the rainy season. In Ghana, diarrhoea morbidity is higher during the rainy seasons. In Ghana, diarrhoeal diseases have been associated with the rainy season. In Ghana, diarrhoeal diseases have been associated with the rainy season (Agyeman Bonsu et al, 1993). Checkley et al, (2000) in their study in Latin America found that increases in temperature as a result of El Nino Southern Oscillation increased the number of admissions to hospitals as a result of diarrhoea than temperatures before the occurrence of the El Nino event.

4.2.3 Meningococcal Meningitis

About 162 million people in Africa live in areas with a risk of meningitis (Molesworth et al, 2003). Meningococcal meningitis (MCM) according to Sultan et al, (2005) has affected Sahelian regions of Africa for centuries and has become endemic in the past 25 years. WHO (2000) registered between 25,000 and 200,000 disease cases of MCM per year in 1980, with about 10% of them resulting in death. Just like the other infectious diseases, MCM’s highest effect is on young children. Meningitis appears to be linked particularly to drought although the causal agent is not yet known (Sultan, 2005).

Meningococcal meningitis is the bacterial form of meningitis that causes inflammation of the protective membranes covering the brain and spinal cord (WHO, 2011). It is the only form of meningitis that can spread in epidemic form. Meningococcal meningitis is most commonly found in sub-Saharan Africa and infection rates typically increase between February and late May (Sultan, 2005). The bacteria is transmitted from person to person upon
close contact through droplets of respiratory or throat secretions (Molesworth et al., 2003). The meningitis belt of sub-Saharan Africa, stretching from Senegal in the west to Ethiopia in the east, has the highest rates of the disease (Molesworth et al., 2003).

Symptoms of infection include stiff neck, sensitivity to light, confusion, high fever, headaches and vomiting. Even when diagnosed early and treatment is started, five to fifteen percent of patients die within forty-eight hours of infection (WHO, 2011). The geographical coverage of meningitis has expanded in West Africa especially due to land use change and changes in regional climatic conditions (Molesworth et al., 2003).

### 4.3 Poverty in Ghana

Poverty can be seen as a multidimensional concept which is characterised by low income, malnutrition, ill health, illiteracy, and insecurity. Poverty can either be absolute or relative. Whereas absolute poverty measures number of people living below a certain income threshold (for instance US$ 1 per day) or the number of households unable to afford certain basic goods and services, relative poverty determines an individual as poor if he/she has an income which is below the average income and life style enjoyed by the rest of the society in which one lives. Some definitions classify poverty as living on less than US$ 2 dollars a day per person. But recent studies and analysis by UNDP as captured in Human Development Report use a Purchasing Power Parity (PPP) figure of US$ 1.25 as the limit for capturing income poverty. Various means exist for measuring poverty but this study relies on income poverty as the means of capturing poverty in Ghana. In Ghana, two types of poverty exist; (1) extreme poverty (living on less than GHS 288.47 per annum per person) and (2) poverty (living on less than GHS 370.89 per annum per person).

The issue of poverty and its reduction to the barest minimum have been central to the development agenda of both past and present governments of the Republic of Ghana. This is evidenced from the implementation of various national development strategies and other donor funded projects and programmes. These include Economic Recovery Programme and the Structural Adjustment Programme, Vision 2020, Ghana Poverty Reduction Strategy (GPRS I), Growth and Poverty Reduction Strategy (GPRS II) and Ghana Shared Growth and Development Agenda (GSGDA), 2010-2013. Apart from these national development policies, there are several other regional and district specific policies, programmes and projects aimed at ensuring equitable development and poverty reduction. But available evidence suggests that poverty is not evenly distributed between regions, districts, communities and households in Ghana.

In spite of the effort by development partners to reduce poverty to a minimal level, four of every ten Ghanaians still live in poverty. Many of them work in agriculture, mostly as food crop farmers. Others are engaged in micro and small enterprises, or finding a survival income as daily casual labour.

Poverty Profile in Ghana shows that the proportion of rural poor increased from 43% in 1970 to 54% in 1986 (IFAD). A rough estimates provided by Green (1988) also shows that the number of urban people below the poverty line increased from average of between 30 and 35% in the late 1970s to a range of 45-50% in mid 1980s whilst for rural people, Green estimated that poverty increased from a range of 60-65% in late 1970s to between 67% and 72% in mid 1980s. The first empirical work on poverty was by Boateng et al., (1990) using data based on the first half year results of Ghana Living Standard Survey (1987/88). They set poverty lines for the “poor” and “very poor” in Ghana at 432,981 and 416,491 per head, per year, in the constant prices of September 1987, respectively. These represented 30% (poor) and 10% (hard-core poor) of the population, respectively. They observed that about 19.2 percent of the “hard-core” poor live in the urban areas while 65.8 percent live in the rural areas.

There have been several analyses of GLSS data for poverty trends which show the trends in indicators of poverty in Ghana and some main geographic locations between 1991/92 and 1998/99. The results of these analyses
show that estimated income poverty fell from 51.7% of the population in 1991/92 to 39.5% in 1998/99. But there are strong geographic patterns to this, with almost all the poverty reduction having occurred in Accra or in the urban and rural areas of the forest zone.

4.4 Conceptual Framework: Climate Change and Health Nexus

One of the most comprehensive frameworks that explains the links between climate change and climate variability to health outcomes has been provide by the Haines and Patz (2004). This has been modified and adopted for the study. In the original form, the framework links natural phenomena and human influence to climate change and variability. The changes in regional and local climatic conditions manifest as extreme weather conditions, changes in precipitation and rise in oceanic and atmospheric temperature (global warming). These stressors will act directly or indirectly to determine health outcomes (IPCC, 2007).

Directly, an increase or decrease in atmospheric temperature causes heat or cold waves leading to heat stroke and other diseases. In addition, climate change will elevate sea levels due to factors such as the melting of arctic ice sheets and rising sea surface temperature. These trigger storm surges and floods that will put settlements especially, coastal ones at risk.

Indirectly, through “ecological disturbance” high temperature and changes in patterns of precipitation (stressors) will alter the global pattern of infectious diseases. Global warming will create a suitable environment for disease vectors and pathogens to thrive and enhance the frequency of human contact in most parts of the world.

Climate change is also expected to induce tertiary feedbacks through conflicts and displaced population who are likely to increase the pressure on social amenities such as public health services in host communities and/or increase cross infections as well as the outbreak of new diseases. These events could lead to morbidity and/or mortality. The tertiary effects are broadly captured as social and economic disruptions by IPCC (2007).

From the framework, health outcomes of climate change will be conditioned by the interplay of modulating and adaptation measures. Modulating factors are exogenous of climate change. Adaptive measures, however, are implemented in response to or in anticipation of climate change (IPCC TAR, 2001). The earlier model as described by Hainz and Patz (2004) combines these two intervening variables but the modified framework, as presented below in Figure 2, separates these two factors in order to emphasizing the importance of adaptation in the climate change-health nexus.
Figure 2 Climate change and health nexus

Source: Adapted from Haines and Patz (2004)
5.0 Methodology
ASSESSMENT OF EXISTING RELEVANT CLIMATE
HEALTH, POVERTY AND VULNERABILITY INFORMATION
In order to achieve the objectives mentioned above, the study made use of both primary and secondary information to examine the trend of historical data on the three diseases (CSM, malaria, diarrhoea), climate, poverty and vulnerability at the district level. The secondary data provided both qualitative and quantitative information, while the primary data provided qualitative information.

