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MODELING THE CLIMATIC AND SOCIO-DEMOGRAPHIC INFLUENCE ON MALARIA TRANSMISSION IN ACCRA

BY

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Declaration

I APPIAH MARGARET do hereby declare that, except for the reference to other works, which are duly acknowledged, this work is my original work undertaken at the Regional Institute for Population Studies, University of Ghana, and that neither part nor whole of this work has been presented elsewhere for another degree.

Signed ……

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Dedication

I dedicate this work to the one and Holy God who is more than able to accomplish whatever concerns me and whose strength has brought me this far.

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Abstract

Climate change and variability affect the suitability of environmental conditions for malaria transmission. Although malaria transmission is place-specific, existing assessments of malaria transmission have largely focused on large-scale changes in malaria transmission and overlooked the socio-demographic factors that modulate climate and malaria nexus with the result largely indicating widespread increase in areas suitable for malaria transmission. In its recent assessment report, the Intergovernmental Panel on Climate Change (IPCC) observed the lack of models that incorporate modulating factors in malaria transmission and emphasizes the need for such models to adequately account for local level transmissions. In the context of climate change and variability, and population dynamics, the present study modelled malaria transmission over Accra, accounting not only for the climatic but actual socio-demographic factors for current and different future climatic scenarios at the macro level. The study also assessed socio-demographic and environmental factors influencing malaria incidence at the micro level. The main sources of data used include time series rainfall and temperature data for Accra (1970-2010) from the Ghana Meteorological Agency (GMeT) and census-based demographic data (1970-2010). In addition, cross-sectional household data from three selected coastal communities (James Town, Ussher Town and Agbogbloshie) in Accra were also used. To facilitate future assessment of malaria transmission, both climatic and demographic data were projected using Bergen Climate Model Version 2 and Spectrum respectively. While the VECTRI was used in analysing the climatic and demographic data, Binary Logistic Regression was employed to estimate malaria incidence and coping/adaptation strategies in the household. The results indicated increasing and temporal variability of rainfall and temperature while population also shows an increasing trend in spite of the declining population growth rate. Moreover, similar trend was observed for the future scenario (climatic and demographic factors). At the macro level, compared with the un-adjusted estimation, the population adjusted models show relatively lower malaria transmission levels presently and in the future. Annual malaria transmission shows significantly declining trend over time. There is also observed seasonal shift in the significant malaria transmission months. Results of the micro level analyses showed that socio-demographic factors significantly have far-reaching influence on malaria incidence than climatic factors. In the multiple regression analyses, experience of flooding did not have a significant influence on malaria incidence. The type of toilet facility used, malaria risk perception, the age of household head and the use of coping/adaptation measures were significant predictors of malaria incidence. Particularly, age of household head was positively related with malaria incidence. Comparatively, households that used flush toilet facility had higher risk of malaria incidence. The use of coping/adaptation measures was also significantly related with malaria incidence. The findings suggest the need to account for actual socio-demographic effects besides the climatic conditions for more accurate malaria transmission estimations to guarantee acceptable transmission levels for appropriate and effective interventions to sustain decline in malaria transmission. There is also the need to intensify and scale up the use of household coping/adaptation strategies to minimise malaria incidence.

Key words: Climate, Population, Malaria, transmission, Coping/adaptation

Chapter One

Background of the Study

1.1 Introduction

Malaria continues to be one of the major public health concerns in the world. Malaria is associated with high morbidity and mortality globally, especially in developing countries (WHO, 2016). Estimated worldwide cases of malaria ranged between 149 and 303 million, with 214 million new cases and an estimated 438,000 global deaths in 2015. Global efforts have resulted in significant malaria mortality decline (60%) between 2000 and 2015 (WHO, 2015).

Scale-up of diagnosis, treatment and prevention has resulted in decline of malaria burden in sub-Saharan Africa (O'Meara et al., 2010). Estimates indicate that expansion of malaria interventions contributed to 30 percent and 34 percent reduction in malaria incidence globally and in Africa respectively between 2000 and 2013. Mortality rates due to malaria also saw a significant fall both in Africa (54%) and at the global levels (47%) (WHO, 2014). In spite of the decline in population affected by malaria worldwide, sub-Saharan Africa continues to bear a disproportionately high morbidity and mortality burden of the global malaria, with 88% of malaria cases and approximately 90 percent malaria deaths occurring in 2015 (WHO, 2016; HELI, 2015). Sub-Saharan Africa, therefore, lags behind the observed global decline in malaria transmission (WHO, 2016). Infection rates in Ghana are high in children peaking at more than 80 percent among those aged 5-9 years and declining to low levels in adults (Ministry of Health, 2009). There is a higher risk of malaria infection among pregnant women due to low levels of immunity during

pregnancy, resulting in maternal anaemia, foetal loss, pre-term delivering, intrauterine growth retardation and low birth weight delivery (<2.5kg or <5.5 pounds) (CDC, 2012).

Ghana has made significant gains in malaria control due to scale up of preventive and curative interventions. However, like most countries in sub-Saharan Africa, malaria remains a major health burden and it accounts for 30 percent of out-patient department (OPD) attendance as well as 27.9 percent in-patients in Ghana (GHS, 2015). Among the factors that have accounted for the high malaria burden in Ghana are favourable climatic conditions and the predominance of the efficient mosquito parasite species, *plasmodium falciparum* (CDC, 2016).

Climatic factors influence the abundance, distribution of malaria transmission and the ability and capacity to manage the disease (WHO, 2012; Adger, 2014; Smith et al., 2014). It has become increasingly apparent over the past few decades that human actions are amplifying the disease transmission because anthropogenic contribution to climate change has increased in recent times (IPCC, 2014). Climatic changes present additional challenge for malaria transmission and distribution as it affects the variability of climatic variables (e.g., temperature and rainfall) (McCarthy, 2001; Adger et al., 2014).

Ghana is not an exception to climatic impacts with evidence showing significant changes in rainfall and temperature patterns. These are manifested in erratic and extreme rainfall, warmer temperatures and sea water intrusion, raising major concerns about the potential consequences on malaria transmission (Environmental Protection Agency EPA, 2009; Stanturf et al., 2011; Tschakert et al., 2010; World-Bank, 2009). While rainfall patterns show declining volume and increasing variability, there has been 1^0C increase in temperature in the last 30 years in Ghana. The localities along the coast of Ghana registered a significant linear increase of about 0.9°C in mean annual air temperature between 1960 and 2001 with the maximum and minimum temperatures increasing by 2.5°C and 2.2°C, respectively

(Dontwi et al., 2008). Significantly less rainfall occurred in 1981-2000 compared with the period 1951-1970 with mean annual rainfall decreasing by 260.5 mm in the Accra Station. Potential change in mean temperature over Accra by 2050 is expected to be 1.74 percent for dry season and 1.08 percent in the wet season. Precipitation is also expected to change by 3.19 percent and 2.65 percent in dry and wet seasons respectively over Accra by 2050 (EPA, 2008).

With projections indicating high population growth in urban agglomerations, urban areas will bear the full brunt in terms of the relatively high population density and especially for economically disadvantaged populations (Satterthwaite, 2007; Smith et al., 2014). Urban communities in sub-Saharan Africa, including coastal savannah climatic zone in Ghana, are not exempted from this variation in malaria transmission due to increasing climatic events and ever-increasing population growth. The projected climatic conditions are favourable for the development stages and survival of the malaria vector as well as the disease transmission risk (EPA, 2009; Stanturf et al., 2011; Tschakert et al., 2010; World-Bank, 2009). Projections show increasing frequency of climatic events such as floods, sea-level rise, storms and excessive heat in recent years. Sea-level rise is projected to increase flood frequency probabilities, inundate low-lying coastal areas, cause shoreline recession on sandy shore and raise coastal water tables (EPA, 2011). All these have potential risk for increased malaria transmission as a result of the creation of favourable breeding sites.

IPCC scenarios from the fifth assessment report, (Smith et al., 2014) have shown that climate change, social and economic development have substantial influence on malaria risks. The IPPC report also show that the relationship between climate and malaria is not linear but modulated by contextual non-climatic factors including socio-demographic factors such as the population distribution, urbanization, household

characteristics and housing conditions, affecting the spatial and temporal distribution of the disease and at the same time coping/adaptation strategies (De Silva and Marshall, 2012).

These socio-demographic conditions also influence coping/adaptation strategies which enable populations to moderate malaria transmission impacts. Adaptation which involves adjustment in natural and/or human systems in response to actual or expected climatic stimuli or its effects, moderates harm or exploits beneficial opportunities, hinges essentially on socio-demographic factors (Confalonieri et al., 2007). These socio-demographic factors that modulate climate change influence on malaria transmission and coping/adaptation are expected to be impacted differently by climate change to the disadvantage of populations that are already burdened with malaria incidence, hence, limiting their ability to cope/adapt (Confalonieri et al., 2007). Therefore, favourable climatic conditions, coupled with increasing population growth in urban communities in sub-Saharan Africa and low socio-economic status has the potential to alter malaria transmission levels and to affect coping/adaptation strategies (Dobson, 1994; UN, 2014). Therefore, assessments of climate and malaria relationship that overlook the local socio-demographic conditions that modify the effects of climate will potentially over-simplify the ecology of malaria transmission (Hales and Woodward, 2003).

Notwithstanding, existing studies on climate-malaria linkage have largely focused on large-scale changes in malaria transmission over time in the face of changing climatic conditions and overlooked the influence of socio-demographic factors. These studies largely indicate a widespread increase in the areas suitable for malaria transmission (Hay et al., 2000).

In understanding the influence of climate variability/change and socio-demographic factors on malaria transmission/incidence in an urban poor setting, the following questions are asked:

i. What is the current and future outlook of malaria transmission in Accra in view of the actual climatic and socio-demographic conditions?
ii. What are the main socio-demographic factors that lead to household malaria incidence in urban poor communities in Accra?
iii. To what extent do socio-demographic factors influence the impact of malaria transmission in Accra (macro level) on household (micro-level) malaria incidence in urban poor communities in Accra?
iv. What coping/adaptation strategies are currently being adopted to moderate malaria incidence at the household level?

1.2 Statement of the Problem

Recent reports and projections on climate change impacts show that climate change will have effects on both human and animal systems, exacerbating the burden of malaria (IPCC, 2001; McCarthy, 2001; 2007 and Adger et al., 2014). Changes in local temperature and rainfall as a result of climate change and variability are altering the distribution of some water and vector-borne diseases, including malaria in many parts of the world (IPCC, 2014). Africa and Asia are found to be the most important regions for climate-related impacts on malaria (Martens et al., 1995; van Lieshout et al., 2004). Climate change has both direct and indirect impact on malaria. The direct impacts include the effect on the behaviour and geographical distribution of the mosquitoes and the life cycle of the parasite. Climate change indirectly affects malaria by influencing environmental factors such as vegetation and the availability of breeding sites (Barrow et al., 2000; Martens et al., 1999, Smith et al., 2014). Projections indicate increasing

morbidity and mortality associated with climate sensitive diseases, particularly among the poorest and most vulnerable populations (i.e. fishers, slum dwellers, etc) (IPCC, 2001).

Urban communities face unique challenges as a result of high rate of urbanization (Satterthwaite et al., 2009). Although health indicators tend to be better in urbanized areas compared with rural areas, there are caveats as some urban areas are disadvantaged in terms of disease susceptibility and prevention. Hence, marginal urban communities are likely to be disadvantaged as their relatively worse conditions are shrouded in the general urban situation. Ghana has seen improvement in the health of its population over the years, indicated by decreasing infant mortality from, 64 per 1,000 live births in 2003 to 50 per 1,000 live births in 2008 and under five mortality from 111 per 1,000 live births in 2003 to 80 per 1,000 live births in 2008 (GSS, 2009). However, improvement is not apparent everywhere and substantial inequalities in health persist within and between regions in Ghana. The susceptibility of urban population to climate change impacts is exacerbated by growing informal settlements and inadequate infrastructure, limited resources as well as weak and ineffective governance systems (Ayers, 2011). Poor sanitation conditions in poor urban communities, especially in slums or informal settlements favour the vectors, pathogens and parasites that cause diseases such as malaria (Yarnal, 2007; Yanda, 2005). Populations vulnerable to climate change impacts such as malaria transmission, are therefore, expected to increase, especially in developing countries as a result of growing urbanization (Satterthwaite et al., 2009).

Climate impacts are projected to slow down economic growth, creating new poverty traps especially in urban areas (Smith et al., 2014). It has been observed that disproportionate impact of climate change on vulnerable individuals or households can plunge them into poverty (Pastuer, 2011). The high morbidity and mortality associated with malaria have negative consequences on productivity and development in general as

over-stretched resources are channelled into treatment of the disease. Individuals and households bear the direct cost of malaria, in terms of prevention and treatment, which impact on their disposable incomes (Asante et al., 2003; Mostafa et al., 2007; Sachs and Malaney, 2002). The economic impact of extreme climatic events such as destruction and loss of property, livelihood and health has been observed in Ghana (World Bank, 2009). In its assessment, the IPCC projection of population at risk of malaria with the A1B climate change scenario with constant GDP per capita showed 5.2 billion people at risk by 2050. However, keeping climate change constant with strong economic and social development reduced the population at risk to 1.74 billion within the same period (Smith et al., 2014). Therefore, the lack of adequate understanding of how socio-demographic conditions influence malaria transmission/incidence in the face of climate variability and change and increasing urbanization can increase malaria-related morbidities resulting in impairment of quality and loss of life (Frumkin et al., 2008; Githeko, 2001).

Beside climatic conditions, Accra is already burdened with poor environmental and socio-demographic conditions that influence the dynamics of malaria. Therefore, increased flood hazard as a result of climate variability and or change is likely to directly and indirectly exacerbate malaria transmission/incidence among the population in these areas than those in other parts of the country.

To understand the climate-malaria linkage for current and future situations, several models have been used over space and time. The models used include biological (Martens et al., 1995, 1997, 1999; Martin and Lefebvre, 1995), epidemiological (Anderson & May, 1992; Martens et al., 1999), mathematical (Parham and Michael, 2010; Hoshen et al., 2001; Aron, 1988) and statistical (Rogers and Randolph, 2000). These earlier assessments and projections linking climate and malaria transmission have, however, not adequately quantified the socio-demographic factors that moderate the linkages (Ebi, 2008; Smith et al., 2014). Some have

also assessed climate-malaria linkage at a highly aggregated level (global and regional) with conclusions which do not reflect local level situations. The large-scale assessments are imprecise and conceal vulnerability to climate change impacts on malaria and potentially obscure insight on the true or accurate malaria transmission scales (Patz et al., 2000; Lieshout et al., 2004; Ebi et al., 2008; Huang et al., 2011). Moreover, malaria transmission estimations that incorporate socio-demographic factors have assumed a constant population density and growth rate over space (Emert et al., 2011). This, therefore, does not provide a true picture of the state of affairs with regard to the actual malaria transmission at the local level.

Although there is conclusive evidence that the overall balance effects of climate change on health is likely to be negative, there is also substantial uncertainties about the role of climate change in the development of malaria transmission dynamics in recent times (Smith et al., 2014; Haines et al 2016; Hay et al., 2000). The IPCC projections indicate (with high level of confidence) mixed climate change effect (positive and negative) on health outcomes, including malaria, due to inter and intra-regional variations in climatic conditions as well as varied socio-demographic conditions. While in the short-term (mid-century), climate change will exacerbate health problems, the long-term health outcomes are uncertain. In the case of vector diseases such as malaria, the geographical range will either contract or expand with changing transmission season (Adger et al., 2014). This reflects one of the key gaps identified in the climate change and health relationship (IPCC AR5), that is, how climate variability/change affects health, including malaria, among vulnerable populations in coastal and low-lying areas as well as regions with high population growth (Smith et al., 2014). Hence, there is a limit to what the existing global transmission estimates explain as far as climate-malaria linkage at the local or population level is concerned. Understanding malaria transmission dynamics at the local level, therefore, require specific transmission estimations for different socio-demographic settings.

Additionally, accurate and reliable malaria transmission information at the local level is a key requisite for coping/adaptation to malaria. Although climate variability/change is a global problem, exposure, sensitivity and intrinsic adaptive capacity contribute to a highly differentiated regional vulnerability and resilience to impacts (Bosello et al., 2009; Füssel et al., 2006). Feasibility assessment for climate change adaptation was, therefore, a central theme of the Working Group II of the third assessment report of the IPCC (IPCC, 2001), which was intended to address issues related to reducing the negative impacts of climate change and building resilience.

Populations affected by extreme climatic events and impacts better define their own risks and adaptation strategies due to the understanding of their environment. Such populations are also likely to be intuitive and knowledgeable of the local resources and capacity available for coping (Pastuer, 2011). Individuals and communities may have already developed local strategies for predicting climatic events, early warning, preparedness and coping which may be relevant for current and future malaria risks (Berkes, 2007; Pastuer, 2011). It is argued that these private coping/adaptation measures will dominate adaptation response to a large extent as individuals adjust in order to reduce climate change related risks with high cost implication (Parry et al., 2009). The current coping/adaptation decisions for future climate induced malaria risks are however complicated by uncertainties and variations associated with distribution of impacts over time and space (Tompkins et al., 2013). Therefore, quantification of malaria transmission that does not account for micro level socio-demographic factors can be detrimental to effective malaria coping/adaptation planning especially, among vulnerable populations with multiple risks of exposure, sensitivity and low adaptive capacity to combat malaria (Few, 2003: Mandal et al., 2011).

This study assesses malaria outcome at macro (Accra) and micro (household) levels. This approach of modelling malaria transmission at a sub-national level (Accra) is useful in

estimating the current and future malaria transmission in Accra using the actual climatic and socio-demographic factors and also assess how households are likely to be impacted by the macro level transmission based on socio-demographic conditions. A sub-national modelling is also useful in identifying important drivers of malaria transmission in a poor urban setting with high malaria burden in an era of global climate change for prioritised interventions as envisaged by the IPCC. Furthermore, the current understanding serves as a basis for the implementation of tailored coping/adaptation interventions to curtail future climate change impacts on malaria transmission (IPCC, 2001).

1.3 Rationale of the Study

The risk of malaria transmission depends on mosquito population, infective status and interaction with human population, i.e., stinging (de Vries, 2001; Hoshen and Morse, 2004). The malaria parasite requires both human and mosquito for its life cycle to complete (Mandal, 2011). The abundance and distribution of malaria is sensitive to weather conditions (WHO, 2016). Due to the sensitivity of the malaria vector to climatic conditions, climate change has the potential of modulating the behaviour and the geographical distribution of the mosquito that causes malaria, the life cycle of the parasite as well as human behaviour with diverse consequences on actual malaria transmission. Again, the growing population, resulting in high population concentration and densities, especially in urban areas of Africa, influences the actual malaria transmission levels. Therefore, in accounting for malaria transmission, the use of field data or actual population data can provide a realistic estimation of malaria transmission (Emert et al., 2011).

The knowledge on actual malaria transmission will be useful in monitoring, preventing, coping/adaptation to malaria and ultimately reduce malaria epidemic to its barest minimum and avert deaths and economic costs associated with it (Emert et al., 2011; Smith et al., 2014). Estimation of lower level malaria transmission will, therefore, serve as a baseline to

initiate bottom-up planned adaptation and evaluating post-adaptation interventions. Adaptation to the varied impacts of climate change has become a priority for many countries in the world, especially, in developing countries in view of the current national and global evidence of climate change impacts. Ghana's effort in this direction is demonstrated in its strong commitment and prioritization of climate resilient developments and managing climate-induced health risk, as documented in the second third communication document to the United Nations Framework Convention on Climate Change (UNFCCC) (EPA, 2011; Republic of Ghana, 2015). The development of adaptation plans, however, follows a top-down approach and lack empirical evidence from the household level as well as spatial variation on what works best for affected populations in different locations with different climatic conditions and socio-economic contexts (EPA, 2011). As a result, little gains have been made in reducing incidence of malaria after many years of interventions. This is evidenced in the increasing trend in the incidence of climate-sensitive diseases such as malaria, diarrhoea and cholera (Baah-Boateng et al., 2012). A bottom-up approach is considered essential in assessing climate change impacts on malaria incidence and coping/adaptation to malaria. Evidence of future climate change impacts on malaria and resilience-building at the individual level will serve as an invaluable knowledge and a guide to initiate bottom-up strategies aimed at addressing malaria incidence and consequently enhance capacity for adaptation to future impacts on malaria (Kovats et al., 2005). Moreover, without adequate knowledge to inform coping/adaptation strategies, climate change-related malaria outcome could pose a major threat to gains made in the health-related Millennium Development Goals (MDG), such as improving maternal and child health. Ghana's potential in attaining the Sustainable Development Goals (SDG 1 and 3) and the national development agenda of reducing poverty and attaining higher levels of development will also depend on evidence-based interventions.

1.4 Objectives

The main objective of the study is to assess the influence of climate and socio-demographic influence on malaria transmission and incidence in Accra at both macro and micro levels.

The specific objectives are to:

i. Model the current and future malaria transmission over Accra by accounting for socio-demographic factors.

ii. Examine climatic (flooding) and socio-demographic determinants of malaria incidence at the household level.

iii. Assess the relationship between coping/adaptation strategies and malaria incidence.