5.1 Documentary Gathering
The research team gathered existing literature on malaria, diarrhoea and CSM; burden of disease; climate change variables; poverty and vulnerability information pertaining to the three pilot districts (Bongo, Keta, Gomoa West). Sources of the literature on health issues included the National Health Information Centre, the three pilot districts’ health records and online sources. Climate data on the three pilot districts were sourced from the Ghana Meteorological Services Agency (GMA). With respect to poverty, the consultants made use of the third, fourth and fifth rounds of the Ghana Living Standard Surveys (GLSS).

5.2 Stakeholders’ focus group discussion
District level stakeholder workshops or focus group discussions were held with participants from the three pilot districts. From each of the pilot districts, stakeholders gave narrative accounts of the historical and extant situation related to the burden of the three diseases, vulnerability and poverty. From the Keta District, stakeholders from who attended focus group discussion work at the following departments: Municipal Planning, Health Information, Municipal Evaluation, Regional Meteorological Service, Municipal Disease Control, Municipal NADMO and Regional Health Service. Bongo district also had participants in the focus group discussion from the following departments: Environmental Health, Health Information, District Disease Control, District Public Health Nurse, Municipal Planning and the District National Disaster Management Organisation (NADMO). Also, Gomoa West district was represented by stakeholders in the departments such as Health Information, Meteorological Service, Community Health Nursing school, Disease Control, NADMO and Environmental Health.

5.3 Data
As stated earlier, the study made use of both primary and secondary data. In relation to the primary data, we undertook stakeholder workshops in the various districts to have first hand information about the current level of poverty, the occurrence of the three diseases, the severity of climate change and the vulnerability of community members to climate change effects. Pertaining to the secondary data, we gathered some documents that are repository of data on the three (3) key diseases (malaria, diarrhoea, cerebrospinal meningitis) of paramount interest in this project from Keta, Bongo and Gomoa West districts.
ASSESSMENT OF EXISTING RELEVANT CLIMATE HEALTH, POVERTY AND VULNERABILITY INFORMATION
6.0 Analysis
This section encompasses analyses on the historical trends of poverty and the three diseases (malaria, diarrhoea and CSM) at the district level. Due to the paucity of poverty data within the three districts under consideration, the regional level poverty statistics of the three regions in which these districts belong have been used as proxies for each district, complemented by the qualitative primary data. Also, the trend of climate variables and vulnerability linkages in the three districts were examined. In addition, the linkages between poverty, climate change and malaria, diarrhoea and CSM were teased out using correlation test. The current analysis below thus starts with the trends of poverty at the three districts, using the regional figures. This is followed by an analysis of the historical trends of malaria, diarrhoea, CSM and climate variables in these three districts.

6.1 Trend of Poverty in Keta, Gomoa West and Bongo Districts (using regional figures as proxy)

As indicated earlier on, the absence of district level poverty data in Ghana meant that the consultants had to make use of the poverty data for the three regions (Volta, Central and Upper East), generated by the various GLSS reports. Having identified the likelihood of the non-representativeness of these data on the districts, the stakeholder workshops were conducted a complement, to tease out the perceived prevailing trends of poverty therein.

- Figure 3: Patterns of Extreme Poverty (%) by Region in Ghana, (Poverty Line: GHS 288.47)

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<tr>
<td>Central</td>
<td>24.1</td>
<td>31.5</td>
<td>9.7</td>
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<tr>
<td>Volta</td>
<td>42.1</td>
<td>20.4</td>
<td>15.2</td>
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<tr>
<td>Upper East</td>
<td>53.5</td>
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<td>60.2</td>
</tr>
<tr>
<td>National</td>
<td>36.5</td>
<td>26.8</td>
<td>18.2</td>
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Source: Authors’ Compilations from Ghana Statistical Service, April 2007.
Regional distribution of extreme poverty in Ghana is presented in Figure 3. At the national level, extreme poverty levels decreased consistently from 36.5 percent in 1991/1992 period to 18.2 percent in 2005/2006. Extreme poverty in Central region increased from 24.1 percent in 1991/1992 period to about 31.5 percent in 1998/1999 period before reducing drastically to about 9.7 percent during the 2005/2006 period. In the Volta region, extreme poverty decreased consistently drastically between 1991/1992 to 2005/2006. The GLSS reports show that extreme poverty decreased from about 42.1 percent in 1991/1992 to about 15.2 percent in 2005/2006 period. Meanwhile, the poverty figures for the Upper East region reveal a rising trend just like the Central region. Extreme poverty in Upper East increased from 53.5 percent in 1991/1992 period to about 79.6 percent in 1998/1999 period before decreasing to about 60.2 percent during the 2005/2006 period.

Volta region’s extreme poverty figures showed a similar trend similar to the overall national extreme poverty figures. That is to say, it has been decreasing consistently. During the 1991/1992 period the national extreme poverty level was lower than Volta and Upper East regions, except the Central region which was lower than the overall national average. However, during the 1998/1999 period, the overall national extreme poverty level was lower than the figures for Upper East and Central regions, except the Volta region where extreme poverty was lower than the overall national average. For the 2005/2006 period, the overall national extreme poverty level was higher than two regions (Central and Volta regions), except Upper East region where the figure was higher than the overall national average. For the entire periods under consideration, the extreme poverty levels in the Upper East region were higher than Central and Volta regions and also the overall national figure. This means that the poverty level for Bongo district is presumably higher than that of Gomoa West and Keta districts. The Central and Volta regions have been alternating as far as the region with the least extreme poverty levels for the entire period under consideration is concerned.

**Figure 4: Trends of Regional Poverty Incidence (%) in Ghana, 1991/1992 to 2005/2006**

(Poverty Line: GHS 370.89)

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<tr>
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<td>44.3</td>
<td>48.4</td>
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<tr>
<td>Volta</td>
<td>57</td>
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</tr>
<tr>
<td>Upper East</td>
<td>66.9</td>
<td>88.2</td>
<td>70.4</td>
</tr>
<tr>
<td>National</td>
<td>51.7</td>
<td>39.5</td>
<td>28.5</td>
</tr>
</tbody>
</table>

Source: Authors’ Compilations from Ghana Statistical Service, April 2007.
Figure 4 presents the trends of regional poverty incidence in Ghana using the poverty line of GHS 370.89 from 1991/1992 to 2005/2006. The overall national poverty level decreased consistently from the 1991/1992 level of 51.7 percent to about 28.5 percent in 2005/2006 period. Poverty in Central region increased from 44.3 percent in 1991/1992 period to 48.4 percent in 1998/1999 period before dropping to about 19.9 percent in 2005/2006 period. From 1991/1992 period to 2005/2006 period, poverty figures in Volta region lost about 26 percentage points from 57.0 percent in 1991/1992 to about 31.4 percent in 2005/2006. This trend in poverty reduction in Volta region was similar to that of the overall national figures for the entire period. The poverty figures for the Upper East region show that poverty increased from 66.9 percent in 1991/1992 to 88.2 percent in 1998/1999 before decreasing to 70.4 percent in 2005/2006 period. Poverty levels in the Upper East region have been consistently higher than the other two regions and also the overall national average. The overall national poverty figure for the 1991/1992 period was lower than the figures for the Volta and Upper East regions, except Central region. For the 1998/1999 period, the overall national poverty figure was higher than that of the Volta region. In 2005/2006 period, the overall national poverty figure was only higher than Central region, as both Volta and Upper East regions surpassed the overall national average. In sum, the trends of poverty and extreme poverty levels for the three regions were similar for the periods under consideration.

6.2 Annual Household Expenditure and Income by Region, 2005/2006

Emphasis on annual household expenditure and per capita expenditure by region for the 2005/2006 period are presented in Figure 5. Annual household expenditure in Ghana was about GHS 1,918 with per capita expenditure of GHS 644. Upper East region is one of the poorest regions in the country with respect to household expenditure and per capita expenditure. Upper East region had an annual household expenditure of GHS 1,066 and per capita household expenditure of GHS 229, which were below the national average. Central region had the highest annual household expenditure and annual per capita expenditure for the three regions under consideration, followed by the Volta region. This means that Gomoa West has the highest probability of having a highest annual household expenditure and annual per capita expenditure than the other two districts (Keta and Bongo). Upper East had the least annual household expenditure and annual per capita expenditure. Further, all the regions (Upper East, Central and Volta) recorded annual household expenditure less than the national annual average for the entire period under consideration. On the other hand, two regions (Volta and Upper East) had annual per capita household expenditure lower than the annual average.
The mean annual household income and per capita income by region for the period 2005/2006 are presented in Figure 6. From the Figure 6, it could be observed that Ghana’s annual household income for the 2005/2006 period was GHS 1,217, whilst the average per capita income for the same period was recorded as GHS 397. The Central region had both annual household income and annual per capita income above the national average. Both Volta and Upper East regions had figures for both categories less than the national average. When comparison is made between the three regions, Central region had the highest figures for the two categories, followed by Volta region, with the Upper East region recording the least figures.

**Figure 5: Mean Annual Household Expenditure and Per Capita Expenditure by Region, 2005/2006**

![Mean Annual Household Expenditure and Per Capita Expenditure by Region, 2005/2006](image)

Source: Authors’ Compilations from Ghana Statistical Service, April 2007.

**Figure 6: Mean Annual Household Income and Per Capita Income by Region, 2005/2006**

![Mean Annual Household Income and Per Capita Income by Region, 2005/2006](image)

Source: Authors’ Compilations from Ghana Statistical Service, April 2007.
6.3 Assessment of Malaria, Diarrhoea, CSM, Climate Change, Poverty and Vulnerability in Keta District

This section examines the trends of malaria, diarrhoea, CSM, climate variables, poverty and vulnerability in Keta district. From 2008 to 2011, rainfall levels have been high on average, and oscillated around 60mm in the Keta district. From the year 2008, the level increased through to the year 2011 where the level decreased slightly. Temperature levels have been stable in the Keta district from 2008 to 2011, with values ranging from 27°C to 28°C. Likewise, the incidence of malaria and diarrhoea in the period under consideration has been relatively stable (see Table 1 & Figure 7).

Table 1: Diseases and Climate figures in Keta district from 2008 - 2011

<table>
<thead>
<tr>
<th></th>
<th>Malaria</th>
<th>Rainfall</th>
<th>Diarrhoea</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>34.07</td>
<td>57.90</td>
<td>3.51</td>
<td>27.75</td>
</tr>
<tr>
<td>2009</td>
<td>36.52</td>
<td>63.88</td>
<td>3.42</td>
<td>27.96</td>
</tr>
<tr>
<td>2010</td>
<td>38.86</td>
<td>67.49</td>
<td>2.92</td>
<td>28.25</td>
</tr>
<tr>
<td>2011</td>
<td>35.18</td>
<td>63.71</td>
<td>4.30</td>
<td>28.16</td>
</tr>
</tbody>
</table>

Source: Authors’ Compilations from district Health Service’s Records & Meteorological Service, 2012.

In order to establish the relationship between incidence of malaria, rainfall, diarrhoea, poverty and temperature using monthly data from the district from 2008 to 2011, a correlation test was carried out. The results show that malaria and rainfall have a weak positive relationship (see Table 2). Thus, when it rains heavily for some time this may bring about stagnant waters due to the poor drainage systems, hence creating breeding places for the type of mosquitoes that carry the malaria parasite and vice-versa.
### Table 2: Correlation matrix for Keta District using monthly data from 2008 to 2011

<table>
<thead>
<tr>
<th></th>
<th>Malaria</th>
<th>Rainfall</th>
<th>Diarrhoea</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaria</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfall</td>
<td>0.128</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>-0.055</td>
<td>0.08</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>-0.299</td>
<td>-0.119</td>
<td>0.115</td>
<td>1</td>
</tr>
</tbody>
</table>

**Source:** Author’s computation

In the same vein there were positive relationships between the following pair of variables: diarrhoea and rainfall; and temperature and diarrhoea, albeit weak. However, the correlation test showed a weak negative relationship between temperature and malaria. The positive relationship between diarrhoea and rainfall supported the oral accounts submitted by participants in the Keta district stakeholder’s workshop discussion. One stakeholder noted that:

“...when there is heavy rainfall and most of the waters are contaminated, people end up drinking this contaminated water and get diarrhoea and other diseases out of it.”

The relationship between poverty and two of the three diseases (that is, malaria and diarrhoea) was seen to have a positive correlation. This relationship means that as people become poor they in turn become very vulnerable to contracting these diseases. Their vulnerability level rises because of the lack of affordability of the very things that will prevent the occurrence of the diseases. Thus, an increase in poverty also propels an increase in the incidence of malaria and diarrhoea in the district. In the district stakeholders’ discussion, it came out clearly that the level of poverty in the district has been increasing over the years. One stakeholder gave a succinct, but graphic account of the poverty situation of the district as follows:

“I think the poverty level is going up, in that when we take the fishermen for example, formerly, the catch in the sea is very great but this time it has depleted in such a way that the fishermen are really in dire need. They go about even without three square meals a day; they take one meal a day.”

Climate change elements have also compounded the poverty level in the Keta district. These elements are both natural and man induced. This can be inferred from this submission from one of the stakeholders:

“The catch the fishermen have been harvesting over the years has shrunk and part of it is due to the climate change... The flow of the Volta River into the lagoon has changes over the years, with some lagoons drying up sometimes. Also, some of our people are also using unauthorized methods of fishing. For example, the net type (mosquito net type) is used in fishing, so they catch even the fingerlings in the process ... consequently, it has led to the reduction in the fish stock, and at present when they go for fishing, they catch very little or nothing.”