1.5 Organization of Chapters

The study is organised into eight chapters. Chapter one covers the introduction to the study, statement of the problem, rationale of the study, objectives and research questions. It also highlights the organization of the study into chapters. Chapter two comprises a detailed literature review and theoretical underpinning of the study as well as conceptual framework for the study.

Chapter three describes the methodology of the study which includes a detailed description of the study area. It also outlines the methods of data collection, organisation and analyses. Chapter four presents the current and future malaria transmission in Accra detailing the annual and seasonal transmissions.

Chapter five entails the description of household socio-demographic characteristics (background characteristics of households, perceptions of climate and malaria risk and adaptive capacity, coping/adaptation measure and malaria incidence) and experience of flooding. Chapter seven presents the results of bivariate analyses of household experience of flooding, background characteristics of households, perceptions of climate and malaria risk,

adaptive capacity, coping/adaptation measures and malaria incidence. Chapter eight reports on the report of multiple regression analyses of the relationship among household socio-demographic characteristics (background characteristics of household, perceptions of climate change and malaria risk and adaptive capacity), experience of flooding and incidence of malaria. Chapter nine is the concluding chapter that provides a summary of the study findings, conclusion and recommendations.

Chapter Two

Literature Review

2.1 Introduction

There is conclusive evidence including IPCC assessment reports (FAR, AR4, AR5) that global warming is occurring and will continue for centuries due to increase in greenhouse gases in the atmosphere with diverse impacts over the past few decades (IPCC, 2001; Confalonieri et al., 2007; Adger, 2014). Human actions are largely responsible for amplifying the natural greenhouse effect and changing atmospheric composition, thereby causing global climate change at high rates (Kaser et al., 2004). The atmosphere's concentration of carbon dioxide has increased by one-third since the inception of the industrial revolution (WHO, 2003). In the recent past (1995-2005), there has been a higher growth rate in the concentration of carbon dioxide with an average of 1.9 parts per million per year (IPCC, 2007). The IPCC (2001) estimated that changes in atmospheric composition of greenhouse gas will result in a rise of global average temperature by 1.4°C to 15.8°C. The future changes in average climatic conditions to a large extent will involve an intensification of present variability and extremes, resulting in frequent extreme climatic events (IPCC, 2001). Global average sea level rose at an average rate of 1.8 mm per year between 1961 and 2003. Temperature rise between 1850–1899 and 2001–2005 was 0.76°C and the observed change is attributable to increase in anthropogenic greenhouse gas concentration (Confalonieri et al., 2007). The IPCC (Confalonieri et al., 2007) indicates that global temperature will increase by 0.2°C per decade for the next two decades. In a more recent report, the IPCC (Adger, 2014) affirmed the human influence on climate system resulting in further increase in the concentration of greenhouse gases, positive radiative forcing and observed warming. The report also concluded that the atmosphere and ocean have warmed; the amounts of snow and

ice have diminished with risen sea level. Projections indicate continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system (Adger, 2014).

2.2 Climate Variability/Change and Health Implication

Climate has both direct and indirect negative repercussions on human health outcomes (Kovats et al., 2005; McMichael et al., 2008). Direct health impacts of extreme climatic events include injuries and deaths while indirect impacts include changes in the geographic distribution and biological behaviour of vector organisms of vector-borne infectious diseases such as malaria and dengue fever as well as mental health disorders. The direct effects of health occur through changing weather patterns (such as temperature rise, precipitation), sea-level rise and more frequent extreme events while indirect effects occur through climate impacts on water, air, food quality and quantity, ecosystems, agriculture, health, livelihoods and infrastructure (Costello et al., 2009; Githeko, 2001; IPCC, 2001; Kovats et al., 2005; WHO, 2003; Githeko, 2001; Hajat et al., 2005; Miller et al., 2009).

There has been observed increase in the frequency of extreme climatic events with enormous impact on health in many parts of the world in recent times; notably, floods in China, Mozambique, Bangladesh, and Europe; famine in Sudan; and Hurricane Mitch, which devastated Central America (Githeko, 2001; Knowlton et al., 2011). The fourth assessment report of the IPCC (2007) is replete with evidence of health effects of extreme climatic events in many parts of the world, notably, impact of heat waves on mortality in France (14,800deaths), Belgium, the Czech Republic, Germany, Italy, Portugal, Spain, Switzerland, the Netherlands and the UK (all with excess mortality within the range of 35,000 deaths) (IPCC, 2007). In addition, the IPCC (2007) outlined some health impacts of major flood and drought events which occurred in many countries including China (130 million people were

affected by floods), Venezuela (30,000 deaths due to floods), Mozambique (1,813 deaths due to floods) and in Brazil (280,000 to 300,000 people affected by drought). Floods are caused by factors including heavy or intense rainfall with long duration with additional threat to coastal areas from the proximity of the sea (Few et al., 2004). Tidal and wave extremes are the second major cause of floods, bringing seawater across land above the normal high tide level. Cyclonic storms may create dangerous 'storm surge' in which low atmospheric pressure causes the sea to rise (Few et al., 2004). Floods are considered the second largest cause of disaster-related mortality in recent times. The IPCC third assessment report predicts the rise in yearly average near-surface temperatures across the globe between 1.4°C and 5.8°C in the next 100 years, resulting in further increase in flood hazard in some areas because of sea level rise, changes in seasonal precipitation or the pattern of wind storms (McCarthy et al., 2001).

According to the IPCC (AR4) (Confalonieri et al., 2007), increasing rise in sea levels, rise in sea surface temperature and intensification of tropical cyclones induced by climate change could affect human health through coastal flooding, damaged coastal infrastructure, saltwater intrusion into coastal freshwater resources, damage to coastal ecosystems, coral reefs and coastal fisheries, as well as population displacement. In addition, there is potential for climate change to affect health in ways that are completely unexpected with negative consequences (Bayntun, 2012; Kovats et al., 2005).

Extreme climatic events present many challenges to health policy and delivery system especially in sub-Saharan Africa where there is high burden of climate sensitive-diseases. Malaria and diarrhoea incidence for instance poses a high morbidity burden in many countries in sub-Saharan Africa (Adams et al., 2004; Baah-Boateng et al., 2012). Climate variability/change brings new challenges to the control of these climate-sensitive diseases in many parts of Africa, including Ghana. Ill-health associated with climate variability and

change increases vulnerability by reducing natural resilience and reduces the capacity of individuals and groups to adapt to other climate change impacts (Confalonieri et al., 2007; IPCC, 2001). In addition, extreme climatic events bring in their wake disasters and injuries which put extra burden on health care and obstruct access to care. While in the more developed countries, advanced technologies are being utilised in mitigating the impact of climate related health stressors, developing countries is expected to bear the full brunt of climate-related health impacts if appropriate adaptation measures are not taken (Githeko, 2001; Kalkstein, 1993).

A study which sought to understand the potential impact of global warming on human health in Egypt, The Peoples' Republic of China, Canada and USA estimated an increasing mortality associated with heat waves in all the four countries (Kalkstein, 1993). An extensive review of literature on health effects of flooding between the period 1975-2005 by Hajat et al. (2005) revealed a range of potential health effects of climate variability and change. Two main categories of health effects, namely: physical and mental health outcomes were noted. Injuries, outbreak of infectious diseases, anxiety and depression were also found associated with floods. A long-term increase in mental health disorders associated with extreme climatic events has also been observed (Hajat et al., 2005). Long-term common mental conditions including stress, depression and anxiety may arise either through direct and indirect pathways (Few, 2003). The debilitating effect of physical illness, loss of life and property as well as livelihoods due to extreme climatic events have the potential of causing anxiety and depression (Miller et al., 2009). The significant changes observed in rainfall and temperature pattern in Ghana, manifested in erratic and extreme rainfall, warmer temperatures and seawater intrusion, have major health implications (EPA, 2009; Stanturf et al., 2011; Tschakert et al., 2010; World-Bank, 2009). The elderly, persons with disability, children, women, ethnic minorities, and people with low-income status are the most at risk. Climate-

sensitive health outcomes such as diarrhoea, cholera and malaria constitute a major cause of childhood morbidity and mortality in Ghana and many other developing countries. The evidence shows seasonal variations in the incidence of these climate-sensitive diseases (EPA, 2009).

2.3 Climate Variability/Change and Malaria Linkages

Earlier studies have revealed that temperature and rainfall play an important role in the inter-annual variability of incidence of malaria; while rainfall influences the transmission of mosquitoes, temperature acts as a regulatory force (Zhou et al., 2004; Paaijmans et al., 2009; Martens et al., 1995). Climate change indirectly affects incidence of malaria by influencing environmental and socio-economic factors such as availability of breeding sites, vegetation and preventive practices (Martens et al., 1995). As a result, there is varying impact of climate change on malaria outcome across space and time. As an indicator of malaria expansion, seasonality analyses show that a longer transmission period reduces epidemic risks with implications for malaria control. Analysis with climate-driven malaria seasonality model in Africa shows future decline in the length of malaria transmission season in West Africa due to the drying and warming trend in the malaria belt. In East Africa, however, higher temperatures and stable precipitation patterns will result in longer transmission season. Projected climatic conditions will not be conducive for malaria in the northern Sahel (Emert et al., 2013).

The IPCC (2001) has established that in areas with limited or deteriorating public health infrastructure, an increase in temperature with adequate rainfall will cause some vector-borne diseases including malaria and dengue to extend to higher altitudes and latitudes. In the highlands of southern Uganda, a strong relationship is found between global increase in average surface temperature of 0.6°C and increase in malaria incidence (Loevinsohn, 1994; McMichael et al., 1996). They further predicted that as global warming

continues, malaria is set to spread in locations where malaria was previously limited due to cooler climate. On the other hand, findings of a study of four high altitude sites in East Africa where there have been reported increases in malaria show no significant change in climatic elements such as temperature, rainfall, vapour pressure and number of months suitable for p. Falciparum transmission (Hay et al., 2001). The upsurge of malaria has rather been attributed to multiple factors including drug resistance, mosquito control programmes, public health facilities, population migration and living standards (Hay et al., 2001). Notwithstanding, a recent analysis of climate change and population scenarios indicates that the tropical highland regions are a more suitable area for future malaria transmission (Caminade et al., 2013). In Ghana, studies have shown linkages between rainfall and malaria incidence. Among other factors, total rainy days were responsible for the variations in malaria incidence in Ghana (Akpalu, 2013). A spatiotemporal analysis of climate variability impacts on malaria also revealed a significant relationship between malaria prevalence and rainfall in Ghana (Adu-Prah and Tetteh, 2014).

These divergent findings provide an indication of uncertainties in the future outcome as a result of the interplay of complex interactions and varying scale of observation. With these observed varying linkages, future changes in climatic conditions are expected to alter the malaria incidence.

2.4 Determinants of Malaria Transmission

As indicated earlier, malaria transmission is influenced by space and time. A systematic literature review showed that the range of factors that contribute to malaria transmission in urban areas in sub-Saharan Africa include socioeconomic, environmental, and ecological factors (Breman, 2001). Place of residence serves as exposure unit to the malaria vector and subsequently the risk of transmission. In terms of geographical location, the coastal zone of Africa faces higher risk of climate change impacts. Climate change is

expected to exacerbate existing physical, ecological/biological and socio-economic stresses on the African urban and coastal zones (Smith et al., 2014). Informal urban settlements for instance provide niches for the breeding of mosquitoes. Hassi (2005) identified the location of homes in relation to mosquito breeding sites, the design of buildings, the materials used to build them, the use of screens and bed nets as significant contributors to man-vector contact (Alnwick, 2000).

Africa is undergoing rapid demographic change, with growing proportion of population moving to urban areas where impact of climate change is expected to be high (Parnell, 2011; Neumann et al., 2015; Smith et al., 2014). As a major economic hub, most coastal communities in Africa, serve as a pull to large inhabitants, resulting in high concentration of population along the coast. Western and Eastern Africa in particular are expected to experience the highest rates of population growth and urbanization in the coastal zones (Neumann et al., 2015). Ghana is also experiencing increasing trend in urban population and for the first time since 1960, more than half of Ghana's population live in urban areas having increased from 23.1 in 1960 to 50.9 in 2010 (UN, 2012; GSS, 2013). Ghana's urban population is estimated to increase further by 40 percent in 2020 according to the United Nations World Urbanization Prospect (UN, 2012). The Greater Accra Region is the most urbanised region (90.5%) in the country (GSS, 2013). Ghana's urbanization is characterized by high population densities and poor housing conditions. Urbanization, coupled with high population density, intensity in climatic events, poor environmental and socio-demographic conditions provide niches for the breeding of the malaria vector with the consequence of increasing malaria transmission/incidence risk in the country.

The low-lying coastal countries of Africa in particular are susceptible to increased flooding caused by storm surges and intense rainstorms. The IPCC (AR5) has shown that

virtually all the projected growth in populations will occur in urban agglomerations with a high proportion of the workforce deployed outdoors (Smith et al., 2014). The susceptibility of West Africa in particular is attributable to the fact that a large proportion of its urban population is resident in coastal cities (Neumann et al., 2015). While an estimated 22.6 percent of Nigeria's population lives along the coastal zone, 66.6 percent (4.5 million) of Senegalese population live along the coastal zone. The high concentration of population along the coast is attributable to the concentration of economic activities. Economic activities in some of these coastal communities have served as a pull to large inhabitants. In countries along the West Africa coast, most of the economic activities that form the backbone of the national economies are located within the coastal zone, hence drawing population from other parts of the country. Moreover, sub-Saharan African countries in Western and Eastern Africa in particular are expected to experience the highest rates of population growth and urbanization in the coastal zone (Neumann et al., 2015). Without rapid improvements, the urban environment will intensify malaria transmission as more niches are created for the breeding of mosquitoes.

Socio-demographic factors influence the breeding and survival of mosquitoes as well as the treatment measures against incidence of malaria. It was also found that in urban sub-Saharan Africa, high malaria transmission occurs around breeding sites, characterised by lower socio-economic status (De Silva and Marshall, 2012). Historically, it has been shown that malaria declines with socioeconomic development and improved drugs. The industrial revolution in Western Europe in the nineteenth century, marked by the macro-level development and interventions, resulted in the decline of disease conditions including malaria (Gould, 2009). In countries such as England and the Netherlands, progressive improvements of social, economic, agricultural, educational and public health were associated with reduction in malaria transmission (Dobson, 1994). There is also evidence of marked

reduction and variation in malaria transmission in the past through public health measures, infrastructural and socio-economic development (Béguin et al., 2011; Sachs and Malaney, 2002; WHO, 2014). A study that sought to explore the relationship between socio-economic status and malaria parasites at the microeconomic (household) level found a negative association between socioeconomic status and malaria parasitemia. Variables such as age of the individual, use of mosquito net and the number of people living in the household were significantly associated with parasitemia (Somi et al., 2007). An economic analysis of climate impact on malaria has shown that among other things formal education and income levels explain variations in malaria incidence in Ghana (Akpalu and Codjoe, 2013).

Other studies (WHO, 2003; Action Aid, 2006) have also identified among other things, factors such as population density, income level and distribution, local environmental conditions, pre-existing health status, and the quality and availability of public health care as factors that influence malaria incidence.

However, there are instances where little or no significant variations were found in malaria incidence as a result of economic differentials. A study in Ghana using income levels compared malaria incidence in two communities; one with relatively low average income (73,824 Cedis/year), and one with relatively high average income (138,167 Cedis/year) found that malaria incidence in the poorer community was not significantly different from incidence in the richer community (Biritwum et al., 2000 as cited in Worrall et al., 2003). A study which examined the incidence of diseases with randomly selected children from three ecologically different sites in North West of Burkina Faso established a significantly higher risk of malaria among children under five, living in houses with mud roofs (Yazoumé Yé et al., 2006). Although socio-demographic factors have influence on malaria outcomes, the actual effect is dependent on context of observation.

At the institutional level, health systems are considered an essential element of health resilience due to their ability to use knowledge, opportunity and political influence for advocacy and actions to reduce health burdens (McMichael et al., 2008). Sanderson (2000) observed that a well-functioning public health system would increase the capacity of societies to reduce the health impact of climate change. Schoon and Bartley (2008) in their study on capability and resilience noted quality of human relationships and quality of public services as factors responsible for increasing human capacity for resilience. This view is corroborated by other authors who have emphasized the need for collaborative efforts at all levels including the health sector to commensurate individual and community action and policies in managing health outcomes of climate change (McMichael et al., 2008; Costello et al., 2009). Costello et al. (2009) recommended among other things, actions intended to understand events linking climate change to disease and appropriate public health systems to deal with adverse outcomes.

In addition to enhancing the capacity of individuals and communities to manage malaria risk associated with climate change, the role of health systems has also been emphasized (Bell, 2011; Githeko, 2001). Public health preparedness and response activities are considered vital in building community resilience and minimising health vulnerabilities associated with climate variability and change (Confalonieri et al., 2007; Keim, 2008). Where poverty and excessive health burdens serve as barriers to adaptation, it has been observed that public health measures and strategies play a major role in off-setting the effects of health outcomes due to climate change. However, it has been observed that in many developing countries, health systems are ill equipped to meet health needs resulting from climatic events. Inadequate institutional knowledge, human resources for health, poor infrastructure and poor health delivery are major setbacks to curtailing climate change health outcomes (Bell, 2011). Moreover, the additional hazard factor implied by climate change on health has the potential

to render populations more vulnerable and also place unanticipated demands on health care provision and other life-supporting services (Githeko, 2001).

2.5 Epidemiology of Malaria

Malaria transmission occurs through successive infection between two hosts, human and the mosquito. This interaction is influenced by both climatic factors and the socio-demographic factors as demonstrated in Figure 2.1. With a bite from an infected person, mosquito draws blood which contains microscopic malaria parasites. After a week, the parasites, mixed with the mosquito's saliva, are injected into another person when the mosquito takes its next blood meal (CDC, 2016). Another mosquito that bites the infected individual may ingest gametocytes, which pass through the gut wall after fertilization. They then develop and ultimately produce sporozoites which become infected when they migrate to the mosquito salivary glands. In humans, the parasites grow and multiply in the liver cells and move to the red cells of the blood. Successive broods of parasites grow inside the red cells and destroy them, releasing daughter parasites (merozoites) that continue the cycle by invading other red cells.

The blood stage parasites cause the malaria symptoms in humans. The female anopheles picks up the blood stage parasites (gametocytes) during a blood meal and initiates another cycle of growth and multiplication in the mosquito. The parasites (sporozoites) are released after 10-18 days through the mosquito’s saliva as the mosquito takes a blood meal on another human, hence, starting another human infection. The parasites secreted in the mosquito's salivary glands are termed as "sporozoites". Thus, the mosquito carries the disease from one human to another, acting as a vector. Unlike the human host, the mosquito vector does not suffer any negative effects from the presence of the parasites (CDC, 2016; Emert et al., 2011).

Ambient temperature plays an important role in the biting and the development of sporozoite (immature form of malaria parasite) process. The population size of the mosquitoes is influenced by both climatic (temperature, rainfall and land-cover) and socio-cultural and demographic factors (local knowledge of the mosquito life cycle and the means to apply the knowledge for control measures) through the regulation of the survival of the mosquito (de Vries, 2001; CDC, 2016).

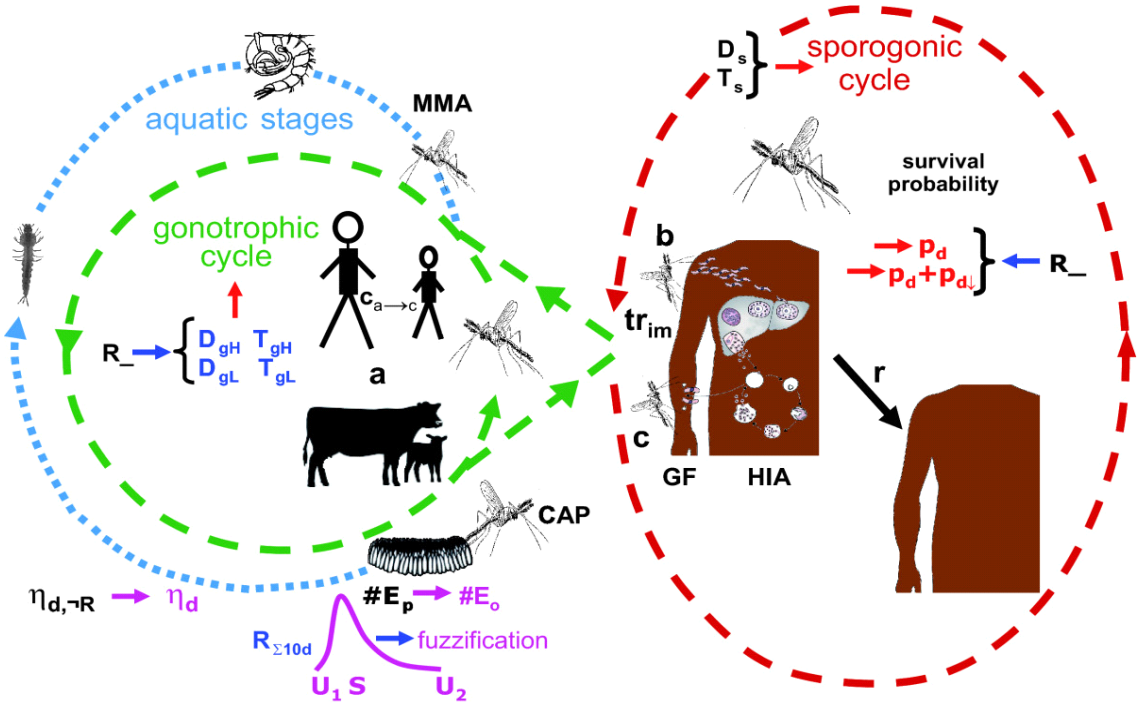


Figure 2.1: The malaria cycle.

Source: Emert et al., 2011

2.6 Coping/Adaptation to Climate Variability/Change and Health Impacts

The level of impact of climate change on human population is a measure of the population's exposure and susceptibility which is determined by both inherent and exogenous factors. Populations that have lower levels of these factors are vulnerable. Decisions concerning adaptation are considered relevant in reducing the negative impacts of climate on health (Kovats et al., 2005; McCarthy et al., 2001; Willows et al., 2003). Coping/adaptation is considered as a necessary strategy at all scales to complement climate change mitigation

efforts; it reduces exposure and enables individuals and communities to cope with the adverse impacts of climate (McCarthy et al., 2001; Kovats et al., 2005). Paton (2005) observed that the factors that influence susceptibility and adaptation co-exist in a system, implying that as much as a system may be vulnerable, it could also have potential capabilities to offset its vulnerabilities to disturbances. Instead of managing risks, he stressed the need for these two main categories of factors to be managed to enhance adaptive capacity. While vulnerability factors expose and render people susceptible, resilience factors enhance their ability to cope/adapt to climate change-related impacts.

Climate vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate variability and extremes (IPCC, 2001). Vulnerability assessments have been criticised for focusing on deficits rather than strengths (Adger, 2006; Walker et al., 2002). Such risk-based approach is essential in identifying those indicators in the system that act as drivers of vulnerability of the system. Vulnerability factors constitute attributes in a population that constrain adaptive capacity and increase susceptibility to climate change impacts. It is argued that, the utility of identifying risks is only to the extent that risks can either be reduced, or individuals can be helped to cope in spite of them. In addition, risks create the possibility of negative stereotyping, stigmatization and low expectation with potential effect on performance, thereby reinforcing low expectations and creating a vicious circle (Bankoff, 2001). This view is akin to the argument by Schoon and Bartley (Schoon and Bartley, 2008) against the use of deficit model in the promotion of population health because it tends to emphasize the helplessness of human population in the face of adversity.

In contrast, resilience approach focuses on individuals' or population’s strengths and resources utilized in the face of hazards. Resilience has also been defined as the capacity of a system to absorb disturbances and reorganise while undergoing change, yet retain essentially

the same function, structure, identity and feedbacks. Folke (2006) posited that unlike vulnerability systems where minimal disturbances are likely to result in dramatic changes, disturbances in a resilient system provide opportunities for learning. It is also argued that resilience provides a useful framework to analyse coping/adaptation processes as well as identifying appropriate policy responses (Nelson et al., 2007). Resilience, therefore, challenges the passive attitude of victims of undesirable perturbations which vulnerability studies tend to portray and highlight victims as restorative agents (Popay et al., 2007). Resilience is considered as ideal social goal because it puts a system in a much better position to withstand harsh conditions and recovers quickly after exposure (Adger et al., 2005). In relation to this view, Few (2003) emphasized the importance of focusing resilient studies on actions undertaken in the home and within community.

Similarly, Nelson et al. (2007) consider resilience as a component of the inherent characteristics of a system as well as networks, social capital and resources that promote institutional learning. Accordingly, responses to climate-related health outcomes can take place at different scales by different actors with different capabilities due to the high degree of interconnectedness across individuals, communities as well as scales of governance and institutions (Cutter et al., 2010; Few et al., 2004). In application of the concept of resilience, Few et al. (2003) observed that individuals who are affected by floods, in proximity to floods, or subject to flood risk require the services and inputs from several sources including (i). Community-based organisations (ii). Local health care providers (dispensaries, surgeries, clinics, health centres, hospitals); (iii). Local service providers in preventive health (health education, public safety and environmental health teams); (iv). Local water and sanitation providers; (v). Regional and national government departments; (vi). Non-governmental organisations (NGOs) and (vii). International agencies

As a measure of the relationship existing between individuals and their larger neighbourhoods and community, social capital has been used as a related concept of resilience (Cutter et al., 2010). It is conceived as norms and networks that enable people to act collectively (Woolcock et al., 2000). It is understood that social capital theory explains how individuals use their relationships with other actors in societies for their own good and the collective good of the wider society (Adger, 2003).

Different aspects and forms of social capital have been identified by earlier scholars. A distinction is made between formal and informal as well as trust and reciprocity (Pelling, 2002; Putnam, 2000). A distinction is also made between bonding social capital and networking or bridging social capital (Adger, 2003; Narayan et al., 1999). While bonding social capital involves the sharing of knowledge, financial risk, market information, or claims for reciprocity in times of crisis within relationships based on friendship and kinship, networking social capital on the other hand extends to economic and other ties external to a group. As a result, while bonding social capital tends to rely on informal rules of enforcing sanctions of collective action, networking social capital is based on economic and other ties (Adger, 2003). Another construct of social capital looks at structural and cognitive dimensions (Grootaert et al., 2003; Krishna et al., 2000). Perceptions of support, reciprocity, sharing and trust constitute the cognitive dimension of social capital. On the other hand, the structural dimension constitutes the extent and intensity of associational links.

The linkages between social capital and health (Narayan and Pritchett, 1999) and climate change disaster resilience (Cutter et al., 2010) have been empirically established at different levels with varying results. While several studies have shown that social capital fosters social participation and reduces health risks including mental health problems (Friedli, 2009; Poortinga, 2006; Rose, 2000; Veenstra, 2000), others have shown that social capital does not reduce vulnerability to climate health impacts (Wolf et al., 2010). Cutter et al.

(2008) in a climate resilience study, for example, used sense of community, place attachment and citizen participation to denote social capital and the result showed a positive influence of social capital on resilience to disaster. Morgan and Swann (2004) have also used indicators such as trust, participation and reciprocity in measuring social capital. A study of the relationship between social capital and poverty in Tanzania which used the extent of associational activity and trust in various institutions and individuals, showed that social capital raises household income and in addition, the free flow of information and reduces transaction cost, thereby making available extra money for other needs. It was also found that communities with high levels of social capital had better mental health (Narayan and Pritchett, 1999). In a study intended to understand the relationship between social capital and self-rated health status in Canada, trust, commitment, identity, participation in clubs and associations and civic participation were used. Although the result generally showed weak relationship between social capital and health, there was a strong positive relationship between some individual elements of social capital such as socialization with work-mates, attendance at religious services and participation in clubs and associations and health, especially among the elderly (Veenstra, 2000).

Adaptation mechanisms are categorized based on the purposefulness of adaptation, the timing of implementation, spatial and temporal scale, sector of activity, or actors designing and implementing the mechanisms as shown in Table 2.1 (Smit et al., 1999; Adger et al., 2007). In terms of actors undertaking the adaptation, distinction is made between autonomous (private) and planned as well as anticipatory (proactive) or reactive adaptation IPCC (AR4) (2007).

Planned adaptation is a result of deliberate policy decision based on awareness that conditions have changed or are about to change and that action is required to return to, maintain or achieve a desired state. Planned adaptation is concerned with the future increases

in health risks caused by anthropogenic climate change (Füssel et. al., 2004). Autonomous adaptation on the other hand, refers to actions that are taken as individuals, institutions, enterprises, and communities independently to adjust to their perceptions about climate risk. Such autonomous actions may be short-term adjustments which are often considered as unplanned. The IPCC defines autonomous adaptation as a measure that does not constitute a conscious response to climate stimuli, but triggered by ecological changes in natural systems and market welfare changes in human systems. Autonomous adaptation is not limited to reactive actions, but also anticipatory, that is, private actions taken based on an assessment of future conditions and are taken before danger occurs (Adger et al., 2005; Fussel, 2007). In spite of the distinctions, both categories are not independent, but complement each other. For instance, Tol and Fankhauser's (1997) analysis of the costs of autonomous adaptation was not exclusive of reactive adaptations undertaken privately.

Table 2.1Typologies of adaptation.

General Differentiating Concept orAttribute	Examples of Terms Used
Purposefulness	Autonomous ⟷ Planned Spontaneous ⟷ Purposeful Automatic ⟷ Intentional Natural ⟷ Policy Passive ⟷ Active Strategic
Timing	Anticipatory ⟷ Responsive Proactive ⟷ Reactive *Ex ante* ⟷ *Ex post*
Temporal Scope	Short term ⟷ Long term Tactical ⟷ Strategic Instantaneous ⟷ Cumulative Contingency Routine
Spatial Scope	Localized ⟷ Widespread
Function/Effects	Retreat - Accommodate - Protect Prevent - Tolerate - Spread - Change - Restore
Form	Structural - Legal - Institutional - Regulatory - Financial - Technological
Performance	Cost - Effectiveness - Efficiency - Implementability - Equity

Source: Smit and Pilifosova, 2003

In terms of timing of adaptation, a distinction is made between anticipatory and reactive types of adaptation. While anticipatory adaptation involves long-term policies with programmes taking place before impact, reactive adaptation involves actions taken immediately in response to the impact.

Other criteria for distinguishing adaptation measures are between localised or widespread (Füssel and Klein, 2006) and by function, legislative/regulatory, technical, advisory/educational, and cultural/behavioural or technological, financial, institutional and informational (Smit et al., 1999). The performance of adaptation processes can be evaluated according to the generic principles of policy appraisal: cost-efficiency, cost-effectiveness, administrative feasibility and equity (Smit et al., 1999; Smit and Pilifosova, 2003).

Under public health categorisation, three categories of adaptation have been identified. These are: primary-health interventions put in place to avoid damage by reducing the exposure, such as water and sanitation programmes, warning systems and flood protection; secondary-intervention measures such as surveillance and monitoring programmes put in place right after the impact of climate stimuli to prevent incidence of disease outbreaks; and third, tertiary-curative treatments to minimise health impacts (Markandya et al., 2009). The effect of adaptation is characterised by its ability to accommodate, retreat, protect, prevent and tolerate.

According to Few et al. (2004) health coping strategies are actions geared at preventing and promoting treatment, including the continued functioning of health services such as prevention of exposure to disease through flood-proofing of latrines or the use of bed-nets; by vaccination or social support networks; and recovery through stockpiling of medicines or ensuring health services continue to function.

Effective adaptation hinges on adaptive capacity. Adaptive capacity includes wide range of factors such as human capital (e.g. education), available technological options for adaptation, access to risk spreading process (insurance), stock of social capital, the structure of critical institutions and perceived attribution of the source risk or stress (Brooks and Adger, nd). The concept of adaptive capacity (response capacity) which is sometimes used as analogous term of resilience has been defined as the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages to take advantage of opportunities, or to cope with the consequences (McCarthy et al., 2001). Adaptive capacity is also considered by others as a component of a resilient system (Turner et al., 2003; Walker et al., 2002). Walker et al. (2002) conceptualised adaptive capacity as an aspect of resilience that reflects learning, flexibility to experiment and adopt novel solutions, and development of responses to broad classes of challenges. Paton (2005) distinguished between two elements of adaptive capacity. The first being resources required to facilitate coping strategies while the second is the systems and competences needed to manage the resources to address the challenges and consequently adapt to the outcome of the hazard.

Adger (2003) conceptualises adaptive capacity in terms of access to resources in cognisance with the fact that the availability of resources does not necessarily translate into adaptation. Smit and Pilifosova (2001) relate adaptive capacity to the social, economic, institutional and technological conditions that facilitate or constrain implementation of adaptation measures. Grothmann et al. (2005), in examining the cognitive determinants of adaptation, however, conceive adaptive capacity as a process of decision-making which is based on risk perception and perceived adaptive capacity. Relative risk perception is a measure of the perceived probability of being exposed to climate change impacts and the assessment of perceived severity of the impacts compared to how harmful other problems or challenges in life are (Grothmann et al., 2005). It is further indicated that the primary goal of

building adaptive capacity is to reduce future vulnerability to climate variability and change by increasing the ability of countries, communities, and individuals to effectively and efficiently cope with the impacts of climate variability and change. It is evident that some adaptation measures could have potential consequences on mitigating the process of climate change. It also has the benefit of reducing the financial burden of developed countries towards adaptation financing (De Silva and Marshall, 2012; Confalonieri et al., 2007; Sachs and Malaney, 2002).

2.6.1 Malaria Prevention and Control in Ghana

The control of malaria has been on the agenda of the World Health Organization as well as countries where malaria is endemic. Recent classification indicates that malaria remains a huge challenge for the African continent. To accelerate progress in malaria control, the 2005 World Health Assembly advanced the Roll Back Malaria targets (RBM) and set a coverage target of 80 percent or more for four key interventions including the use of Insecticide Treated Nets (ITNs) for people at risk (WHO, 2009). In this regard, interventions such as bed-nets and indoor insecticides targeted at women and children as well as massive support towards home-based malaria control artemisinin-based combination therapies (ACTs) for those already affected by the disease were provided by the World Health Organization. With 85 percent reduction in malaria cases between 2000 and 2010, it was indicated that malaria-prone countries have made enormous progress towards their elimination goals. However, there are some challenges with regard to the disparities in the ownership and use of preventive measures in sub-Saharan Africa. An extensive review of literature in sub-Saharan Africa showed a high variation in the ownership of ITN ranging between 3-80 percent. The finding also showed less than 60 percent use of ITN among those who had the ITNs, indicating a discrepancy between ownership and usage. The main determining factors of ITN ownership were level of education, community involvement, socio-economic status,

knowledge of malaria and parity while barriers to coverage include cost and supply of nets (Singh et al., 2013).

Ghana as a malaria endemic country has undertaken a number of interventions aimed at reducing and ultimately eradicating malaria. Ghana's malaria control programme predates Ghana's independence with the use of dichloro-diphenyl-trichloroethane (DDT) for mass spraying exercises. Malaria accounts for a large share of outpatients and inpatients in health facilities in Ghana (Adams et al., 2004). Currently, case management remains the dominant approach to malaria control with presumptive treatment and is highly dependent on availability and access to effective malaria drugs (MOH, 2009). Following scientific evidence of high resistance to mono-therapies in the treatment of Falciparum malaria, and WHO recommendations, Ghana changed its anti-malaria drug policy with the introduction of ACT in 2004 based on efficacy, cost-effectiveness, compliance side effects and key demographic variables. Artesunate-Amondiaquine was introduced as a first line drug for the treatment of uncomplicated malaria. Subsequently, other types of ACT have been introduced, namely, ArtemeterLumefantrine and Dihydroartemesinin/Piperaquine, following initial adverse reactions to Artesunate-Amondiaquine (MOH, 2009). The current interventions include at least two doses of SP/Fansidar during pregnancy.

Coping/adaptation strategies for malaria control include use of insecticide treated nets (ITN), intermittent preventive treatment during pregnancy and environmental cleanliness (Hightower et al., 2010). In the case of Ghana, the prevention strategies include vector control, which is mainly the distributing of Long-Lasting Insecticide Treated Nets (LLIN) across the country. Another prevention strategy used is the Social and Behaviours Change Communication (SBCC). This strategy involves the use of mass media campaigns to advocate and intensify education on test, treat and track; compliance, use and improve provider confidence in RDT, Intermittent preventive treatment in pregnancy (IPTp) and

proper care and use of LLIN. Although there has been a substantial increase in the use of ITNs among pregnant women (3% to 20%) and children under five years (4.0% to 28.0%) between 2003 and 2008, the figures are still low compared to progress made worldwide (GSS, 2009). The burden of malaria in Ghana continues to increase over time and several factors have accounted for this trend (Adams et al., 2004; Baah-Boateng, 2012). Among the factors influencing the increasing burden of malaria include drug resistance, malaria and HIV and AIDS linkages, poor and deteriorating living conditions as well as climate and environmental change and inadequate logistics for intervention and control (Amekudzi et al. 2015). It has been shown that out of the one in five children who had malaria two weeks preceding the GDHS Survey (2008), only 43 percent took malaria drugs. Again, less than fifty percent (48.8%) of Ghana's population in malaria-risk areas use effective malaria prevention and treatment measures (GSS, 2009). In spite of the extensive nature of Ghana's malaria control strategies, in the case of vector control, emphasis is placed on the distribution of ITNs with less attention on the prevention of the breeding of the vector.

To improve malaria treatment by facilitating accessibility to health care delivery, the Government of Ghana introduced the National Health Insurance Scheme (NHIS) in 2003 as a social policy strategy. The scheme provides universal health coverage where all people will obtain full and equal coverage and access to health care needed. The goal of the policy was to ensure all residents in Ghana would join the scheme within five years of implementation (Agyepong et al., 2008). The scheme provides a comprehensive health benefit package to general outpatient and inpatient, normal and assisted maternity care, eye care, diagnostic tests, oral care as well as generic medicines and emergency care, which include malaria (UAHC, 2013). In spite of the objective of the scheme, it has been established that it is not pro-poor as envisaged, as the poor and unemployed are found to be less likely to enrol onto the scheme (Barimah et al., 2013).

2.7 Models for Estimating Climate and Malaria Transmission

Malaria transmission occurs through a complex process including biological, environmental and socio-demographic processes. There has been evolution of models for analysing climate and malaria linkages. Earlier malaria transmission models ranged from complex integrated mathematical and biological to statistical (regression) and empirical models (Martens et al., 1995; Lindsay and Martens, 1998; Hay et al., 2001) as shown in Table 2.2. The different models analyse the different aspects of climate-malaria linkage. While some of the existing models have been criticised for over-emphasizing temperature change without due attention to other ecological factors such as rainfall, humidity and human host exposure, others have been criticised for the assumption that the historical geographic distribution will mimic the present situation, disregarding the influence of socio-demographic factors and interventions (IPCC, AR5).

Table 2.2 Models of climate and malaria linkage

	Type/Name of model	**What it measures**	**Key variables used**	**Author (s)**	**Limitation**
1	Biological HadCM2	Measures extent to which the natural world (the global environment-climate complex) would allow the transmission of malaria without human-imposed constraints -Net increase in potential transmission zone -Regional increases and a few decreases in the seasonal duration of transmission in current and prospective areas	Global climate (emphasis on temperature)	Martens *et al*., 1995, 1997, 1999; Martin and Lefebvre, 1995) (AR5) (IPCC, 2014).	-Global scale -No other human-imposed constraints on transmission.
2	Epidemiological MIASMA v2.0	Uses R_0 to measure new cases of a disease that will arise from one current case when introduced into a non-immune host population during a single transmission cycle	Global temperature and rainfall	Anderson &May, 1992; Martens et al., 1999	-Global scale -Not accounted for actual population effects
3	Statistical (S92a (unmitigated)	The models are mostly data-specific and applicable primarily to the particular data set studied. Useful for	Temperature	(Rogers and Randolph, 2000)	Global scale -Not accounted for

	climate)	prediction in specific contexts, but not scenarios. -Number of people in actual transmission areas - No significant net increase in actual transmission areas			modulating effects
4	CLIMEX	Changes in global and national (Australia) distribution of malaria vectors	Vectors' temperature and moisture requirements	(Bryan *et al.*, 1996 and Sutherst, 1998).	-Global scale - Not accounted for modulating effect
5	Dynamic process-based mathematical	It evaluated the simultaneous effects of rainfall and temperature on mosquito population dynamics, malaria invasion, persistence and local seasonal extinction, and the impact of seasonality on transmission	Temperature and Rainfall	Parham and Michael 2010	National scale Emphasis on mosquito population dynamics
6	Mathematical	Mathematical models address feedback and nonlinear effects that enhance or suppress the effects of factors such as, exposure, immunity, spatiotemporal heterogeneities	Temperature and rainfall	Hoshen et al, 2001; Emert et al.,2011; Aron, 1988	

2.7.1 Biological (or process-based) Models

Biological model, which is used to estimate the potential transmission of malaria, is a measure of the extent to which the natural world (the global environment-climate complex) would allow the transmission of malaria if there were no other human-imposed constraints on transmission. Global level biological models have generally shown increase in potential transmission of malaria and changes in the seasonal transmission under different climate scenarios (Martens et al., 1995, 1999; Martin and Lefebvre, 1995). However, in areas where declines in rainfall are expected to limit survival of mosquitoes, a decline in malaria transmission is predicted. These highly aggregated models do not consider local environmental and ecological circumstances. Nevertheless, they are useful for forecasting the broad direction and potential magnitude of future change. One such model (Martens et al., 1999) is the vector-specific information regarding the temperature-transmission relationship and mosquito distribution limits. The application of a revised version of one of such model

(HadCM2) using a vector specific information regarding temperature transmission relationship and mosquito distribution limits indicated a projected increase of 260-320 million people in potential transmission areas by 2080. The findings presented a two-four percent increase in the number of people at risk with malaria (AR5) (IPCC, 2014).

The flaw of the biological models is over-emphasis on temperature change without due attention to other ecological variables that influence transmission such as humidity, rainfall and host exposure. Generally, public health strategies, environmental conditions as well as other social adaptive responses that modulate current or future malaria risk have not been incorporated into the modelling techniques (Sutherstet al., 1998).