In relation to the vulnerability level of the Keta district to three diseases (malaria, diarrhoea and CSM), the results showed that the district is very vulnerable to malaria and diarrhoea. The absence of records for CSM at the district rendered the assessment of the district’s vulnerability to this disease impossible. Some of the conditions that make the district more vulnerable to malaria are the numerous water bodies (wells, lagoon, and rivers), sporadic heavy rainfall and intermittent floods. The stakeholders who partook in the discussion were unanimous about the fact that malaria has been severe over the years as a result of these conditions. Likewise, the conditions that make the district vulnerable to diarrhoea include rainfall. Many of the stakeholders perceived the district’s vulnerability to this disease to be very severe.
Climate change elements such as drought, flood and storms were also assessed as far as the district’s vulnerability to them is concerned in the course of the district’s stakeholder discussion. The participants brought to light that the rate of vulnerability of Keta district to drought is less severe. However, the cases of flood and storms are severe in the district in recent years. One stakeholder observed that:

“…..as for the flood, it’s severe. You will realize that every two years we have the stream (River Tozi), which feeds into the Keta lagoon coming with great force. So it will come and destroy the crops for those people who farm along the stream and they cannot replant”.

6.4 Assessment of Malaria, Diarrhoea, CSM, Climate Change, Poverty and Vulnerability in Bongo District

From 2008 to 2011, Bongo district has had a relatively stable incidence of diarrhoea and temperature levels. However, incidence of malaria had experienced a persist decrease from the year 2009 through to the year 2011 (See Table 3). Incidence of malaria peaked in the year 2009 with a figure of 74.8%. CSM incidence had a lower rate during the years under consideration, with the highest rate (0.27%) occurring in 2010. The rainfall levels in the district had a leap in 2009, followed by persistent decline over the years (See Table 3).

Table 3: Diseases and Climate figures for Bongo District from 2008 - 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>Malaria</th>
<th>Rainfall</th>
<th>Diarrhoea</th>
<th>CSM</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>60.07</td>
<td></td>
<td></td>
<td></td>
<td>28.71</td>
</tr>
<tr>
<td>2009</td>
<td>74.8</td>
<td>91.73</td>
<td>5.0</td>
<td>0.05</td>
<td>26.79</td>
</tr>
<tr>
<td>2010</td>
<td>61.7</td>
<td>82.16</td>
<td>7.4</td>
<td>0.27</td>
<td>29.13*</td>
</tr>
<tr>
<td>2011</td>
<td>59.0</td>
<td>65.41</td>
<td>7.4</td>
<td>0.04</td>
<td>29.19*</td>
</tr>
</tbody>
</table>

Source: Authors’ Compilations from Bongo District Health Service’s Records & Ghana Meteorological Service, 2012.

*Authors’ computation

Figure 8: Trend of Malaria, Diarrhoea, Rainfall and Temperature for Bongo from 2008 – 2011

Source: Authors’ Compilations from Bongo District Health Service’s Records & Ghana Meteorological Service, 2012.
The research findings showed that a positive relationship between rainfall and the three diseases (malaria, diarrhoea and CSM) exists. This means that heavy rains may increase the incidence of malaria, diarrhoea and CSM in the district. During the Bongo stakeholder workshop, stakeholders pointed out that, during periods of heavy rainfall, the water bodies which serve as a source of drinking water for the populace in the community usually get contaminated. Coupled with this, the district has poor sanitation and this worsens during heavy rains, hence increasing the incidence of the diarrhoea.

It was noted from the stakeholders’ discussion that most of the people in the Bongo district (about 80%) are into agriculture, and are faced with the problems of low soil fertility, short rainfall patterns and longer period of dry season. These problems hamper economic activities in the area, hence making the district more vulnerable to poverty. In a bid to shield themselves from poverty, the youth in the Bongo district usually emigrate to different parts of Southern Ghana after the rainy season.

The oral accounts of the stakeholders showed that the district is vulnerable to malaria and diarrhoea mostly in the rainy season. During this season, malaria cases reported are mostly children under five years and pregnant women. Similarly, the district has been experiencing persistent cases of CSM and the conditions prevailing in the district deepens its vulnerability to the disease.

In relation to the climate change factors such as drought, flood and storm, the research results show that the district is more vulnerable to drought since the area is characterized by longer dry season and shorter rainy season. This has the tendency to exacerbate the poverty level in the district as most of the people are into agriculture. In the same vein, the location and some characteristics of the district exposes it to flood and storms. The quotation from a participant in the Bongo district’s stakeholder discussion illustrates the severity of storms in the district.

“Wind and rain storms are serious. I think, I remember on the 7th of April, 2012 we had a serious wind storm and that even had displaced over 870 houses, 7 schools and at the end of the day we lost one 17 year boy... If you look at the nature of our buildings, we are very prone to those things.”

6.5 Assessment of Malaria, Diarrhoea, CSM, Climate Change, Poverty and Vulnerability in Gomoa West District

Rainfall values for Gomoa West district from 2008 to 2011 have been fluctuating within the boundaries of 80mm and 90mm, with the year 2011 experiencing the highest value (see Table 4 & Figure 9). However, temperature level in the district has been very stable ranging around 27°C. In relation to the incidence of diseases, both malaria and diarrhoea have been experiencing a decreasing trend from 2008 to 2011.

| Table 4: Diseases and Climate figures for Gomoa West district from 2007 - 2011 |
|---------------------------------|------|---------------|---------------|-------|
|       | Malaria | Rainfall | Diarrhoea | Temperature |
| 2007  | 14.56   | 62.3     | 1.60       | 27.54 |
| 2008  | 19.69   | 81.97    | 0.53       | 27.99 |
| 2009  | 32.64   | 89.95    | 2.29       | 27.60*|
| 2010  | 32.02   | 82.30    | 2.92       | 27.84*|
| 2011  | 31.31   | 92.55    | 2.26       | 27.62*|

*Source: Authors’ Compilations from district Health Service’s Records & Meteorological Service, 2012.

*Authors’ computation
In carrying out a correlation test using monthly data, which are available from 2009 to 2011, it came out that a weak positive relationship between rainfall and malaria, and rainfall and diarrhoea (see Table 5) exist. This is in sync with the oral accounts from the Gomoa West district stakeholders’ discussion. A participant noted that:

“We have a problem with the drainage system. Normally when it rains we have a lot of stagnation around, which is responsible for the breeding of mosquitoes, hence causing malaria and other diseases”.

- **Figure 9: Trend of Malaria, Diarrhoea, Rainfall and Temperature of Gomoa West District from 2007 - 2011**

![Figure 9: Trend of Malaria, Diarrhoea, Rainfall and Temperature of Gomoa West District from 2007 - 2011](image)

**Source:** Authors’ Compilations from Gomoa West district Health Service’s Records & Ghana Meteorological Service, 2012.

- **Table 5: Correlation matrix for Gomoa West District using monthly data from 2009 to 2011**

<table>
<thead>
<tr>
<th></th>
<th>Rainfall</th>
<th>Malaria</th>
<th>Diarrhoea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td>0.244902</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>0.010341</td>
<td>0.366929</td>
<td>1</td>
</tr>
</tbody>
</table>

**Source:** Authors’ computation

Stakeholders indicated that the level of poverty in the district has been increasing over the years. The views expressed below from a participant show the severity of poverty in the district;

“...looking at how people in the district are rushing for the social livelihood intervention of GHS 8 per month. In fact I can say that things are not better. For instance, I was asked to tell the community members that the money is coming and unfortunately it delayed. Beneficiaries constantly called me on my cell phone to verify when the money would be disbursed. When the money finally came and I sent it to them they were very happy. …… Now people are yearning for
more. Those who are not on the program want the authorities to expand the program so that they can also get something to make ends meet. From this illustration I’m not sure things are getting better.”