2.7.2 Epidemiological Model

The Epidemiological models of infectious disease use the basic reproduction rate (R0) to measure malaria transmission. The basic reproduction rate measures the number of new cases of a disease that will arise from one current case when introduced into a non-immune host population during a single transmission cycle (Anderson and May, 1992). A related concept, the "vectorial capacity" is determined by interactions of host, vector, pathogen environmental factors, which are sensitive to climatic factors. Mosquito density, feeding frequency and mosquito survival are sensitive to temperature.

2.7.3 Statistical Model

The application of a statistical-empirical model to estimate the number of people living in an actual transmission zone in contrast with potential transmission zone showed a different result (Rogers and Randolph, 2000). The result showed that the proportion of the world's population living in actual malaria transmission zone will remain the same by 2080 under unmitigated climate scenario while in other areas malaria transmission is expected to increase or decline depending on the prevailing climatic conditions. This model is criticized

for a potential bias due to approximating the actual historical geographic distribution before modern health interventions to the present world (IPCC, AR5).

2.7.4 The CLIMEX Model

CLIMEX model is used to estimate the distribution of the mosquito vector based on the vectors' temperature and moisture requirements under a range of climate scenarios at both regional and global levels (Bryanet al., 1996; Sutherst, 1998). The application of this model shows a projected increase in the distribution of the Anopheles gambiae in southern Africa under three climate change scenarios (Hulme, 1996).

2.7.5 The Dynamic Model

A weather-driven dynamic mathematical malaria model is a causal model that allow for the estimation of new malaria infections in the human host. This model is used to determine the impact of weather as well as demographic variables on malaria infections (Smith and McKenzie, 2004; Emert et al., 2011). The advantage of this model is its ability to use meteorological variables from ground-based observation and satellite or modelled weather data as well as climate change scenarios. Based on this, early warning or interventions can be introduced to curtail impacts (Tompkins and Emert, 2013; Asare, 2016; Smith and McKenzie, 2004). Mathematical models of malaria help significantly in understanding the epidemiology of malaria. As a dynamic model, VECTRI provides understanding of the processes linking malaria infection at the individual level to the infection or disease at the population level over time (Smith and McKenzie, 2004).

2.8 Climate Change Scenarios and Malaria Transmission

Scenarios are important in assessing climate change impact, vulnerability and adaptation to provide alternative views of future conditions considered likely to influence a given system or activity. A scenario is coherent internally consistent and plausible description

of a possible future state of the world. Scenarios provide alternative images of how future climate might unfold (IPCC, 2000). With scenarios, it is possible to establish baseline socioeconomic vulnerability, pre-climate change; determine climate change impacts; and assess post-adaptation vulnerability. A distinction is made between climate and non-climatic scenarios. Climate scenarios describe the forcing factor of climate, and non-climatic scenarios provide the socioeconomic and environmental context within which climate forcing operates. Socioeconomic scenarios identify several different topics of assessing climate vulnerability and adaptive capacity (IPCC, 2014). Scenarios, therefore, serve as a useful guide for assessing alternative adaptation strategies for enhanced resilience.

The types of climate scenarios include the following;

(i) Qualitative storylines that describe assumptions about the initial state, the driving forces, events, and actions that lead to future conditions.

(ii) Models that quantify the storyline.

(iii) Outputs that explore possible future outcomes if assumptions are changed.

(iv) Consideration of uncertainties.

Scenarios help to better understand the potential impacts of climate variability and change as well as policy relevant analyses of possible consequences of mitigation. Scenarios also help to facilitate the development and implementation of effective and efficient adaptation strategies, policies, and measures to reduce negative impacts. IPCC sponsored 40 emissions scenarios for GHGs, sulfur dioxide, and other gases - A1, A2, B1 and B2. Six of the scenarios have been used for detailed climate calculations; A1B, A1FI, A1T, A2, B1, and B2. The scenarios are published in a Special Report on Emissions Scenarios (SRES) (IPCC, 2000).

In this chapter, literature on climate and malarial nexus and epidemiology of malaria. It also analysed factors that modulate climate malaria nexus over space and time has been assessed. The existing studies have shown that the influence of climate on health outcomes

including malaria, vary over space and time. The literature also shows that factors affecting malaria transmission/incidence are varied including climatic and socio-demographic factors. However, the interaction of these factors with malaria transmission has largely been examined at larger scales, namely, regional and national levels. It is also evident that few climate-malaria studies have assessed the influence of climate and socio-demographic factors on malaria transmission/incidence at the local level. In fact, one of the key gaps identified by the IPCC fifth assessment report was lack of climate malaria model that incorporates modulating effects and other social adaptive responses. It was evident that socio-demographic factors also contribute to the extent to which populations affected by malaria are able to cope/adapt to it. Thus, accounting for socio-demographic factors besides climatic variables in malaria transmission/incidence at the local level is relevant for identifying key determinants of malaria transmission/incidence for effective malaria control in the era of climate change.

2.9 Theoretical/Conceptual Framework

This study is informed by the Sociological, Epidemiological, the IPCC model, the Haines et al. model and the Dumb Farmer Hypothesis (White, 2002; Rothman 2002; Smith et al., 2014; Haines et al. 2006 and Fussel and Klein, 2012). The Epidemiological theory deals with incidence, distribution, and control of disease in a population. It accounts for the factors that control the presence or absence of a disease. The Sociological theory explains the social cause rather than the biological cause of disease. The theory posits that disease outcome is a result of inequalities that result from uneven distribution of economic, social and political resources necessary for a healthy life. While the IPCC (Smiths et al., 2014) model describes the interaction between climate and health outcomes, moderated by non-climatic factors. The dumb farmer's hypothesis addresses the conscious response by people exposed to climate-related risks (Fussel and Klein, 2012).

The IPCC and Haines et al. conceptual models complement each other in addressing the potential health impacts of climate change. They show the pathways of exposure to climate stressors, translation of exposure to actual health outcomes through moderation effect of local environmental conditions and socio-demographic factors. The framework identifies three exposure pathways, namely, directly (floods), indirectly (disease vector) and pathways mediated by human systems (undernutrition). The expression of change or variability in climate is through local environmental conditions such as baseline weather and geography. The actual effect or consequences of the exposure conditions is regulated by the factors within and outside the system such as socio-demographic status, adaptation and primary health care. There are also mechanisms, positive or negative, which indicate that there may be feedback between societal infrastructure, public health and adaptation measures and climate change itself (Figure 2.1).

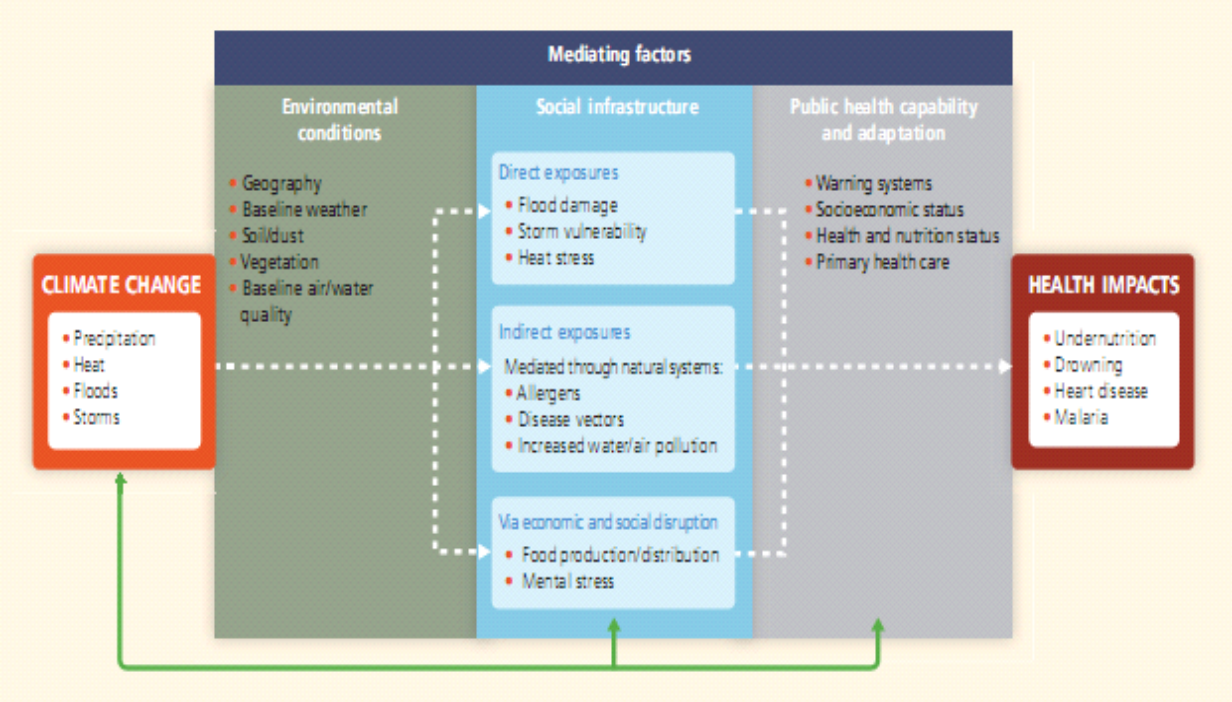


Figure 2.1 Framework showing pathway of climate exposure and health impacts.

Source: Smith et al. 2014.

Similarly, Haines et al.'s model also highlights the pathways linking climatic conditions to outcomes of climate sensitive diseases including malaria. The linkage is modulated by socio-demographic factors including population density and growth as well as adaptation measures as shown in Figure 2.2. A recent study in Ghana presents a detailed explanation to the levels and relevance of the different set of indicators that influence the outcome of climate sensitive diseases. Dovie et al. (2017) study in Ghana found eleven categories of indicators relevant for resilience building for three climate sensitive health conditions including malaria, cerebrospinal meningitis and diarrhoea. Among the 11 categories of indicators identified were demographic, physical, epidemiological, adaptation vulnerability, meteorological and biological. The interaction of these factors occurs at different levels, direct or indirect or both with varying relevance. Of these factors, population structure, population health, wealth status, sanitation, stagnated water, flooding and rainfall, extreme weather and atmospheric temperature were among the factors with very high relevance to building resilience to the climatic health outcomes.

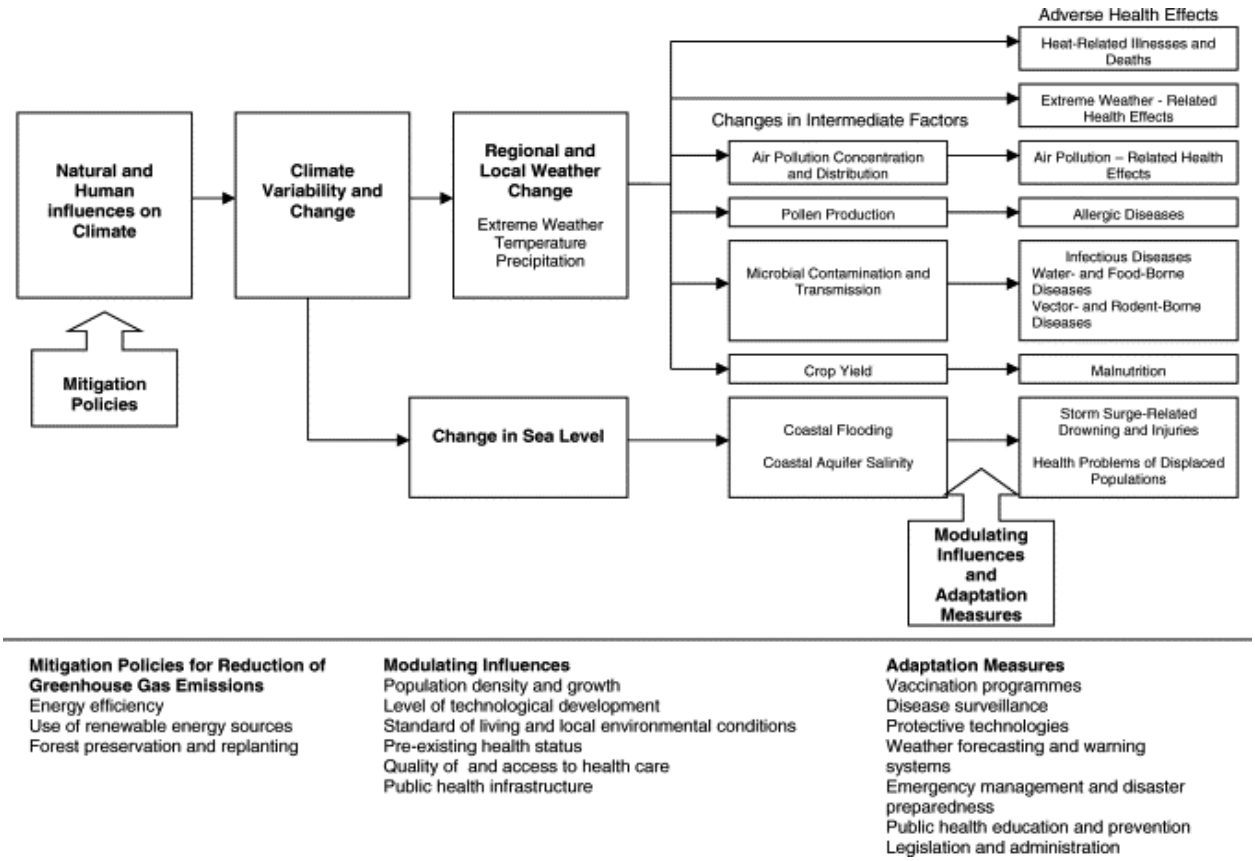


Figure 2.2 Potential health effects of climate variability and change.

Source: Haines et al., 2006

The 'dumb farmer's hypothesis is an assumption t.at an object impacted by a climatic stressor does not anticipate or react to the changing conditions, but will continue to behave or act as though nothing has changed. Fussel and Klein (2012), however, argue that people are not unconscious or unconcerned of the happenings around them, but respond intuitively or adjust in anticipation of a stressor. The responses are, however, varied depending on knowledge, perception, and resources available. They are of the opinion that most people, representing a 'typical farmer' would adjust certain practices in order to cope with the situation while the 'smart farmer' would proactively adapt guided by available information. The third category, the 'clairvoyant farmer' constitutes the farmer who claims perfect knowledge of future climate conditions and face no impediments to the implementation of

adaptation measures (Figure 2.3). This implies that inherent in people exposed to climate risks are also opportunities for coping and adapting.

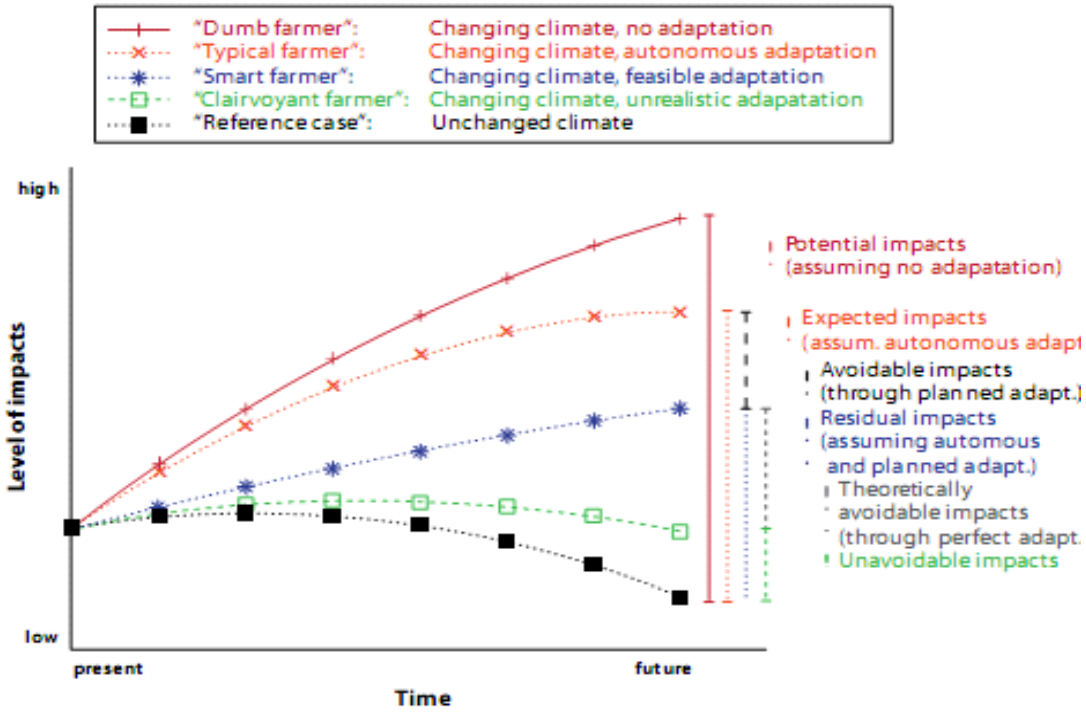


Figure 2.3 The 'Dumb Farmer' Hypothesis.

Source: Fussel and Klein, 2002

Drawing on the explanation of the models above, the framework in Figure 2.4 shows a linkage existing between exposure to climatic stimuli and malaria transmission/incidence, modulated by socio-demographic (adaptive capacity) and coping/adaptation measures. The framework describes the climatic, socio-demographic and other factors that influence malaria transmission in Accra at the macro and micro. This is represented by the boxes in the upper panel of the conceptual framework (Figure 2.4).

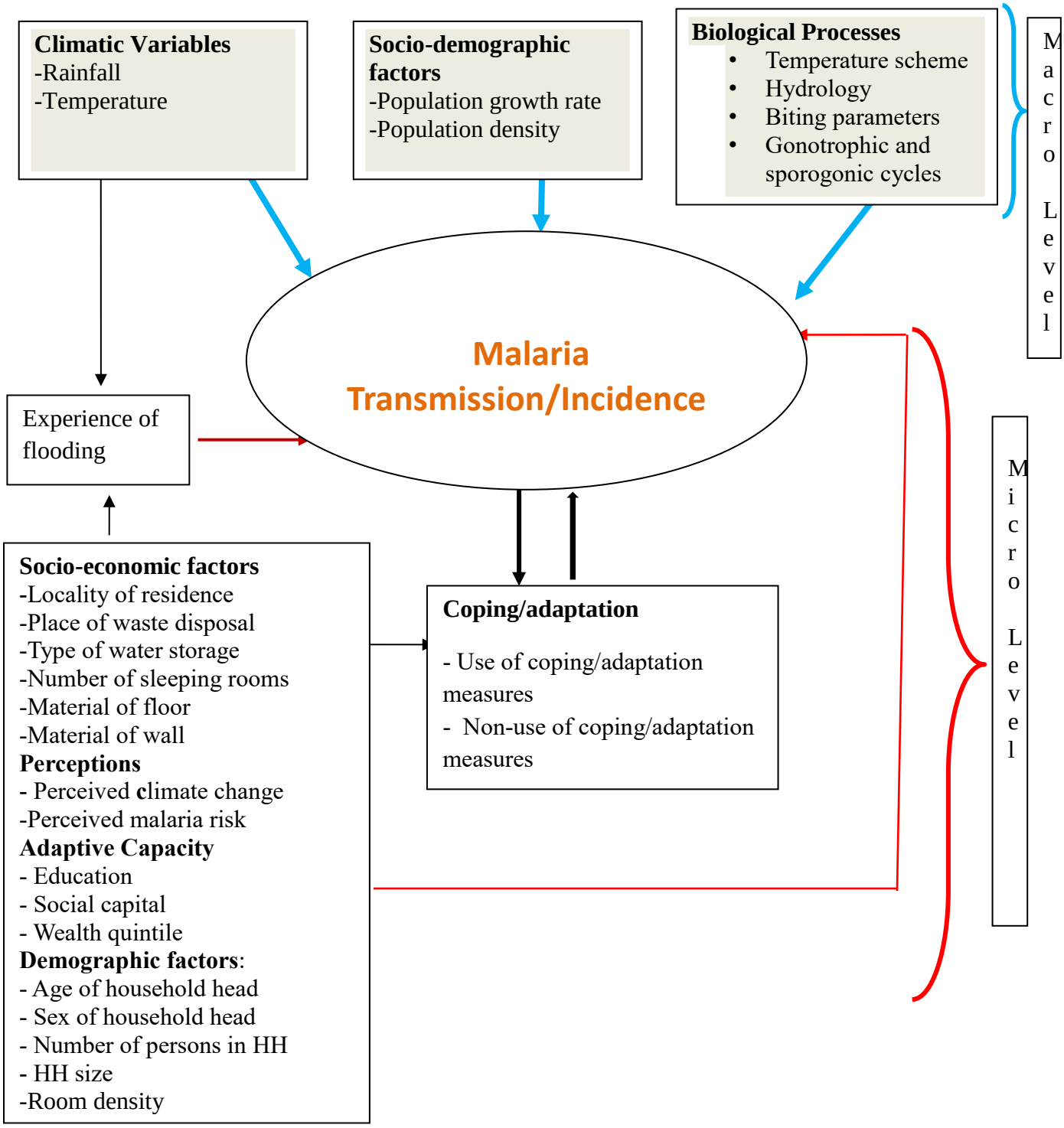


Figure 2.4 Conceptual framework showing climate and modulating influence on malaria transmission/incidence.

Source: Adapted from Smith et al. (2014) framework

At the micro level, flooding constitutes the climatic stimuli households are exposed to. The modulating influences are made of socio-demographic characteristics of households, their adaptive capacity and coping/adaptation measures. These factors could influence malaria incidence directly or operate through coping/adaptation measures to affect malaria incidence. The health outcome is malaria, that is, whether a household had malaria incidence or not in the twelve months preceding the survey.

2.10 Hypotheses

Based on the literature review and conceptual framework, it is hypothesized that;

(i) Malaria transmission models with actual socio-demographic factors are more likely to yield accurate malaria transmission levels in a given location.

(ii) Malaria transmission risk relates inversely with population density.

(iii) There is positive relationship between household experience of flooding and malaria incidence.

(iv) Households with improved socio-demographic indicators are less likely to experience high malaria incidence when exposed to flooding.

(v) Households that used coping/adaptation measures are less likely to have malaria at the household level.

Chapter Three

Study Area and Methodology

3.1 Study Setting Design

The study was conducted in Accra, which lies along the coast of Ghana. the study used quantitative approach in data collection and analyses. Primary and secondary sources of data were used in the study. The first part of the study entailed the use of secondary data in modelling of malaria transmission in Accra while accounting for the demographic influence to assess the current and future level of malaria transmission in Accra. The second part of the study focused on the analyses of primary data on households in Ga-Mashie[1] communities (James Town, Usher Town and Agbogbloshie) in Accra to ascertain the main socio-demographic factors accounting for malaria incidence and how these factors contribute to the extent to which household are likely to experience the large scale transmission in their homes. The choice of these communities provides varied settings for assessing varying socio-economic factors that foster or hinder malaria incidence in among urban poor populations exposed to climate change/variability impacts.

Ghana's coastal zone covers the area below 30-meter contour and represents about two-seven percent of Ghana's land mass. It stretches from the sandy beaches of the west to the rocky beaches of the central coast to the sandy beaches of the east. Like many coastal settlements in Ghana, Ga-Mashie communities are densely populated urban settlements. Fishing and trading are the predominant economic activities in these coastal communities. While the men are engaged in fishing, the women dominate in on-shore post-harvest activities of processing, storing and marketing of fish. Due to the reliance on climate for their livelihood activities (marine fishing and trading), beside health impacts, their vulnerabilities

[1] Ga-Mashie is an enclave of Accra which is the home of the original settlers of Accra

are also tied to the threats on these resources. Analysis of meteorological data in the coastal savannah show an increasing trend in average temperature and decreasing rainfall and increasing variability over the years (EPA, 2009). Although the communities lie within the same climatic zone, (i.e., Coastal Savannah) they vary by exposure and susceptibility to climatic impacts due to differences in socio-demographic characteristics, which consequently influence their adaptation options and capacities. The map of the study area is shown in Figure 3.1.

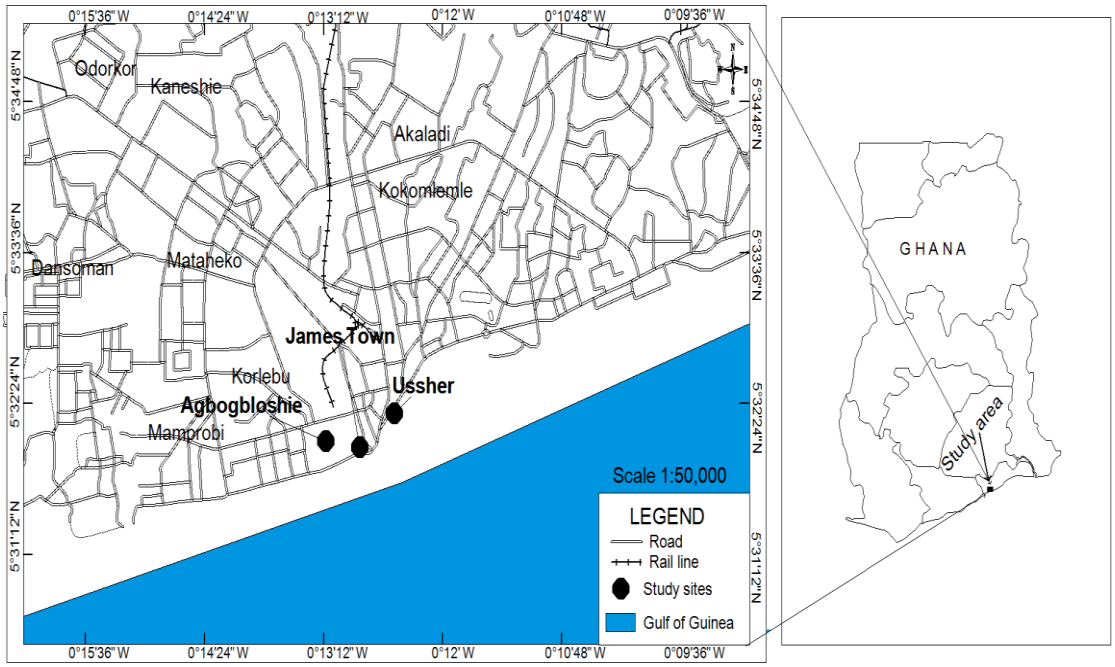


Figure 3.1 Map of Ghana showing the study area

3.2 Climatic Conditions

The rainfall seasons of Ghana are controlled by the movement of the tropical rain belt (also known as the Inter-Tropical Convergence Zone, ITCZ), which oscillates between the northern and southern tropics over the course of a year. The dominant wind direction in regions south of the ITCZ is south-westerly, blowing moist air from the Atlantic onto the continent, but north of the ITCZ, the prevailing winds come from the north east, bringing hot and dusty air from the Sahara Desert (known as the Harmattan). As the ITCZ migrates between its north and south positions over the course of the year, the regions between these

northern and southernmost positions of the ITCZ experience a shift between the two opposing prevailing wind directions. This pattern is referred to as the West African Monsoon (McSweeney et al., n.d.).

The seasonal rainfall in this region varies considerably on inter-annual and inter-decadal timescales, due in part to variations in the movements and intensity of the ITCZ, and variations in timing and intensity of the West African Monsoon. The most well-documented cause of these variations is the El Niño Southern Oscillation (ENSO). El Niño events are associated with drier than average conditions in West Africa (McSweeney et al., nd).

The study area falls within the coastal savannah zone; hence the focus on this climatic zone (EPA, 2008). There are two rainy seasons. The average annual rainfall is about 730mm, which falls primarily during the two rainy seasons. The first begins in May and ends in mid-July. The second season begins in mid-August and ends in October. Rain events are characterised by intensive short storms and gives rise to local flooding where drainage channels are obstructed (Ghana Districts.com, 2011; Amekudzi et al 2015).

3.3 Sources of Data

The study uses both primary and secondary sources of data. While the secondary data were used for estimating malaria transmission at the macro level, the primary data were used for estimating malaria incidence at the micro level. The climate data span from 1970 to 2010. In addition, information on population growth rate and density were based on estimates by the Ghana Statistical Service (GSS, 2013).

Data required for the malaria transmission modelling included current (1970-1984; 1985-2000; 2001-2010) (GSS, 2013) and future (2011-2020, 2021-2030 and 2031-2040) climate (temperature and rainfall) and socio-demographic factors (population density and population growth rate). The estimates for the population variables were derived from national censuses conducted between 1970 and 2010 by the Ghana Statistical Service. With

the use of the Spectrum Software, the baseline population estimates were used to project future population (2020-2040). The population estimates were used to calculate the future population density of Accra. Future temperature and rainfall scenarios were also down-scaled with the Bergen Climate Model Version 2 (AR4-BCM2) scenarios A1B, based on current rainfall and temperature trends. Based on the scenarios generated, transmission of malaria in human population was assessed, under the different scenarios in 2020, 2030 and 2040 with a weather-driven dynamical malaria model.

To assess the socio-demographic factors characterising malaria incidence at the micro level, a cross-sectional representative survey (Urban Health and Poverty Project–(UHPP) Survey-Round 3) was used as shown in Appendix B and C. The variables were selected based on the Sociological and Epidemiological theories of disease as well as the Haines et al. model on the potential health impact of climate change, IPCC's moderating influence between climate and malaria and 'dumb farmer hypothesis' that undergirds this study (White, 2002; Rothman, 2002; Fussel and Klein, 2012).

The household questions covered a wide range of issues including socio-demographic, climate-related issues, health and general environmental and sanitation issues. The survey also collected information on perceptions of climate, observed change in climate over time as well as climate and malaria linkages (based on measures adapted) developed and used to estimate American's knowledge of climate change and its impact (Leiserowitz, 2010). Information on socio-demographic characteristics as well as coping/adaptation measures and factors (e.g. social capital) that facilitate adaptation were also collected. This is based on the view that measures for climate-related health outcomes are derived from activities at the household, community and institutional levels (IPCC, 2001; Few et al. 2003; Cutter 2008; Berkes 2007).

The study was conducted in Ga-Mashie, a study site by the Regional Institute for Population Studies, University of Ghana. The sample for the household survey was drawn from 29 enumeration areas (EAs). The sampled households were proportionate to the population size of each community. In all, 782 households were interviewed. Households were selected for the study based on a simple random sampling method from a household list. In each sampled household, the head of the household was interviewed. In addition, available females between the ages of 15 and 49 years and males between the ages of 15 and 59 years within each household were eligible for individual level interviews. The data collection which involved training of enumerators and administration of research instruments to respondents was done by author together with members of study team and research assistants. The author of this thesis was also actively involved in data management processes such as cleaning and editing. The author was however solely responsible for the analyses of the data generated in this study. The interviews were conducted mainly in two local languages (Ga and Twi) and English.

3.4 Variables in the Study

Two sets of variables were used for the analyses. The first set of variables was used for malaria transmission modelling at the macro level in Accra while the second was used for assessing factors that influence malaria incidence at the household level.

The dependent variable in the household model is malaria incidence. This was measured with the question on the number of times a household had malaria in the past twelve months before the survey. This was categorised into households that had malaria incidence and those that did not. All households that had malaria within the period were categorised as ‘one’ and those without any incidence as ‘zero’.

Exposure to flooding, the independent variable, was used as a proxy measure of households' exposure to extreme climatic events. Rainfall was used because unlike temperature, it has high variability and, therefore, has higher likelihood of modifying malaria incidence within a short period of time. In the survey, the question used to elicit this information was 'during the last rainy season (May-July), did your community experience flooding?' The response was dichotomous, that is, either 'yes' or 'no'.

The intermediate variable used in the study was the use of malaria coping/adaptation measures. To account for the specific measures used, a further question was asked to find out the specific measures used to prevent malaria when it rains. While some households mentioned using a single measure, others used a combination of measures for malaria prevention. The measures were categorized into five which are: (i). Chemicals/coils/mosquito net, (ii). Protective clothing, (iii). Cleaning of environment (iv)., Taking medication, and (v). Staying indoors.

The control variables used in the study included the following categories of factors:

Household demographic and housing characteristic: They include sex of household head, age group of household head, locality name, how water is stored, type of toilet facility used, total number of persons in the household, number of rooms for sleeping, main material of wall and floor and place of solid waste disposal. Age was measured in years as a continuous scale in the survey. It was, however, categorised into three: Young (15-24 years), adult (25-60 years) and elderly (61+) for descriptive purposes. Sex was measured as a categorical variable (male=1, female=2). The localities or communities are Agbogbloshie, James Town and Ussher Town. The type of water storage was re-categorised into uncovered, covered and

sachet while type of toilet facility was re-categorised into no toilet, flush, KVIP[2] and public toilet facilities. Number of sleeping rooms was grouped into one and two or more with the total number of persons in the household grouped into 1-3, 4-6 and 7+. The material used for the outer wall and the floor were re-categorised as: floor (cement/bricks; wood, earth/local material) and wall (wood, bricks/cement, landcrete/natural stones). Solid waste disposal was re-categorised as collected, put in refuse container, indiscriminately disposed-off/ disposed-off into drains. The categories for liquid waste disposal were septic, community drain and indiscriminately.

Perception on climate change and malaria risk: Two indicators were used to ascertain knowledge on climate change and malaria risk. The questions asked were *'have you noticed any change in climate in the past 30 years?* The responses were, 'yes', 'no' and 'don't' know which were re-grouped into 1. Yes and 2. No. The next question asked was on how households perceive their risk to malaria. The response was recoded as No risk, Small risk, Moderate risk and Great risk.

Adaptive capacity: The level of education, wealth quintile and social capital were used as indicators of household adaptive capacity. The level of education of household heads was measured as categorical variable and was re-categorised as no education, primary, JHS/JSS/Middle and SHS/SSS or higher. A Principal Component Analysis (PCA) was applied to household items including ownership of fridge, television, canoe, etc., to generate wealth quintile which was categorised as (poorest=1, poorer=2, poor=3, less poor=4, least poor=5).

Similarly, specific variables were collected that characterized the broader dimensions of social capital (See Box 1). Principal Component Analysis was applied to twelve

[2] Kumasi Ventilated-Improved Pit (Sanitation facility invented in Kumasi)

dimensions of social capital variables to generate three categories of social adaptive capacity, namely, low, average and high social adaptive capacity. In the PCA analysis, correlation matrix was applied and Varimax with Kaiser Normalization was used for rotation method. The analysis (PCA) extracted three components with engen values greater than 1.0. The three factors were extracted and used for estimating adaptive capacity since they accounted for more than 69 percent of the total variance in the dataset as shown in Box 1. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy which is the percentage of the variance explained by the extracted components was 0.79 above the recommended threshold of 0.6. The Bartlett's Test of Sphericity, testing the equivalence of the variances, was statistically significant ($p<0.001$).

Box 1: Indicators of social capital	
I.	How likely are you to ask for help from neighbours if you need it (borrow small amount of money)?
II.	How likely are you to ask for help from neighbours if you need it (medicine or medical)?
III.	How likely are you to ask for help from neighbours if you need it (talk about something)?
IV.	How likely are you to receive help from neighbours if asked (borrow small amount of money)?
V.	How likely are you to receive help from neighbours if asked (medicine or medical care)?
VI.	How likely are you to receive help from neighbours if asked (talk about something worrying you)?
VII.	How likely are you to help a neighbour who need it (borrow small amount of money)?
VIII.	How likely are you to help a neighbour who need it (medicine or medical care)?
IX.	likely are you to help a neighbour who need it (talk about something worrying)?
X.	How likely are you to receive help from friends outside the community (borrow small amount of money)?
XI.	How likely are you to receive help from friends outside the community (medicine or medical care)?
XII.	How likely are you to receive help from friends outside the community (talk about something worrying you)?

3.5 Methods **of Analyses**

The study utilises different analytical techniques in relation to the different objectives of the study. Generally, quantitative analytical tools were employed for the different datasets. In presenting the results, Graphs, Tables and Figures were used.

Estimation of malaria transmission: To achieve the objective of examining demographic influence on current and future malaria transmission in Accra, daily rainfall and temperature data for Accra from the Ghana Meteorological Agency (GMeT) were analyzed. Beside the climate data from GMeT, there was the need to generate future estimates of temperature and rainfall as well as population data for assessment of future malaria transmission.

Climate data: Current climatic parameters, rainfall and temperature, were used as inputs in the Global Climate Models (GCM) to estimate scenarios of climatic conditions based on rates of emissions of greenhouse gases. Climate data from the Global Climate Model (GCM) output of the Fourth Assessment Report, Bergen Climate Model Version 2 (AR4-BCM2) scenarios A1B was down-scaled using statistical down-scaling method described in Gutierrez et al. (2011). The down-scaling portal is able to access Global Climate Models (GCM) output data from 2001 to 2100). However only AR4-BCM2 output for 2011–2040 was used for this report.

This was achieved with the use of Santander MET Group down-scaling portal (Manzanas et al., 2014). This is a dynamic statistical down-scaling portal. Dynamic statistical down-scaling uses dynamic processes in simulating the regional climate patterns from global climate models (GCM). The inputs included global climate information (predictor). The predictand is made up of observed climate data (rainfall and temperature) of Accra from 1970-2010 from GMeT. The simulation generated daily rainfalls and temperatures for a specified period of forty years. This was divided into four decades.

A comprehensive validation over Ghana to assess the quality of Regional Climate Models (RCM) has been reported in Manzanas et al. (2014). The down-scaling portal provides user-friendly homogeneous access to a subset of ENSEMBLES of GCM for both seasonal predictions and climate change projections and RCM outputs, allowing local interpolation or down-scaling to the location of interest and the removal of biases (Gutierrez et al., 2012).

The down-scaling process involved adapting coarse-resolution AR4-BCM2 scenarios A1B provided by the GCM. This was made possible by linking the large-scale outputs of AR4-BCM2 scenarios A1B predictor fields with simultaneous local historical rainfall and temperature (predictants) observations from Ghana Meteorological Agency (GMA) over the study area (Accra). The predictor fields included geo-potential height, horizontal velocity (U and V), and temperature fields all at 850 mb.

Down-scaling relies on the assumption that local climate is a combination of large-scale climatic/atmospheric features (global, hemispheric, continental, regional) and local conditions (topography, water bodies, land surface properties). Representation of the latter is generally beyond the capacity of current GCMs (USAID, 2014). In contrast to the dynamical method, the statistical methods are easy to implement and interpret. They require minimal computing resources, but rely heavily on historical climate observations and the assumption that currently observed relationships will carry into the future (Zorita and von Storch, 1999).

As indicated, while climate data (rainfall and temperature) from the GMeT was used for the baseline estimation of malaria transmission, the future transmission was based on projected climatic conditions. A validation analysis was undertaken to ascertain the robustness and reliability of the projected rainfall and temperature data before they were used. A two-year data (2011-2012) from GMeT was used for rainfall validation and a one-year data (2011) was used for the validation of temperature data.

The result generally shows an agreement between the observed and expected (model) volume of rainfall and number of rainy days (Figure 3.2). A similar observation was made with temperature validation. There was a general agreement between the observed and expected (model) temperature data (Figure 3.3). In few instances where there were variations, the difference was less than 1^0C. Moreover, both the model and projected temperature follow the same seasonal pattern. Hence, projected rainfall and temperature data were found to be reliable and usable.

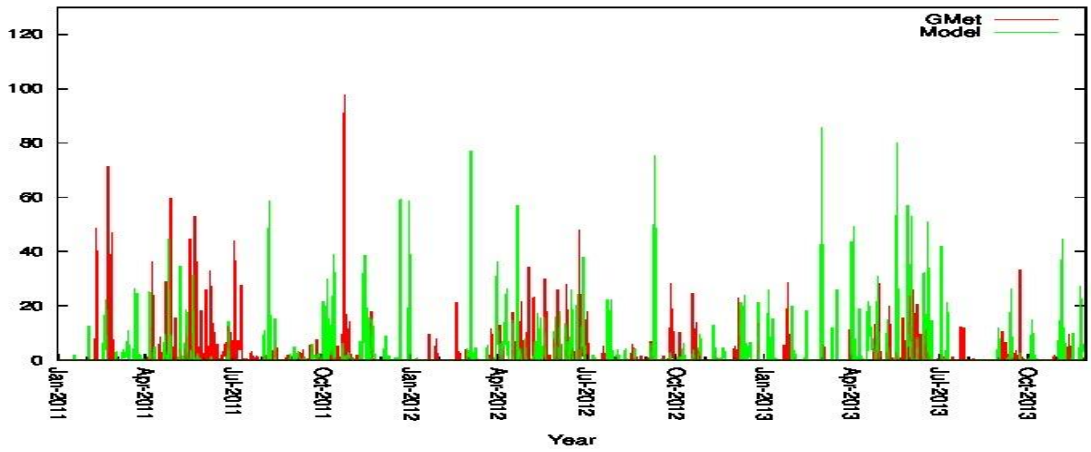


Figure 3.2 Comparison of down-scaling and GMeT rainfall

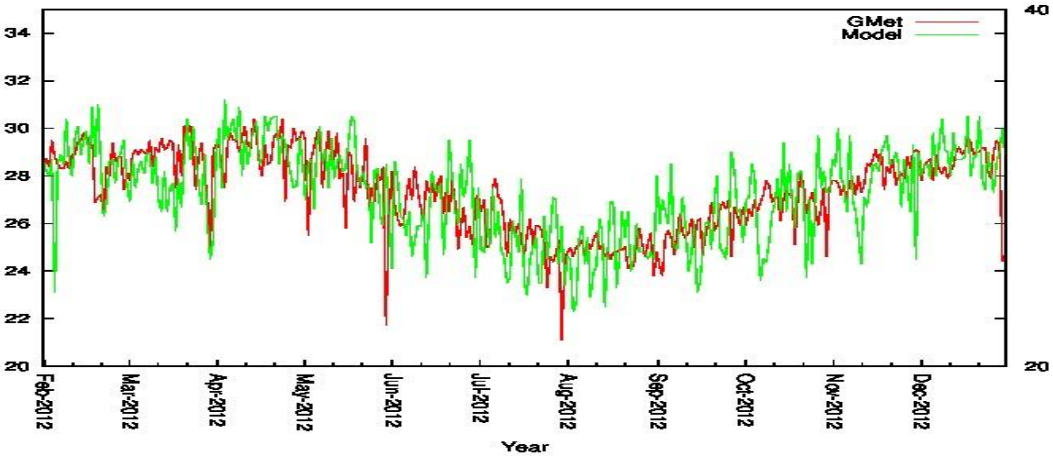


Figure 3.3 Comparison of down-scaled and GMeT temperature

Estimation of Population Growth Rate and Density: The SPECTRUM software was used to estimate the future population from which the population density and growth rate were estimated. The Spectrum projection calculations are based on the standard cohort component projection method which uses the components of demographic change including births, deaths and migration, to project population growth. This method of population projection assumes that the components of demographic change, that is, fertility mortality and migration, will remain the same throughout the projection period. Not-withstanding, it allows vital statistics to be modified and for the purposes of this work, they were modified to reflect the actual demographic experience of Accra. The cohort component method is ideal in instances where age and sex component of the population are needed in a period of five, ten or more years. Projections are made in a five-year interval.