In relation to how the district is vulnerable to malaria, the stakeholders’ discussion revealed that the conditions which make the district vulnerable to malaria include choked sewerage systems, damaged sewerage systems, stagnant water due to the soil type and an increase in population. These conditions, they observed, are responsible for the increase in malaria cases in the district, hence making the district very vulnerable to malaria. Poor sanitation was also identified as the condition that makes the district vulnerable to diarrhoea. In addition, insufficient latrines in the district add to the sanitation problem and this increases the incidence of diarrhoea when it rains, since the source of drinking water is usually polluted.

According to the stakeholders’ accounts, Gomoa West district has experienced fewer droughts in recent times. However, the occurrences of floods and storms in the district have been on the increase for some time now. Accordingly, by the middle of 2012 storms had affected about 420 households. The economic activity in the district is mainly agriculture and this makes the district vulnerable to poverty, since there are fewer infrastructures in the district to support the activities of the farmers and fishermen.
7.0 Summary of Baseline Information
In sum, the main findings on the baseline information for the pilot districts (Keta, Bongo and Gomoa West) in relation to the three diseases (malaria, diarrhoea and CSM), poverty, vulnerability and climate variables, and their relationships are captured in Tables 6, 7 and 8.

### Table 6: Summary of secondary baselines on malaria, CSM, diarrhoea, rainfall, temperature and regional poverty

<table>
<thead>
<tr>
<th></th>
<th>KET A DISTRICT</th>
<th>GOMOA WEST DISTRICT</th>
<th>BONGO DISTRICT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>34232   54229   61446   55840</td>
<td>17543   13648   14549   19772</td>
<td>34     94    2083    296</td>
</tr>
<tr>
<td><strong>Malaria incidence (%)</strong></td>
<td>34.07   36.52   38.86   35.18</td>
<td>19.67   32.64   32.02   31.31</td>
<td>0.06    0.13    2.53     0.35</td>
</tr>
<tr>
<td><strong>Diarrhoea cases</strong></td>
<td>3529   5075  4635  6821</td>
<td>476    959   1325  1427</td>
<td>76     140    162     94</td>
</tr>
<tr>
<td><strong>Diarrhoea incidence (%)</strong></td>
<td>3.51    3.41    2.93    4.30</td>
<td>0.53    2.29    2.92     2.26</td>
<td></td>
</tr>
<tr>
<td><strong>CSM cases</strong></td>
<td>1184   2040  519  255</td>
<td>1184   2040  519  255</td>
<td>1184   2040  519  255</td>
</tr>
<tr>
<td><strong>CSM incidence (%)</strong></td>
<td>2.04    2.88    0.63    0.30</td>
<td>0.13    0.2     0.2      0.11</td>
<td></td>
</tr>
<tr>
<td><strong>Average Temperature (°C)</strong></td>
<td>27.75   27.96   28.25   28.16</td>
<td>27.99   27.60*  27.84*  27.62*</td>
<td>28.71   26.79   29.13*  29.19*</td>
</tr>
<tr>
<td><strong>Rainfall (mm)</strong></td>
<td>57.9    63.88  67.49  63.71</td>
<td>81.97   89.95   82.3    92.55</td>
<td>60.07   91.73   82.16   65.41</td>
</tr>
<tr>
<td><strong>Extreme Poverty (%)</strong></td>
<td>42.1    20.4    15.2</td>
<td>24.1    31.5    9.7</td>
<td>53.5    79.6    60.2</td>
</tr>
<tr>
<td><strong>Poverty incidence (%)</strong></td>
<td>57    37.7    31.4</td>
<td>44.3    48.4    19.9</td>
<td>66.9    88.2    70.4</td>
</tr>
<tr>
<td><strong>Mean annual household expenditure (Ghc)</strong></td>
<td>1514</td>
<td>1810</td>
<td>1066</td>
</tr>
<tr>
<td><strong>Mean annual per capita expenditure (Ghc)</strong></td>
<td>491</td>
<td>676</td>
<td>644</td>
</tr>
<tr>
<td><strong>Mean annual household income (Ghc)</strong></td>
<td>913</td>
<td>1310</td>
<td>616</td>
</tr>
<tr>
<td><strong>Mean annual per capita income (Ghc)</strong></td>
<td>272</td>
<td>464</td>
<td>124</td>
</tr>
</tbody>
</table>

Source: Fieldwork, 2012

*Authors’ computation*
Table 7: Qualitative baseline accounts of the degree of vulnerability of districts to malaria, diarrhoea, CSM, climate effects (drought, flooding, and storms) and poverty from Districts’ stakeholder discussions

<table>
<thead>
<tr>
<th>Diseases, climate change effects and poverty</th>
<th>KETA DISTRICT</th>
<th>GOMOA DISTRICT</th>
<th>BONGO DISTRICT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very severe</td>
<td>Severe</td>
<td>Less severe</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>CSM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drought</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flooding</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storms</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poverty</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Fieldwork, 2012

Table 8: Correlation baselines on climate variables, diseases and poverty in the districts

<table>
<thead>
<tr>
<th></th>
<th>KETA DISTRICT</th>
<th>GOMOA DISTRICT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rainfall</td>
<td>Temperature</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>0.08</td>
<td>-0.115</td>
</tr>
<tr>
<td>Malaria</td>
<td>0.128</td>
<td>-0.299</td>
</tr>
</tbody>
</table>

Source: Authors’ computation
Summary findings of the baseline information on Keta district in relation to the three diseases, poverty, vulnerability and climate variables are as follows;

i. Based on the data available it was found that malaria incidence is within the 30's (in percentage terms) and diarrhoea less than 5%. These diseases have been relatively stable from 2008 to 2011. However, data could not be found on CSM in the district.

ii. The trend of poverty in the district has been decreasing using the regional data from the GLSS report. However, the stakeholders in the focus group discussion gave an oral account that poverty has been on ascendancy in the district.

iii. Also, conditions in the district make the populace vulnerable to poverty, malaria, diarrhoea, storm and flood. However, the district is less vulnerable to drought.

iv. A positive relationship between malaria and rainfall, malaria and poverty, diarrhoea and rainfall, and diarrhoea and poverty exists. However, it was impracticable to estimate the relationship between temperature and the diseases due to data challenges.

In the Bongo district the following baseline information were established regarding the three diseases, vulnerability, poverty and climate variables;

i. Incidence of diarrhoea and CSM in the district has been unstable between from 2009 to 2011. However, the incidence of malaria has been declining within these years.

ii. While rainfall and temperature values have been fluctuating from 2008 to 2011, the poverty level in the district has been increasing.

iii. In addition, the prevailing conditions in the district deepen its proneness to flood, drought, malaria, diarrhoea, CSM and poverty.

iv. Due to data unavailability it was impossible to estimate the correlation between the variables of interest. However, during the stakeholders’ focus group discussion the oral accounts established a relationship between climate variables and the three diseases.