Base year population information including population by age and sex, fertility and mortality and net-migration were used as inputs. With a medium fertility assumption, the fertility Accra will continue to decline and reach a replacement level by 2030. Replacement level fertility is a Total Fertility Rate (TFR) of 2.1 children per woman. Life tables were needed to survive one population group into the next five years. In this regard, the North Model of the Coale-Demeny Model Regional life table was used. The North model assumes low infant mortality, high child mortality and old age mortality beyond age 50. This model has been adopted by the Ghana Statistical Service for the projections in Ghana because it fits the description of mortality experience of Ghana compared. Net migration was held constant throughout the projection period. The sources of this information are the National Population and Housing Censuses and Ghana Demographic and Health Surveys With these inputs the future population for Accra was estimated. The future population growth rate and density were calculated using the future population estimates as shown in Table 3.1 and Appendix A.

Table 3.1 Baseline and projected estimates of population growth and density in Accra

Year	Population	Percentage change in population	Population density of Accra	Population growth rate
Baseline				
1970	851,614	-	278.4	-
1984	1,431,099	40.5	441	3.3
2000	2,905,726	50.7	895.5	4.4
2010	4,010,054	27.5	1,235.6	3.1
Projected				
2020	4,819,966	16.8	1,485.4	1.8
2030	5,454,661	11.6	1,680.9	1.2
2040	5,953,873	8.4	1,834.8	0.9

Source: Author with GSS data, 2013

The baseline as well as the down-scaled climate data and demographic parameters (population density and population growth) were used as inputs in VECTRI to estimate both baseline and future malaria transmissions in Accra.

The VECTRI is a mathematical, weather-driven, regional, high resolution and dynamical malaria model used for malaria transmission. It is a vector-borne disease community model developed by the International Centre for Theoretical Physics, Trieste, Italy (ICTP). The model incorporates population density, population growth rate, surface hydrology and climate data such as temperature and rainfall to study malaria transmission at a reasonably high resolved scale (1 km). It also accounts for the impact of temperature and rainfall variability on the development cycles of the malaria vector in its larval and adult stage, and also of the parasite itself (Tompkins et al., 2013; Caminade et al., 2015). As a dynamic model, VECTRI analyses focus on the estimation of changes in the incidence or prevalence of an infectious disease in a population over time. It explicitly resolves the growth stages of the egg-larvae-pupa cycle as well as the gonotrophic and sporogonic cycles (Tompkins et al., 2013: 2013, Asare, 2016). As a result, VECTRI provides better

understanding of vector-borne diseases and their short-term management and makes projections of their future likely impacts. The various stages and the factors that influence the stages of malaria transmission are accounted for in the model. They include biting, gonotrophic, sporogonic, immunity and population parameters, differential immunity, endemicity, resistance, temperature dependence of mosquito development and hydrology, rainfall and temperature as well as population density and growth rate. With accurate projection, of the climatic parameters, VECTRI provides outputs useful for early warning systems (Tompkins and Ermert, 2013).

Unlike the earlier versions, the current VECTRI model (Version v1.3.1.) incorporates pond geometry and nonlinearities of infiltration and runoff to the hydrology scheme (Asare et al., 2015). Hence, the model accounts for various local hydroclimatic and environmental variables that control mosquito and parasite life cycles.

The VECTRI model was run in segments for different periods of time in keeping with the census-based population growth rate and density generated at different census periods (Baseline -1984, 2000 and 2010). The future estimations were generated for the periods 2011-2020; 2021-2030 and 2031-2040. The outputs were then merged and analyzed.

Malaria transmission model output: VECTRI yields daily estimates of malaria transmission. These were then aggregated into monthly and annual transmissions for annual and seasonal trend and pattern assessment, respectively. Measures used in characterising the rainfall and temperature as well as the transmission indicators included mean, seasonality, variability and anomaly. Mean rainfall measures the average rainfall of an area over a period of time. Seasonality analysis describes the temporal distribution of rainfall on a monthly basis. According to Köppen climate classification, a wet season month for tropical climate is a month where average precipitation is 60 millimetres (2.4 inches) or more (Pidwirney, 2006). Rainfall variability measures the degree to which rainfall amounts vary across an area

(areal variability) or through time (temporal variability). Temporal variability of rainfall can be used to characterize climate of a place and at the same time deduce evidence of climatic change which is determined by the climate anomalies.

Climate anomaly is a diagnostic tool which provides an overview of average climatic conditions compared to a reference value. The term anomaly means a departure from a reference value or long-term average. A positive anomaly indicates that the observed temperature was warmer than the reference value, while a negative anomaly indicates that the observed temperature was cooler than the reference value. The anomaly analysis normalizes climate data so they can be compared more accurately to climatic patterns with respect to what is normal. Thus, it describes climate variability than absolute temperatures do, and provides reference for meaningful comparisons between locations and more accurate calculations of climate trends. Beside the measures above, the VECTRI model yielded daily malaria transmission by various indicators including Entomological Inoculation Rate (EIR) and Human Biting Rate (HBR).

To assess the determinants of malaria incidence in the household, a Principal Component Analysis (PCA) was first done with the various constituents of social capital to build a composite index of social capital as well as ownership of some household items including refrigerator, television, etc., to provide a single indicator for social capital (social adaptive capacity) and wealth quintile (economic adaptive capacity) respectively (Kim et al., 2012; Rayner and Malony 2000; Berkes, 2007; Kim et al., 2009). Several studies have used PCA to compute socioeconomic indices (Lai, 2003; Antony and Rao, 2007; Fukuda, et al., 2007; Fotso and Kuate-defo, 2005; Havard et al., 2008). In contrast with using a simple average index of the three dimensions of human development (longevity, life expectancy and educational attainment), Lai (2003) used a multivariate analysis tool of Principal Component Analysis to find optimal linear combination of indicators. Descriptive analysis was used to

understand household characteristics, housing conditions, climate and malaria risk perceptions and adaptive capacity as well as malaria coping/adaptation measures. With the bivariate analysis, cross-tabulation was used to examine association between household background characteristics and malaria episode on one hand and strategies used for prevention on another hand. The relationship between background (socio-demographic characteristics), and adaptive capacity on one hand and adaptation options on another hand were assessed using regression analysis. With a dichotomous outcome, binary logistic regression analysis was carried out to assess the predictors of malaria episodes and adaptation.

The Unit of measurement is the household which is an individual or group of people living together and bear the direct burden of malaria morbidity, mortality and cost of management.

3.6 Limitations of the Study

Due to the strong non-linear relationship between malaria and rainfall, a model which incorporates surface hydrology is very useful. The current model is an improvement on the earlier model by Tompkins et al. (2013) by accounting for the actual influence of human population in malaria transmission dynamics. However, it is important to note that there are limits to VECTRI's ability to comprehensively explain future changes of malaria distribution. This is partly due to anthropogenic climate change and partly as a result of incorporating limited factors that drive malaria transmission. Other important drivers of malaria transmission such as technological development, immunization, vector and disease control, urbanization and land use change are yet to be included in the model.

In addition, there are limits to VECTRI's ability to comprehensively explain future changes of malaria distribution. However, it provides highly resolved probable spatio-temporal malaria transmission estimates, useful for planning and interventions at the population level.

To overcome this limitation, the projected parameters of the main inputs (climate and demographic factors) were used to assess future changes in malaria transmission. In addition, there are limitations in the model in accounting for other socio-demographic determinants of malaria transmission such as the human immunity at the household level. The inclusion of area-specific parameters helps to account for sub-seasonal variability of climate drivers and more transferable from one location to another.

Another limitation is the use of self-reported status for malaria incidence, which sometimes results in under or over estimation of malaria incidence as against the use of medical reports. However, there is evidence of high correlation between self-reported health status and objective measures of health and, therefore, useful in understanding malaria outcome in the study population (Veenstra, 2000).

This study is part of a project aimed at assessing climate change and health linkages in Accra, particularly in three poor urban communities namely, Agbogbloshie, James Town and Ussher Town. The study communities were therefore used as proxy for poor urban community and not a representation of Accra. It therefore represents a poor urban settlement in Accra. The findings of this thesis are therefore applicable to communities with similar characteristics in coastal areas in Ghana.

Chapter Four

Modeling Malaria Transmission in Accra: Estimation of Current and Future Transmissions

4.1 Description of Climate and Population Trends

Climate variations occur over geographical and temporal scales. Disease transmission is one of the most dramatic and immediate impacts of climate variation, especially vector-borne diseases that affect the poor disproportionately. This chapter describes current (1970 and 2010) and future (2011 and 2040) climate and population patterns and trends. It also assesses the estimation of malaria transmission with VECTRI model at two levels. The first estimation used climatic variables (rainfall and temperature) of Accra with default socio-demographic factors (population growth rate and density). The second estimation used the actual estimated population growth rate and density in Accra. This was to account for the actual socio-demographic effect on malaria transmission in Accra which has been missing from existing malaria transmission estimates. The population growth rate and population density used for baseline estimation were based on past censuses by the Ghana Statistical Service (GSS, 2013). On the other hand, the future population parameters were estimated with the Spectrum programme.

4.1.2 Trends of Baseline Rainfall and Temperature in Accra (1970-2010)

The baseline climate of the study area was assessed using daily rainfall and temperature recorded over four decades (1970-2010). The volume of rainfall over the period shows an increasing trend. The highest annual mean rainfall within the period was recorded in 2008 with a mean value of 1,261.6mm, while the least annual mean rainfall (287.2mm) was recorded in 1977. Rainfall variability ranged between *SD*=-4.2 and *SD*=2.2. While annual rainfall was generally low in the first part of the first decade, the period towards the

end of the last decade saw relatively high amounts of rainfall. The years with rainfall above the minimum threshold (*SD=2* and above) include 1987, 1998, 2006, 2009 and 2010, and the years with below average rainfall (variability within the range *SD=1* to *SD-1*) include 1975, 1976, 1977.

The results show high inter-annual variability of rainfall and temperature in Accra (Figure 4.1). Seasonally, rainfall in Accra showed bimodal pattern. The first peak of rainfall occurred in June and the second peak between September and October. The highest amount of rainfall was recorded in June. Mean temperature in Accra was 27^0C. Seasonally, mean temperature was high between the months of November and April. Mean temperature dropped to its lowest point in August and then rose again towards November.

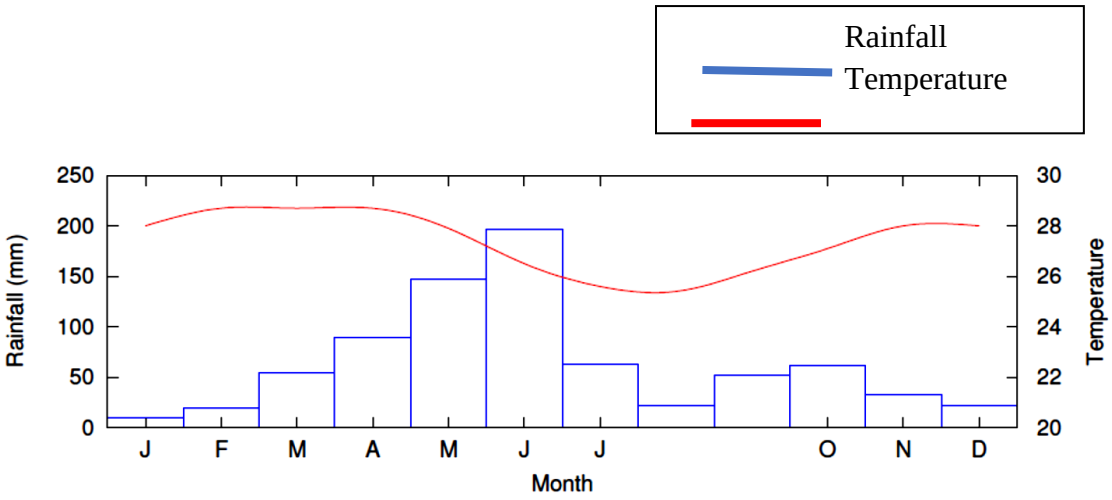


Figure 4.1 Seasonal trends of rainfall and temperature 1970-2010 in Accra

4.1.3 Comparison of Baseline and Projected Rainfall and Temperature

In order to assess the future scenario of malaria transmission, rainfall and temperature were projected. The simulation generated daily rainfall and temperature values for a specified period of forty years. The values were grouped into four decadal periods. Figure 4.2 compares the baseline and future rainfall and temperature trends. Generally, rainfall and temperature showed an increasing future trend. The first panel shows the current and future

rainfall pattern (2011-2040). The years with significant rainfall included 2036 and 2040. Future analysis of temperature showed a rising trend, especially towards the last decade of the projection period (2031-2040). While both baseline and future rainfall variability were similar, the future temperature variability was generally uni-directional compared with the baseline.

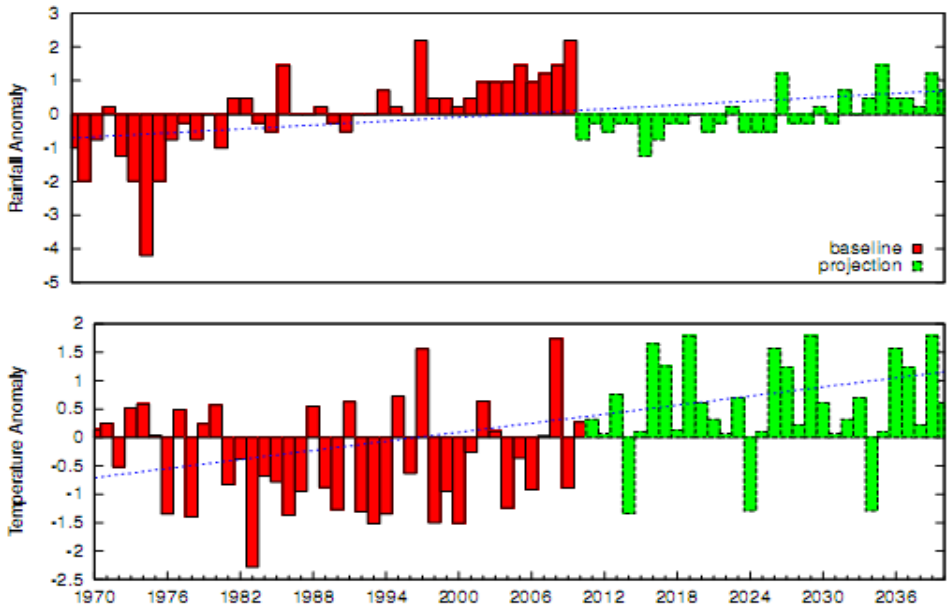


Figure 4.2 Comparison of baseline and projected rainfall and temperature patterns and trends, Accra

The seasonal pattern and trends generally showed some variation of rainfall and temperature (Figure 4.3& Figure 4.4). Unlike the baseline situation, there was a decline in the amount of rainfall in future. In addition, the future pattern showed the disappearance of the bi-modal pattern of rainfall experienced currently. The future rainfall typifies a uni-modal pattern. There was also a shift in major peak of rainfall from June to July and minor peak from October to November. There was also an observed shift in the months with highest amount of rainfall. While rainfall peaks were generally observed in June (major peak) and

October, the future trend shows a shift in major peak from June to July. Although there was a general increase in temperature, a comparison of the seasonal trend showed that future increases in temperature will occur between April and July as well as in December compared to the baseline (November-April). On the other hand, the months between August and November will be less warm in the future.

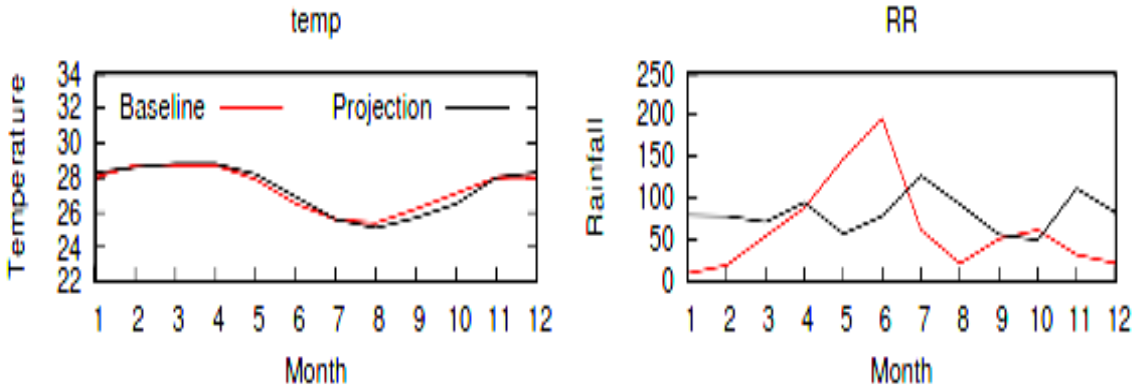


Figure 4.3 Baseline and projected seasonal rainfall and temperature

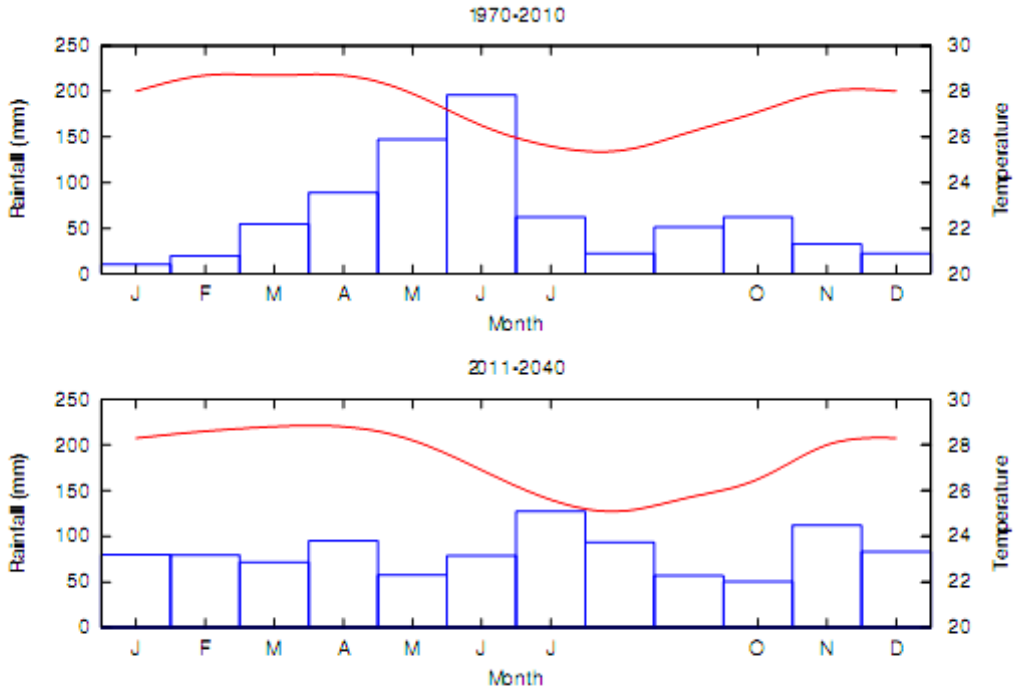


Figure 4.4 Baseline and future seasonal trends of rainfall and temperature, Accra

In summary, there is an indication of rainfall variability in Accra over time, with varying implications for malaria transmission. Projection results showed relatively lower positive rainfall variability compared with temperature. Increasing temperature is an indication of increasing warmer climatic conditions. Warmer conditions can potentially translate to increased malaria transmission in Accra since such conditions promote malaria parasite development. Above average rainfall pattern observed also enhances malaria transmission by providing favourable breeding sites for the development of the malaria parasite and as has been shown that there is pronounced malaria incidence during periods with above-average rainfall (Thomson, 2005). However, if the observed increasing trend continues beyond the temperature range being experienced now, it could be lethal to the mosquito larvae and, therefore, bring down the transmission levels of malaria with all other things being equal.

4.1.4 Trends and Patterns of Population Growth and Density in Accra

Accra recorded a population of 851,614 in 1970 which increased to 4,010,054 in 2010 (GSS, 2013). There was observed downward trend in population growth in the study area (2000-2010, 27.5%; 2010-2020, 16.8%; 2020-2030, 11.6% and 2030-2040, 8.4%). With a land area of 3245 km^2 (1.4% of land area of Ghana), Accra's population density increased from 278.4 in 1970 to 1235.8 in 2010 (Figure 4.5) (GSS, 2013). The projected density for the future is expected to further increase to 1834.8 in 2040. The annual growth rate increased between 1984 and 2000 inter-censal period but declined (4.4% to 3.1%) between 2000 and 2010. Further declines were observed in all the projected decades.