Summary findings of the baseline information on Gomoa West district about malaria, diarrhoea, CSM, poverty, climate variables and vulnerability are as follows;

i. Both malaria and diarrhoea incidence have been unstable from 2007 to 2011. However, there were no records on CSM from 2008 to 2011.

ii. Whereas temperature has been relatively stable from 2008 to 2011, rainfall pattern has been oscillating. Regional poverty in the district assumed a decreasing trend within the period, nonetheless stakeholders’ account revealed otherwise.

iii. The district is very vulnerable to poverty, malaria, diarrhoea, flood and storms, but less vulnerable to drought.

iv. A positive relationship between malaria and rainfall, malaria and poverty, diarrhoea and rainfall, and diarrhoea and poverty exists. However, it was impracticable to estimate the relationship between temperature and the diseases due to data challenges.

In the Bongo district the following baseline information were established regarding the three diseases, vulnerability, poverty and climate variables;

i. Incidence of diarrhoea and CSM in the district has been unstable between from 2009 to 2011. However, the incidence of malaria has been declining within these years.

ii. While rainfall and temperature values have been fluctuating from 2008 to 2011, the poverty level in the district has been increasing.

iii. In addition, the prevailing conditions in the district deepen its proneness to flood, drought, malaria, diarrhoea, CSM and poverty.

iv. Due to data unavailability it was impossible to estimate the correlation between the variables of interest. However, during the stakeholders’ focus group discussion the oral accounts established a relationship between climate variables and the three diseases.

7.1 Data Gaps

With respect to the data that have been gathered and used in this report, a couple of gaps are inherent in them. These gaps in the data are underpinned the inconsistent results that emerged from the assessment on the relationship between the three diseases, climate variables, poverty and vulnerability. The gaps are discussed as follows;

1. Most of the data were unavailable and those available were poor in quality. In relation to climate variables for instance, the weather stations in the three pilot districts (Keta, Bongo and Apam in the Gomoa West) were non-functional. Hence, the researchers did not get data
on climate variables from those stations. The researchers therefore resorted to the use of data from the closest weather stations within the regions: Vea-Dam station for Bongo, Winneba station for Gomoa West and Afife-Weta station for Keta. Besides not being the original weather stations in the three districts, these alternate weather stations had gaps in the monthly recordings, thereby giving erroneous data for the months and years.

In the same vein, the researchers could not access background information of patients who have contracted any of the three diseases. Accessibility to these data would have provided rich information about whether a real relationship exists between the three diseases, climate variables, poverty and vulnerability. Moreover, consistent monthly data on all the diseases were nonexistent, hence stifling the ability of the researchers to tease out the seasonal effect between climate, the three diseases, vulnerability and poverty. The non-accessibility of the monthly data on diseases therefore led to the use of yearly reported cases, irrespective erroneous nature. In addition, at the district level, there was no data on poverty and vulnerability. As a result the researchers had to incorporate the oral accounts of stakeholders in the pilot districts to bring clarity to these variables.

2. Further, the time frame of existing data was short making it impossible to carry a robust analysis. For instance, data on incidence of the three diseases were available from 2008. In that light, the researchers had to restrict the analysis starting from 2008 to 2011. Besides, monthly data on diseases for districts were not available.

3. Inconsistencies between quantitative and qualitative data were very rife. For instance, whereas the quantitative data on poverty was declining for Keta and Gomoa districts (using regional figures as proxies), the qualitative information suggests an increasing trend. Such situation cannot support any strong analysis.
8.0 Recommendations
ASSESSMENT OF EXISTING RELEVANT CLIMATE
HEALTH, POVERTY AND VULNERABILITY INFORMATION
8.0 Recommendations
Based on the findings of baseline study the following recommendations are made;

1. Yearly or biennial rigorous surveys should be conducted on district level poverty and vulnerability in the pilot districts. This will provide up to date information on poverty and vulnerability, and will reveal the exact poverty level in the districts.

2. Non-functional weather stations at the three districts should be revamped through the support of stakeholders in the country. This will enable the recording of accurate climate data since data can be sourced from the weather stations within the districts. Alternatively, the weather stations that data were obtained for this study should be mandated to pick accurate data in order to avoid gaps in monthly records.

3. Districts should compile accurate health statistics on the three diseases and any other diseases including background information of the patience. Monthly health statistics would be most appropriate, since it will enable the examination of seasonal impact on the incidence of the diseases.

4. Aside developing a strong data base at the district level, this health data should also be kept at the National Centre for Health Information.

References


Future Epidemics?" *Tropical Medicine and International Health*, 1, 86-96.


ASSESSMENT OF EXISTING RELEVANT CLIMATE HEALTH, POVERTY AND VULNERABILITY INFORMATION
Appendix

- **Figure A1:** Trend of Rainfall & Temperature in Bongo District from 1981 – 2007

  ![Figure A1](image1.png)

  Source: Ghana Meteorological Service

- **Figure A2:** Trend of Rainfall and Temperature in Keta District from 1989 – 2008

  ![Figure A2](image2.png)

  Source: Ghana Meteorological Service

- **Figure A3:** Trend of Rainfall & Temperature in Gomoa West District from 1984 – 2008

  ![Figure A3](image3.png)

  Source: Ghana Meteorological Service
ASSESSMENT OF EXISTING RELEVANT CLIMATE HEALTH, POVERTY AND VULNERABILITY INFORMATION
Policy Brief: Integrating Climate Change Into The Management Of Priority Health Risks In Ghana
Executive Summary:
The effects of climate change and climate variability on human health have gained great importance in the 21st Century due to their devastating nature. Despite the possible effect of climate change on human health, little has been done in the Ghanaian context to examine the linkages between climate change, poverty, health and vulnerability. Consequently, this study sought to document the existing relevant climate, health, poverty and vulnerability information in Keta, Bongo and Gomoa West districts. Using secondary (documents) and primary (stakeholder focus group discussions) data sources, findings showed certain linkages among the aforementioned variables (climate change, health, poverty and vulnerability) in these three districts. The directions of linkages, however, differ depending on the characteristics and other influencing factors that prevail in the various districts. For instance, the quantitative and qualitative results differ to some extent due to gaps in the data set. As a result, it is recommended that stakeholders should invest in yearly or biennial robust surveys on district level poverty and vulnerability in the pilot districts. Also, nonfunctional weather stations at the three districts should be revamped, while the districts should compile accurate health statistics on the three diseases and any other diseases including background information of the patient.

1. Statement of Issue
Climate change, including climate variability, has multiple influences on human health and these are expected to be either direct or indirect. While direct and immediate impacts such as deaths in heat waves and floods can often be dramatic and provoke immediate policy-responses, the most important long-term influences will likely act through changes in natural ecosystems and their impacts of disease vectors, waterborne pathogens, and contaminants. In Ghana, the continuing high burden of malaria and other tropical diseases like buruli ulcer, diarrhoeal diseases and the recurrence of seasonal epidemics such as CMS and cholera are symptomatic of the vulnerability of the health system and the possible effect of climate change on the health status on Ghanaians. The need to assess current climate related health and vulnerability status is first and foremost based on the generation of evidence not only for measuring progress of project implementation but also to establish the level of climate change resilience within the health sector at the district level. It is also to provide an understanding of the kind of information required as part of the routine monitoring and evaluation system in order to increase the sector’s responsiveness to climate change issues and to factor climate change and its possible impact into action plans and research activities.