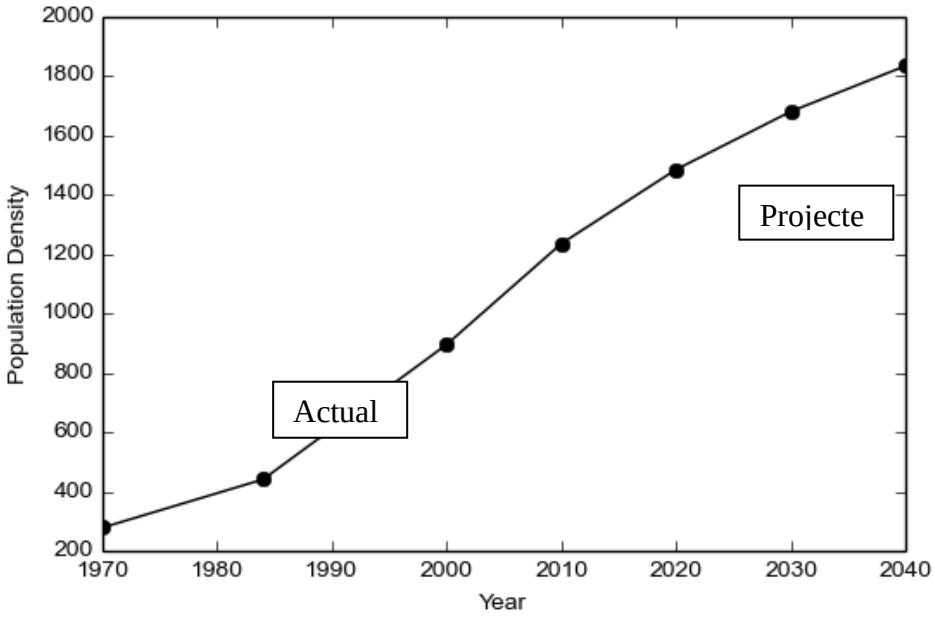


Figure 4.5 Trends in population density (per sq. km in Accra, 1970-2040

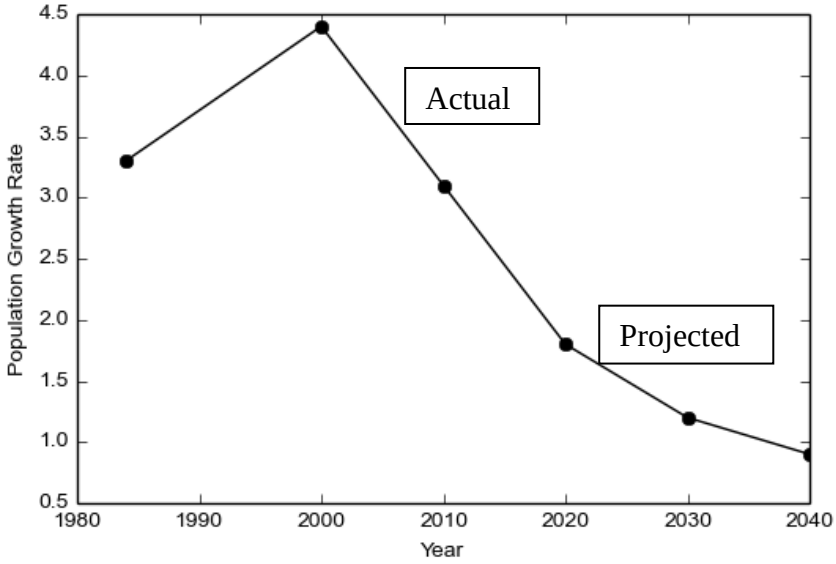


Figure 4.6 Trends in population growth rate in Accra, 1970-2040

4.1.5 Discussion of Trends and Patterns of Climate and Population of Accra

Climatic conditions in Accra show high variability both presently and in the future. While both rainfall and temperature show increasing trend, future observation shows a shift

in the seasonal pattern of rainfall. The rainfall trends are consistent with earlier observations in Ghana and Africa in general (Malhi and James, 2004; Stanturf et al., 2011). Malhi and James (2004) provide evidence that inter-annual rainfall variability is large over most of Africa and in some regions, a substantial multi-decadal variability. In the tropical rain-forest zone, declines in mean annual precipitation of around four percent (West Africa), three percent (North Congo) and two percent (South Congo) for the period 1960 to 1998 were observed. However, 10 percent increase in annual rainfall has been noted along the Guinean Coast in the last 30 years (Nicholson et al., 2000). The variability observed in Ghana is linked to variations in the movement and intensity of the ITCZ as well as variations in the timing and intensity of the West African Monsoon (Stanturf et al., 2011). The most documented cause of these variations on an inter-annual timescale is the El Niño Southern Oscillation (ENSO). The West African Monsoon is influenced either during the developing phase of ENSO or during the decay of some long-lasting La Niña events. In general, El Niño is connected to below normal rainfall in West Africa (Stanturf et al., 2011). The observed climatic conditions, coupled with favourable environmental conditions provide ideal conditions for malaria transmission (Breman, 2001).

Although the annual population growth rate of Accra shows a declining trend, population will continue to grow in the future and consequently intensify the population density. The plausible reason for continuous growth of population in the future in spite of the declining growth rate is the in-built momentum, a situation where a large proportion of the population is in their childbearing ages. Due to this, the number of people added to the population each year will continue to increase and because of this population will continue to grow and only stabilize when the younger group grows beyond their childbearing ages (Espenshade, 2011). A country's population size and distribution have broad range consequences. The changes in a population are mainly through fertility, mortality and

migration levels, which to a large extent, are influenced by the age-sex composition of the migration stream (Knodel, 1999; Espenshade, 2011). The major contributor to Accra's population has been migration; it is one of the major recipients of migrant population from other regions in the country (GSS, 2013). The increasing high population density in Accra presents an extra challenge for the proper management of the dense population in an unplanned settlement with implications on factors that drive malaria transmission, prevention and treatment.

4.2 Current and Future Estimation of Malaria Transmission in Accra

The model outputs for malaria transmission are the Entomological Inoculation Rate (EIR) and Human Biting Rate (HBR). Both annual and seasonal estimates were generated for analyses. The results of the VECTRI malaria transmission model showed varying malaria transmission outcomes.

4.2.1 Human Biting Rate (HBR)

Human biting rate is a measure of average number of mosquito bites, per human, per day (Smith and McKenzie, 2004). The results of the model show a downward trend in HBR. High variations were observed in HBR between 1970 and early 1980 compared with the rest of the years (Figure 4.7).

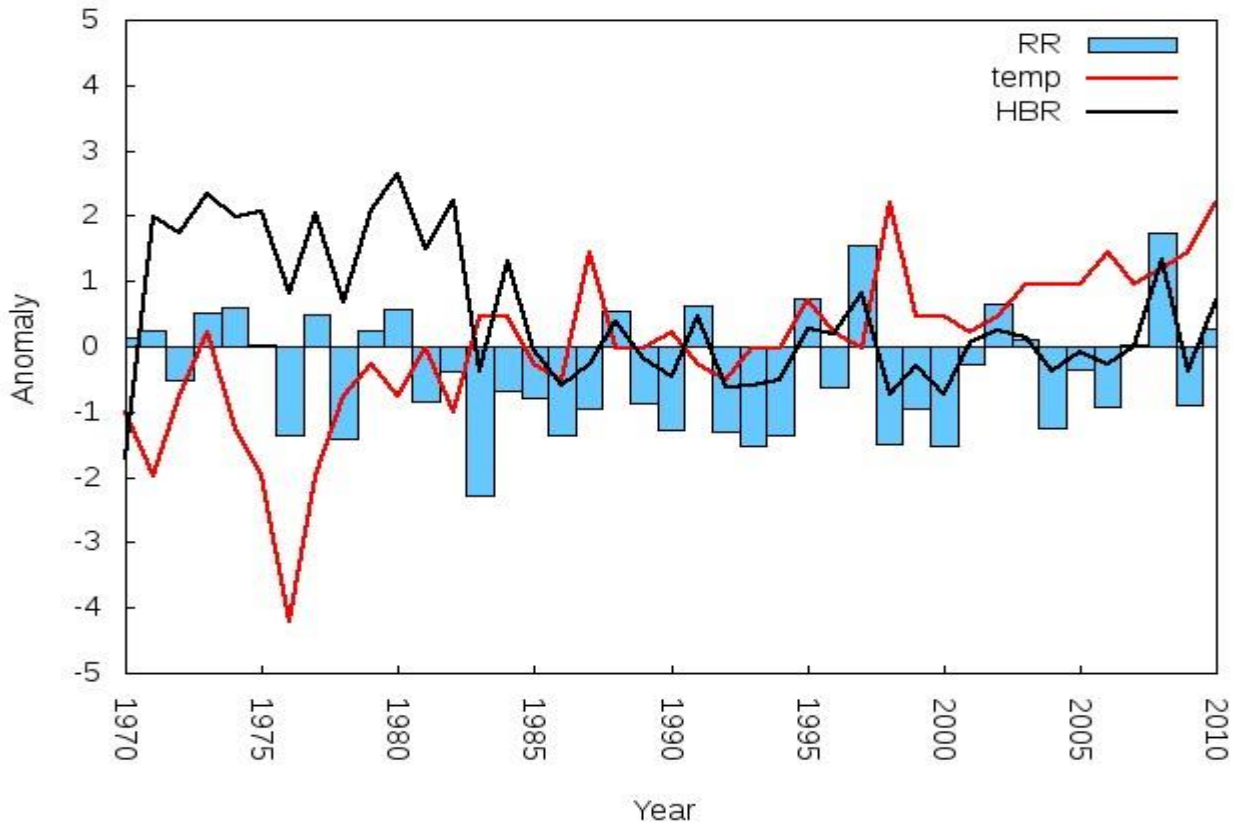


Figure 4.7 Baseline human biting rate (HBR) 1970-2010 in Accra
(RR=rainfall; Temp= temperature; HBR=Human Biting Rate)

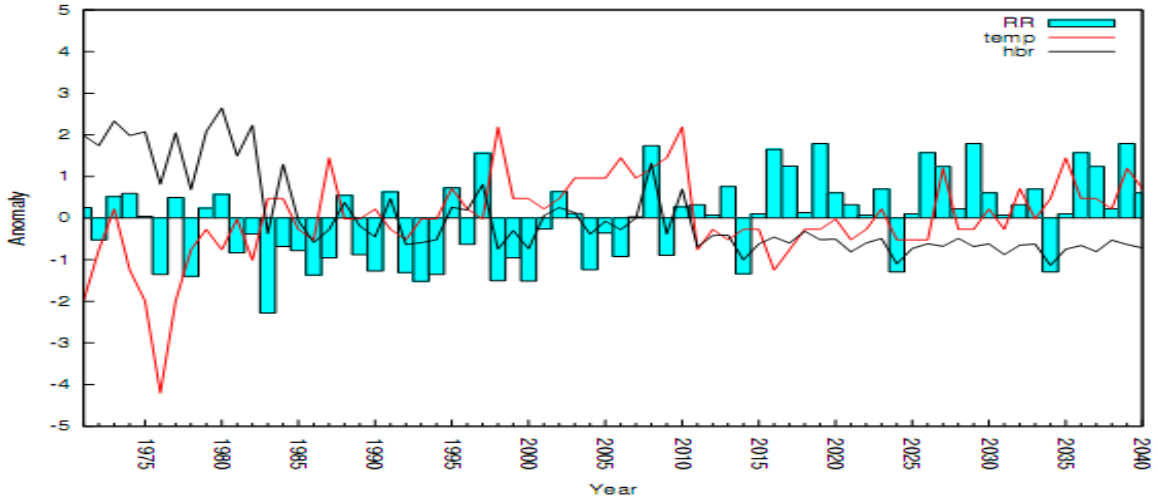


Figure 4.8 Baseline and future human biting rate (1970-2040) in Accra
(RR=rainfall; Temp= temperature; HBR=Human Biting Rate)

The baseline seasonal HBR (red line) shows peaks in June and October (Figure 4.8). This is consistent with earlier observation in trend analysis of malaria transmission explained earlier. In contrast with the baseline HBR, the projected transmission shows peaks in April, July and December. The observed change in HBR was found to be significant (p-value < 0.0001).

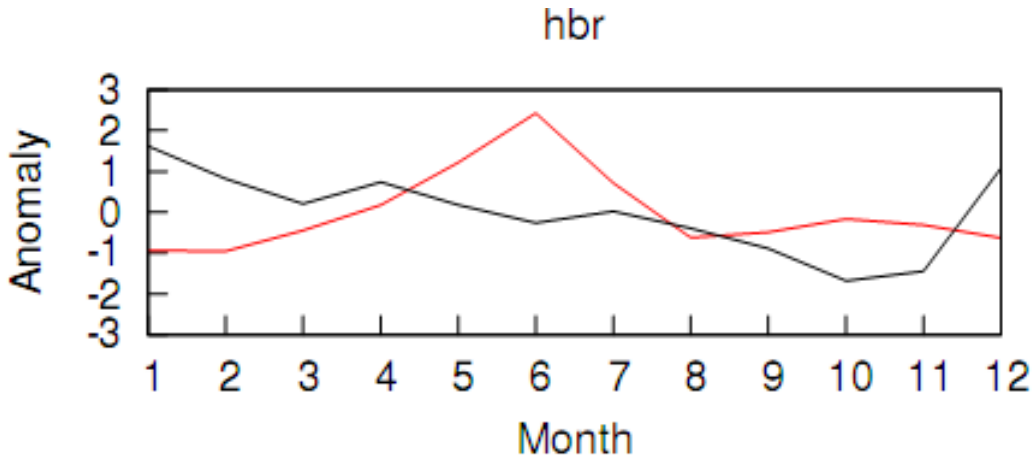


Figure 4.9 Seasonal baseline and future human biting rate (HBR) in Accra

4.2.2 Comparison of Human Biting Rate Estimation with Default and Actual Demographic factors

As in the case of the EIR, HBR estimation with actual population parameters was lower than the estimation with default values. Annual human biting rate dropped from as high as 8500 to as low as 1500 per person (Figure 4.10).

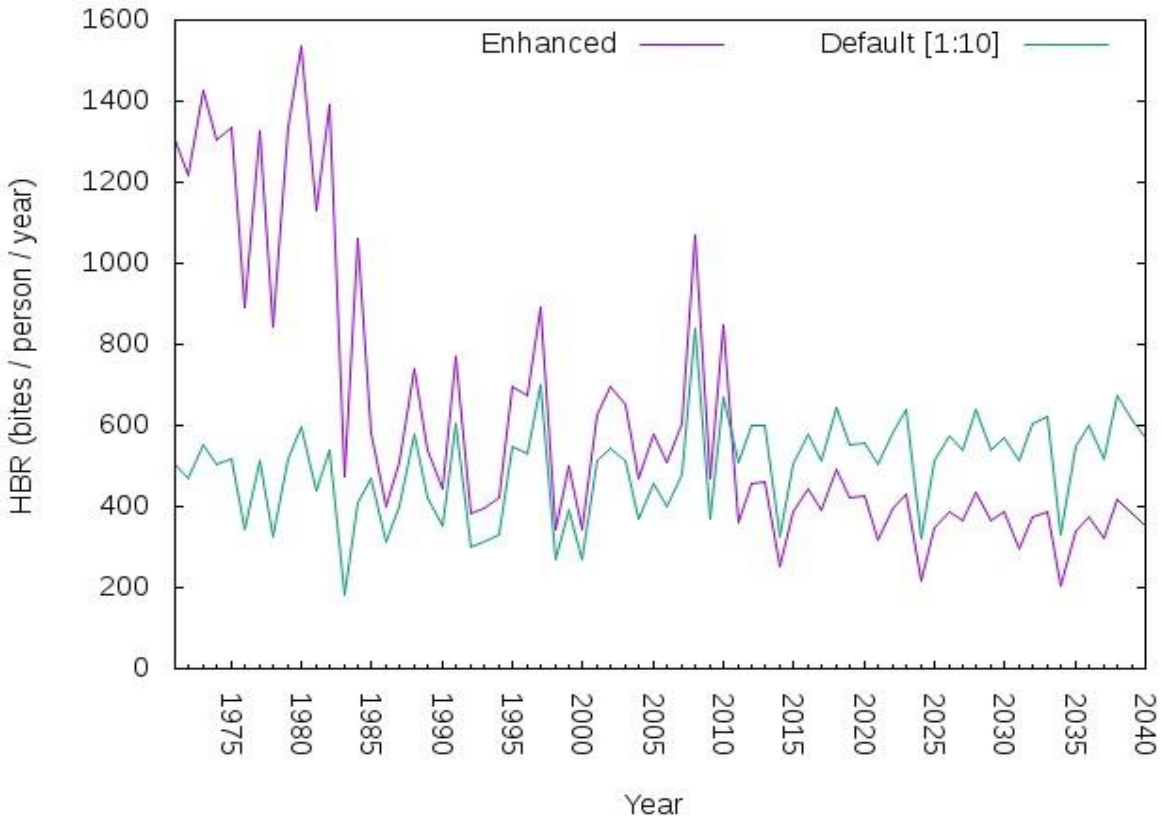


Figure 4.10 Comparison of default and actual annual human biting rate (HBR) in Accra

4.2.3 Entomological Inoculation Rate (EIR)

The actual magnitude or intensity of malaria transmission is measured using the entomological inoculation rate (EIR). The EIR measures the number of infectious bites per person per unit time (usually per year). It is the product of the "human biting rate" – the number of bites per person per day by vector mosquitoes and the "sporozoite rate"- the fraction of vector mosquitoes that are infectious. It is, therefore, the number of infective bites per person per unit time. The EIR is determined by vector density in relation to humans, resulting in the average number of persons bitten by a mosquito in one day (Macintyre et al., 2003). The EIR in Accra generally has an association with temperature and rainfall (Figure 4.11). High variability of EIR was observed in the early part of the baseline period, between 1970 and 1983 compared with the latter part between 1984 and 2010. The highest levels of EIRs were reached in the early part of the first decade (e.g. 1970-1974, 1976) when

temperature variation was at its lowest (SD-4) threshold. Inversely, lower EIRs were recorded when temperature was generally high, an indication of negative association.

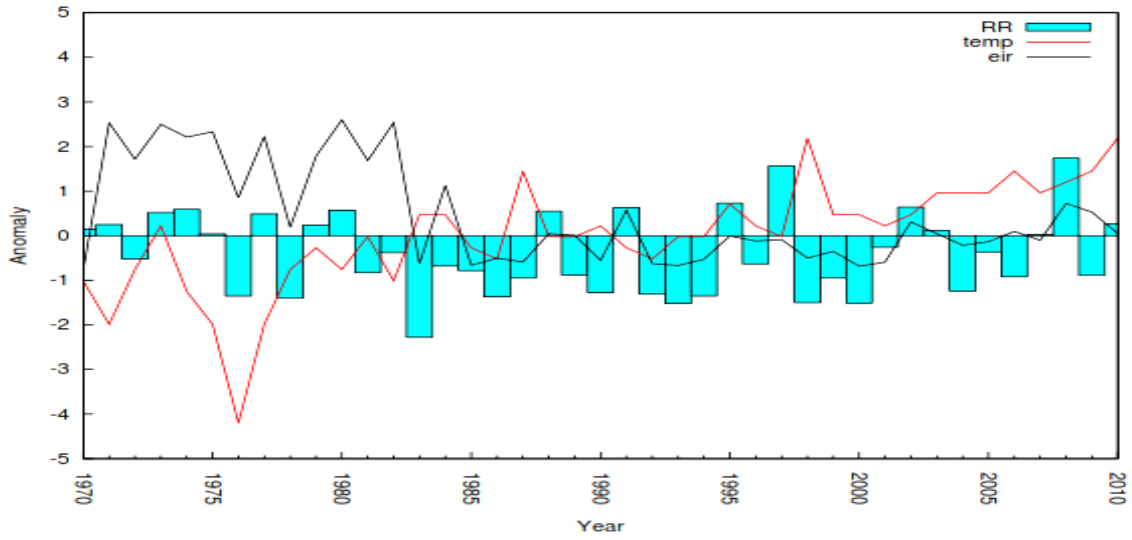


Figure 4.11: Annual baseline pattern and trend of Entomological Inoculation Rate (EIR) with rainfall and temperature (1970-2010) in Accra
(RR=rainfall; Temp= temperature; EIR=Entomological Inoculation Rate)

Rainfall on the other hand, appeared to have positive association with EIR. In the years 1976, 1979, 1983, for example, EIR dropped in response to below average rainfall. Though less variable, a similar observation was made with projected EIR, rainfall and temperature associations (Figure 4.12).