The importance of this study stems from the fact that presently information on linkages between climate, health, poverty and vulnerability information are inadequate in Ghana. What is available does not represent an accepted baseline, thereby making it impossible for rigorous assessment of progress and the documentation of effects of interventions. Against this backdrop, the Ministry of Health (MOH), Ghana in partnership with the United Nations Development Programme (UNDP), commissioned this pilot research project with funding from the Global Environment Facility (GEF) to examine the linkages between climate, malaria, diarrhoea, cerebrospinal meningitis, poverty and vulnerability in Bongo, Keta and Gomoa West districts.

This study has documented the existing relevant climate, health, poverty and vulnerability information in Keta, Bongo and Gomoa West districts. Specifically, this study has been able to achieve the following objectives:

- The collection of baseline information against which the performance of the three project districts (Keta, Bongo and Gomoa West) will be measured;
- The identification of gaps in the existing;
- The establishment of baseline on the status of the three diseases (CSM, malaria, diarrhoea diseases) in terms of incidence, burden, risk factors and vulnerability;
- The proposal of possible robust baseline data gathering approaches for the future.
2. Summary of findings

Using an adapted version of the conceptual framework developed by Haines and Patz (2004) supported by quantitative techniques (graphs, charts, regression analysis) and qualitative tools (stakeholder workshop or focus group discussions) data were gathered and analyzed for this project. In succinct, the conceptual framework looks at the changes in regional and local climatic conditions manifest as extreme weather conditions, changes in precipitation and rise in oceanic and atmospheric temperature (global warming). These stressors act directly or indirectly to determine health outcomes (IPCC, 2007) as shown in figure 1. Directly, an increase or decrease in atmospheric temperature causes heat or cold waves leading to heat stroke and other diseases.

- **Figure 1: Climate change and health nexus**

Source: Adapted from Haines and Patz (2004)
Results from this baseline study showed established linkages between incidence of malaria, rainfall, diarrhoea, poverty, vulnerability and temperature relative to the pilot districts.

In relation to Keta district, results of the analysis showed that a positive relationship between the following pair of variables exists: rainfall and malaria; diarrhoea and rainfall; and temperature and diarrhoea (see Table 3). However, the correlation test showed a weak negative relationship between temperature and malaria. The positive relationship between diarrhoea and rainfall supported the oral accounts submitted by participants in the Keta district stakeholder’s workshop discussion. One stakeholder noted that:

“...when there is heavy rainfall and most of the waters are contaminated, people end up drinking this contaminated water and get diarrhoea and other diseases out of it”.

In the district stakeholders’ discussion, it came out clearly that the level of poverty in the district has been increasing over the years. One stakeholder gave a succinct, but graphic account of the poverty situation of the district as follows:

“I think the poverty level is going up, in that when we take the fishermen for example, formerly, the catch in the sea is very great but this time it has depleted in such a way that the fishermen are really in dire need. They go about even without three square meals a day; they take one meal a day”.

Climate change elements have also compounded the poverty level in the Keta district. These elements are both natural and man induced. This can be inferred from this submission from one of the stakeholders:

“The catch the fishermen have been harvesting over the years has shrunk and part of it is due to the climate change... The flow of the Volta River into the lagoon has changes over the years, with some lagoons drying up sometimes. Also, some of our people are also using unauthorized methods of fishing. For example, the net type (mosquito net type) is used in fishing, so they catch even the fingerlings in the process ... consequently; it has led to the reduction in the fish stock, and at present when they go for fishing, they catch very little or nothing”.

With regard to Bongo district, the account of the stakeholders showed that the district is vulnerable to malaria and diarrhoea mostly in the rainy seasons. The oral accounts of the stakeholders showed that the district is vulnerable to malaria and diarrhoea mostly in the rainy season. During this season, malaria cases reported are mostly children under five years and pregnant women. Similarly, the district has been experiencing persistent cases of CSM and the conditions prevailing in the district deepens its vulnerability to the disease. In relation to the climate change factors such as drought, flood and storm, the research results showed that the district is more vulnerable to drought since the area is characterized by longer dry season and shorter rainy season. This has the tendency to exacerbate the poverty level in the district as most of the people are into agriculture. In the same vein, the location and some characteristics of the district exposes it to flood and storms. The quotation from a participant in the Bongo district’s stakeholder discussion illustrates the severity of storms in the district.

“Wind and rain storms are serious. I think, I remember on the 7th of April we had a serious wind storm and that even had displaced over 870 houses, 7 schools and at the end of the day we lost one 17 year boy. .....If you look at the nature of our buildings, we are very prone to those things”.

In carrying out a correlation test using monthly data, which are available from 2009 to 2011, it came out that a weak positive relationship between rainfall and malaria, and rainfall and diarrhoea (see Table 3) exist. This is in sync with the oral accounts from the Gomoa West district stakeholders’ discussion. A participant noted that;

“We have a problem with the drainage system, normally when it rains we have a lot of stagnation around which is responsible for the breeding of mosquitoes hence causing malaria and other diseases”.
This suggests that there is a positive link between malaria and rainfall, contrary to the results from the correlation test.

Stakeholders indicated that the level of poverty in the district has been increasing over the years. The views expressed below from a participant show the severity of poverty in the district;

“….looking at how people in the district are rushing for the social livelihood intervention of GHS 8 per month. In fact I can say that things are not better. For instance, I was asked to tell the community members that the money is coming and unfortunately it delayed. Beneficiaries constantly called me on my cell phone to verify when the money would be disbursed. When the money finally came and I sent it to them they were very happy. …… Now people are yearning for more. Those who are not on the program want the authorities to expand the program so that they can also get something to make ends meet. From this illustration I’m not sure things are getting better.”

In relation to how the district is vulnerable to malaria, the stakeholders’ discussion revealed that the conditions which make the district vulnerable to malaria include choked sewerage systems, damaged sewerage systems, stagnant water due to the soil type and an increase in population. These conditions, they observed, are responsible for the increase in malaria cases in the district, hence making the district very vulnerable to malaria. Poor sanitation was also identified as the condition that makes the district vulnerable to diarrhoea. In addition, insufficient latrines in the district add to the sanitation problem and this increases the incidence of diarrhoea when it rains, since the source of drinking water is usually polluted.

3. Challenges

With respect to the data that have been gathered and used in this report, a couple of gaps are inherent in them. These gaps underpinned the inconsistent results that emerged from the assessment on the relationship between the three diseases, climate variables, poverty and vulnerability. These gaps are outlined below.

1. Most of the data were unavailable and those available were poor in quality. In relation to climate variables for instance, the weather stations in the three pilot districts (Keta, Bongo and Apam in the Gomoa West) were non-functional. Hence, the researchers did not get data on climate variables from those stations. The researchers therefore resorted to the use of data from the closest weather stations within the regions: Vea-Dam station for Bongo, Winneba station for Gomoa West and Afife-Weta station for Keta. Besides not being the original weather stations in the three districts, these alternate weather stations had gaps in the monthly recordings, thereby giving erroneous data for the months and years.

In the same vein, the researchers could not access background information of patients who have contracted any of the three diseases. Accessibility to these data would have provided rich information about whether a real relationship exists between the three diseases, climate variables, poverty and vulnerability. Moreover, consistent monthly data on all the diseases were nonexistent, hence stifling the ability of the researchers to tease out the seasonal effect between climate, the three diseases, vulnerability and poverty. The non-accessibility of the monthly data on diseases therefore led to the use of yearly reported cases, irrespective erroneous nature. In addition, at the district level, there was no data on poverty and vulnerability. As a result the researchers had to incorporate the oral accounts of stakeholders in the pilot districts to bring clarity to these variables. The disadvantage in this stakeholder workshop from methodological point of view is that, it had the potential to create subjective responses.

2. Further, the time frame of existing data was short making it impossible to carry a robust analysis. For instance, data on incidence of the three diseases were available from 2008. In that light, the researchers had to restrict the analysis starting from 2008 to 2011. Besides, monthly data on diseases for districts were not available.
Inconsistencies between quantitative and qualitative data were very rife. For instance, whereas the quantitative data on poverty was declining for Keta and Gomoa districts (using regional figures as proxies), the qualitative information suggests an increasing trend. Such situation cannot support any strong analysis.

4. Policy Recommendations

Based on the findings of baseline study the following recommendations are made;

1. Yearly or biennial rigorous surveys should be conducted on district level poverty and vulnerability in the pilot districts. This will provide up to date information on poverty and vulnerability, and will reveal the exact poverty level in the districts.

2. Non-functional weather stations at the three districts should be revamped through the support of stakeholders in the country. This will enable the recording of accurate climate data since data can be sourced from the weather stations within the districts. Alternatively, the weather stations that data were obtained for this study should be mandated to pick accurate data in order to avoid gaps in monthly records.

3. Districts should compile accurate health statistics on the three diseases and any other diseases including background information of the patients. Monthly health statistics would be most appropriate, since it will enable the examination of seasonal impact on the incidence of the diseases.

4. Aside developing a strong data base at the district level, this health data should also be kept at the National Centre for Health Information.
5. Trends in Poverty in Keta, Gomoa West and Bongo Districts (using regional figures as proxy)

- Figure 2: Patterns of Extreme Poverty (%) by Region in Ghana, (Poverty Line: GHS 288.47)

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Central</td>
<td>24.1</td>
<td>31.5</td>
<td>9.7</td>
</tr>
<tr>
<td>Volta</td>
<td>42.1</td>
<td>20.4</td>
<td>15.2</td>
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<tr>
<td>Upper East</td>
<td>53.5</td>
<td>79.6</td>
<td>60.2</td>
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<tr>
<td>National</td>
<td>36.5</td>
<td>26.8</td>
<td>18.2</td>
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- Figure 3: Trends of Regional Poverty Incidence (%) in Ghana, 1991/1992 to 2005/2006 (Poverty Line: GHS 370.89)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>44.3</td>
<td>48.4</td>
<td>19.9</td>
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<tr>
<td>Volta</td>
<td>57</td>
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<td>Upper East</td>
<td>66.9</td>
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<td>National</td>
<td>51.7</td>
<td>39.5</td>
<td>28.5</td>
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</table>

- Figure 4: Trend of Malaria, Diarrhoea, Rainfall and Temperature for Keta from 2008 - 2011

![Graph showing trend of Malaria, Diarrhoea, Rainfall, and Temperature for Keta from 2008 to 2011.]

**Source:** Compilations from Keta District Health Service’s Records and Ghana Meteorological Service, 2012.

- Figure 5: Trend of Malaria, Diarrhoea, Rainfall and Temperature for Bongo from 2008 - 2011

![Graph showing trend of Malaria, Diarrhoea, Rainfall, and Temperature for Bongo from 2008 to 2011.]

**Source:** Compilations from Bongo District Health Service’s Records and Ghana Meteorological Service, 2012.
Figure 6: Trend of Malaria, Diarrhoea, Rainfall and Temperature for Gomoa West from 2007-2011

Source: Compilations from Gomoa West District Health Service's Records and Ghana Meteorological Service, 2012.
## Table 1: Summary of secondary baselines on malaria, CSM, diarrhoea, rainfall, temperature and regional poverty

<table>
<thead>
<tr>
<th></th>
<th>KETI DISTRICT</th>
<th>GOMOA WEST DISTRICT</th>
<th>BONGO DISTRICT</th>
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<tbody>
<tr>
<td>Malaria cases</td>
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<td></td>
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<tr>
<td>2008</td>
<td>34232</td>
<td>54229</td>
<td>61446</td>
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<tr>
<td>Malaria incidence (%)</td>
<td></td>
<td></td>
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<tr>
<td>2008</td>
<td>34.07</td>
<td>36.52</td>
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</tr>
<tr>
<td>Diarrhoea cases</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>3529</td>
<td>5075</td>
<td>4635</td>
</tr>
<tr>
<td>Diarrhoea incidence (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>3.51</td>
<td>3.41</td>
<td>2.93</td>
</tr>
<tr>
<td>CSM cases</td>
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<td></td>
</tr>
<tr>
<td>2008</td>
<td>1184</td>
<td>2040</td>
<td>519</td>
</tr>
<tr>
<td>CSM incidence (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>2.04</td>
<td>2.88</td>
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<td>Average Temperature (°C)</td>
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<tr>
<td>2008</td>
<td>27.75</td>
<td>27.96</td>
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<tr>
<td>Rainfall (mm)</td>
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<tr>
<td>2008</td>
<td>57.9</td>
<td>63.88</td>
<td>67.49</td>
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<td>Extreme Poverty (%)</td>
<td>42.1</td>
<td>20.4</td>
<td>15.2</td>
</tr>
<tr>
<td>Poverty incidence (%)</td>
<td>57</td>
<td>37.7</td>
<td>31.4</td>
</tr>
<tr>
<td>Mean annual household expenditure (Ghc)</td>
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<td>1514</td>
<td>1810</td>
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<tr>
<td>Mean annual per capita expenditure (Ghc)</td>
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<td>491</td>
<td>676</td>
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<td>Mean annual household income (Ghc)</td>
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<td>1310</td>
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<tr>
<td>Mean annual per capita income (Ghc)</td>
<td></td>
<td>272</td>
<td>464</td>
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*Authors' computation
Table 7: Qualitative baseline accounts of the degree of vulnerability of districts to malaria, diarrhea, CSM, climate effects (drought, flooding, and storms) and poverty from Districts’ stakeholder discussions

<table>
<thead>
<tr>
<th>Diseases, climate change effects and poverty</th>
<th>KETA DISTRICT</th>
<th>GOMOA DISTRICT</th>
<th>BONGO DISTRICT</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>VULNERABILITY</td>
<td>VULNERABILITY</td>
<td>VULNERABILITY</td>
</tr>
<tr>
<td></td>
<td>Very severe</td>
<td>Severe</td>
<td>Normal</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drought</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Flooding</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storms</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poverty</td>
<td>✓</td>
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</table>

Source: Fieldwork, 2012
Table 8: Correlation baselines on climate variables, diseases and poverty in the districts

<table>
<thead>
<tr>
<th></th>
<th>KETA DISTRICT</th>
<th></th>
<th>GOMOA DISTRICT</th>
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<tbody>
<tr>
<td></td>
<td>Rainfall</td>
<td>Temperature</td>
<td>Rainfall</td>
<td>Temperature</td>
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<tr>
<td>Diarrhoea</td>
<td>0.08</td>
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Source: Authors’ computation

6. References