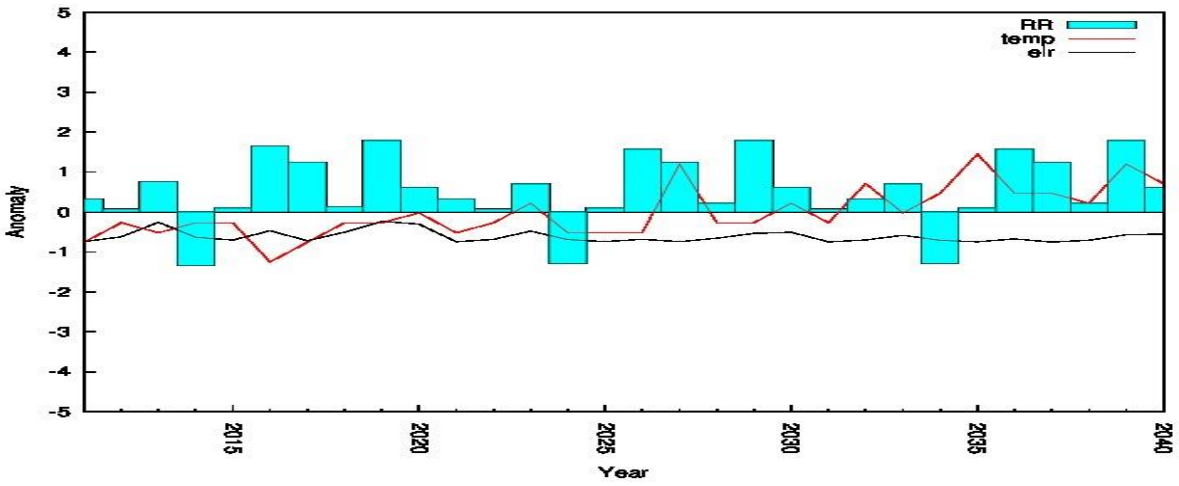


Figure 4.12 Future annual pattern and trend of Entomological Inoculation Rate (EIR) with rainfall and temperature in Accra
(RR=rainfall; Temp= temperature; EIR=Entomological Inoculation Rate).

The projected EIR for the periods 2011-2020, 2021-2030, 2031-2040 as well as 2011-2040 are shown in Figure 4.13. Although a similar seasonal pattern was observed within the periods, the findings showed a general decline over time. Seasonally, the highest EIR generally occurred between months of March and May. The annual EIR range was between 0.24 and 0.70 per thousand population per year in the first decade (2011-2020). However, EIR is expected to drop to as low as 0.1 and 0.22 for 2031 and 2040. With a Z score of -6.4691, the observed change in EIR over time was found to be significant (p-value < 0.0001).

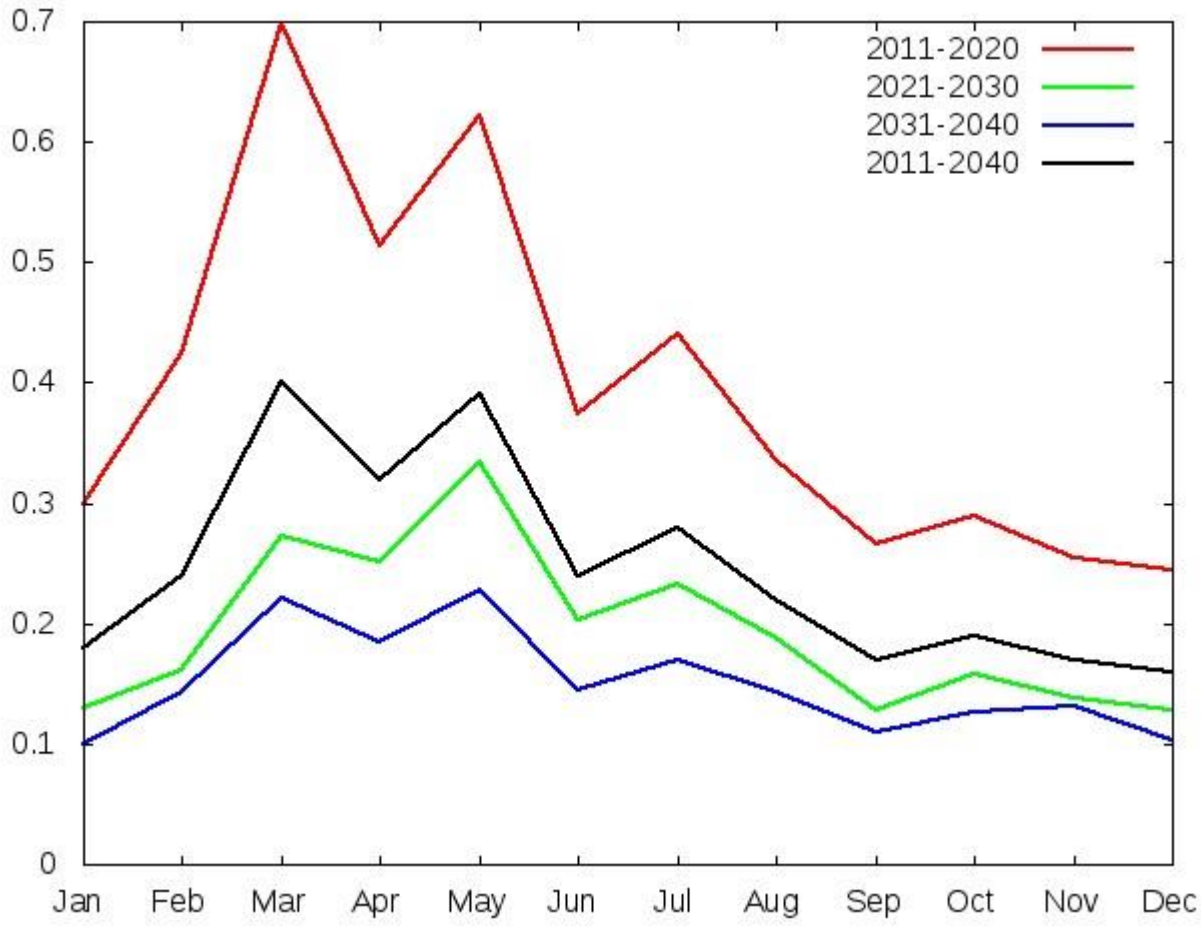
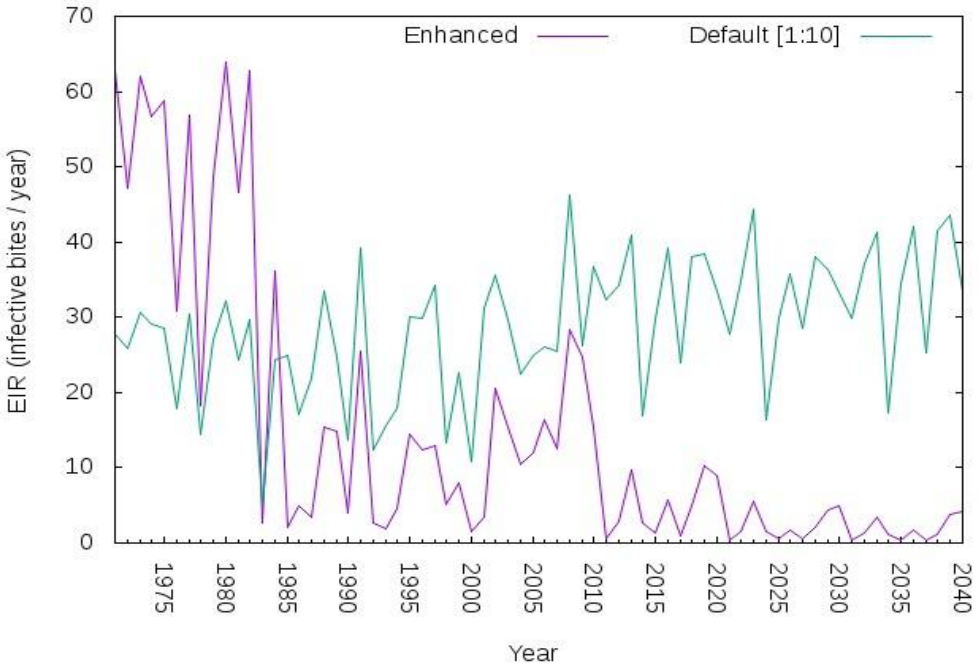


Figure 4.13 Seasonal decadal Entomological Inoculation Rate (EIR) in Accra

4.2.4 Comparison of Malaria Transmission with Default and Actual Socio-demographic Factors

The annual EIR for Accra was found to be generally high with constant population growth rate and density over the period of analysis (baseline and projected). However, when population growth rate and density were replaced with the actual observation in the study area, the EIR dropped significantly (Figure 4.14a). With a default population growth rate and density, annual range of EIR was between 50 and 460 per person. On the other hand, when the population parameters were replaced with actual values, annual EIR dropped to between almost 0 and 65 infective bites per person per year.

a. Annual EIR 1970-2040 in Accra



b. Seasonal EIR 1970-2040 in Accra

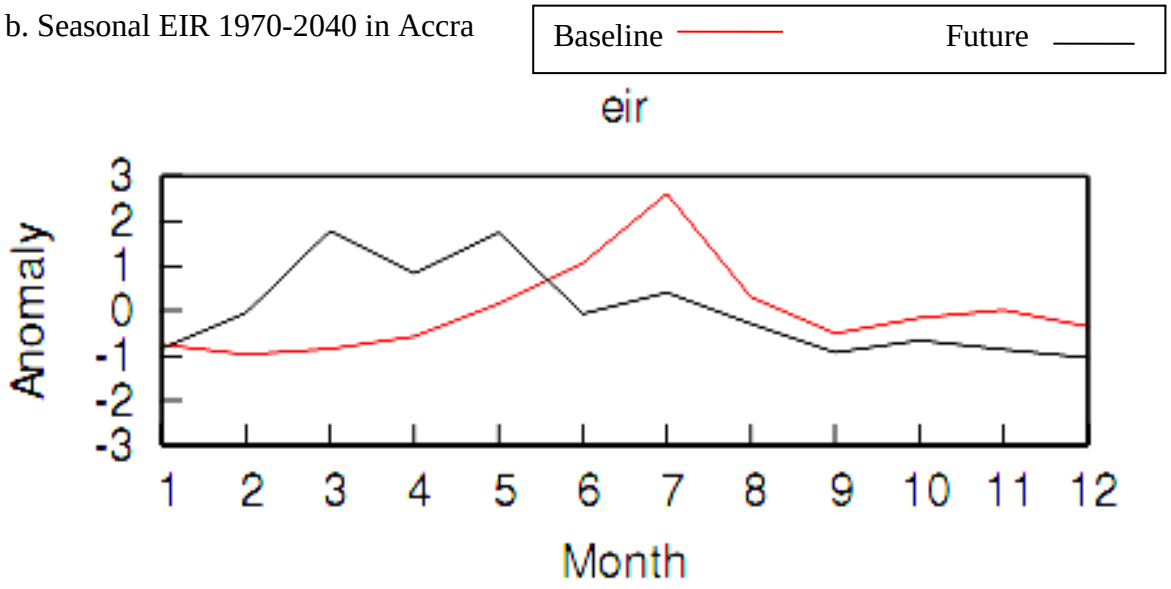


Figure 4.14 (a and b) Comparison of annual and seasonal Entomological Inoculation Rate (EIR) with default and actual population growth rate and density in Accra

Figure 4.14.b shows the seasonal pattern of EIR with default population density and growth rate. While the baseline EIR (black line) has early and double peaks, occuring in

March and July, the future has one peak, ocuring in July. The future EIR, however, has high variability, between -0.8 and 1.5 standard deviation compared with the baseline which ranges between 0 and 0.9 standard deviation.

4.2.5 Discussion

The Entomological Inoculation Rate (EIR) is a useful measure for the understanding of malaria transmission dynamics and helps in determining variation in risk and its consequences on age incidence, prevalence, immunity development, and drug use and drug resistance. It is also useful for informing intervention strategies and impact assessment of prevention programmes (Hay et al. 2008; Killeen et al., 2006; Killeen et al., 2007). Moreover, estimation of malaria transmission allows for the assessment of intra and inter-annual variability, impact of population change as well as climate and land use change (Hay et al., 2000). As an estimate of the level of exposure of an individual to malaria infected mosquitoes, the EIR measures malaria transmission intensity. EIR is considered the most accurate measure for estimating malaria transmission due to a strong correlation between EIR and the prevalence of malaria in a population (Dery et al., 2003).

As was conceptualised, climatic factors alone do not adequately account for malaria transmission, especially the variations across different scales. This finding supports earlier observations on the influence of population on malaria transmission as the Smith et al. (2014) framework hypothesizes. It affirms an inverse relationship between population density and malaria transmission (Tompkins and Emert, 2013). This is explained by the fact that as human population density increases, the mosquito biting rate per human per unit time decreases. The vector and human population interaction become necessary since such interaction contributes significantly to the vector's propensity to transmit malaria (vectorial capacity) (Anderson and May, 1992). It also demonstrates that even in the absence of variations in factors such as surface hydrology, housing conditions, access to health facility

and use of preventive measures, the distribution of human population is important in regulating the transmission intensity, thereby accounting for variations observed in malaria transmission (Tompkins and Emert, 2013).

In accounting for human population, it has been observed that high population densities result in lower parasite ratios (PRs) in urban and peri-urban environments compared with nearby rural locations (Caminade et al., 2015). The finding of this study affirms an earlier observation where transmission rates declined significantly with increasing population density, indicating a substantial influence of population on parasite development (Shaukat et al., 2010). A study showing a comparison of EIRs, climate, elevation and population has shown high rate of EIR in less populated areas (Shaukat et al., 2010; Macintyre et al., 2003). This partly explains why EIR assumes a declining trend with increasing density in the study area. Other studies in several sub-Saharan Africa countries have shown negative relationship between population density and malaria transmission (EIR) especially in urban and peri-urban areas (Hay et al., 2005; Kelly-Hope and McKenzie, 2009; Robert et al., 2003). Although the estimated EIR is comparable with estimates in urban settings, evidence shows considerable variations within cities and different geographical locations (Robert et al., 2003). In terms of location, this finding was found to be consistent with a study finding in southern Ghana with EIR of 3.65 in a coastal community (Prampram), lower than the rates found in a forest community (21.9) (Drakeley et al., 2003). The estimated EIR can be considered lower in comparison with EIR estimates in non-urban settings as evidenced in the results of a meta-analysis of EIR in sub-Saharan Africa where urban estimates of EIR (7.1 in the city centres, 45.8 in peri-urban areas, and 167.7 in rural areas) were found to be lower than in other locations (Kelly-Hope and McKenzie, 2009).

There is, however, a caveat to the relatively lower levels of malaria transmission observed in urban areas since in some settings the reverse is true. With Entomological

Inoculation Rate of 87.9 - infective bites per person per year (EIR), malaria transmission was found to be highest in urban locations in Libreville, Gabon, compared with rural areas with EIR of 13.3. The high level of malaria transmission was associated with slum-like conditions (De Silva and Marshall, 2012). A similar observation was made in Cotonou in Benin where high parasite ratios were recorded among children in urban areas compared with those in the periphery (De Silva and Marshall, 2012). This affirms observation by Yarnal (2007) and Yanda (2005), indicating that sanitation conditions in poor urban communities, especially in slums or informal settlements favour the vectors, pathogens and parasites that cause diseases such as malaria. Urbanization generally has positive effects on malaria transmission by influencing malaria transmission outcomes (Saugeon, 2011). However, Africa's demographically-driven urbanization is occurring without the accompanied socio-economic improvements (Satterthwaite, 2007). Rapid and poorly managed urbanization in Africa, characterised by high accumulation of waste, with poor infrastructural planning, inadequate and poor living conditions, is eroding the health dividend associated with urbanization (Satterthwaite et al., 2009; Ayers, 2011).

In relation to climatic conditions, some studies have observed that EIR is proportional to temperature and rainfall (Paaijmans et al., 2013). Temperature causes heat, which accelerates the sporogonic cycle (parasite multiplication in a mosquito), the time necessary for ingested gametocytes to develop into infectious sporozoites, while rainfall increases available breeding sites. Temperature has a strong influence on parasite extrinsic incubation period (EIP), that is, the period between when vector is infected and becomes infectious (Paaijman et al., 2013). Gonotrophic cycle, that is, the eggs development in vector is also enhanced with warmer temperatures. However, excessive temperatures kill the vector while high water temperature kill larvae. Heavy rainfall can also be lethal to the larvae by washing away the vector (Paaijmans et al., 2007; Tompkins et. al., 2013, Emert et.al., 2011).

There is, however, a threshold of temperature and rainfall that sustains the development of the malaria parasite. As a result, the development of the parasite is threatened beyond extreme temperature and rainfall range. Higher or excessive temperatures increase the mortality rates of adult mosquitoes while intense rain events decrease early-stage larvae through flushing (Pampana, 1969; Macintyre et al., 2003; Caminade et al., 2015). Paaijman et al. (2013) found an inverse relationship between temperature and the EIP such that as temperature increases, EIP declines with potential decline in the EIR. The effects of high temperature result in delays in feeding of mosquitoes, hence decline in transmission.

Seasonal variation in malaria transmission observed in this study is comparable with studies in other settings. This was evident in Ethiopia, where the relationship between climate and confirmed cases of malaria were assessed (Addisu and Belay, 2014). Although the EIR observed in this study is comparable to other studies estimates within Accra earlier findings show variations in Accra as a result of different forms of land use. An investigation of the impact of urban agriculture on malaria transmission risk in urban Accra revealed a higher (19.2) EIR per individual per year in agricultural sites compared with non-agricultural sites (EIR=6.6) (Klinkenberg et al., 2008). This is because the risk of malaria transmission depends on density of mosquito population, their infective status and their interaction with human population (i.e. stinging) (de Vries, 2001; Hoshen and Morse, 2004). In Tanzania, assessment of malaria transmission in an urban setting showed lower malaria transmission compared with rural surroundings (Drakeley et al., 2003). The varying EIR have diverse effects on the affected population in terms of mortality outcome. A study that sought to find out the relationship between mortality and malaria intensity (EIR) showed varying relationships across age. The study generally showed an enormous burden of malaria-driven mortality in the first year of life. While a significant relationship was found between EIR and

under one-year mortality, there was no significant relationship between EIR and mortality among children above one year (Smith et al., 2001).

The annual and seasonal variability of EIR in Accra is similar to earlier observations across Africa, which is largely explained by factors including climate and socio-demographic characteristics. Socio-demographic factors largely predispose populations to favourable environmental conditions suitable for vector development and sustained transmission of malaria (Tanser et al., 2003).

Reducing the transmission of malaria is increasingly seen as an important component of the malaria elimination agenda. However, drugs aimed at reducing human effect do not completely bring it to an end (Churcher et al., 2015). To substantially reduce the prevalence of malaria infection, annual Entomological Inoculation Rate (EIRs) must be reduced to less than one (Shaukat et al., 2010). Although Accra is yet to reach this target, the declining trend of malaria transmission observed provides evidence of Accra being on track in reducing malaria transmission.

The findings, therefore, show that climatic conditions as well as the population of Accra will not remain the same. Beside the variability, rainfall and temperature showed an increasing trend which continues into the future. Temperature, however, shows higher increase compared with rainfall. While the growth rate of human population in Accra is on the decline, population density will continue to increase as a result of increasing population. This study provides an improved measure of malaria transmission (EIR) over earlier estimations by accounting for population growth rate and density. The results show a major influence of human population on malaria transmission. A population adjusted estimate shows a downward trend in malaria transmission. In consistence with the IPCC's non-linearity theory of climate and malaria relationship, the study results clearly demonstrate the

importance of modulating factors in malaria transmission (Smith et al., 2014). This affirms an earlier observation that local environmental conditions, socio-demographic circumstances and a range of institutional, technological and behavioural adaptation taken to reduce threats to health would influence the actual impact of climate change on health (IPCC, 2001; Smith et al., 2014). Again, the study results affirm previous findings indicating that in most malaria-endemic countries, the importance of socio-demographic factors in influencing malaria risk far outweighs environmental factors such as temperature shifts (Yang and Ferreira, 2000).

Chapter Five

Description of Climate and Socio-demographic Determinants of Household Malaria Incidence

5.1 Introduction

In order to validate the observations made at the macro level and examine other socio-demographic factors that modulate climate and malaria linkages, further analyses were carried out using household data from urban coastal communities in Accra. In addition, this micro level analysis assesses the effect of coping/adaptation measures on malaria outcome and factors that facilitate adoption of coping/adaptation strategies.

Malaria risk is highly dependent on the socio-demographic factors of the host population (Béguin et al., 2011; Sachs and Malaney, 2002; WHO, 2014). To explain the underlying socio-demographic factors that modulate households' experience of malaria transmission in order to foster a comprehensive understanding of the present and future transmissions observed at the macro level, household data in three communities in Accra were analysed. As has been noted, range of local environmental conditions, socio-demographic circumstances, institutional, technological and behavioural adaptation taken to reduce malaria threats together influence the actual impact of climate change on malaria outcome, especially for vulnerable populations (IPCC, 2001; Confalonieri et al., 2007).

This chapter provides a detailed description of malaria incidence, household socio-demographic characteristics that predispose and modulate the incidence of malaria in the household. They include experience of flooding, age, education and sex of household (Table 5.1), perceptions (Table 5.2), coping/adaptation measures (Table 5.3) and adaptive capacity (Table 5. 4).

5.2 Household Background Characteristics

In all, 782 household heads responded to the household questions in the survey. Of these, 122 (15.7%) experienced flooding while 654 (84.3%) did not. There were fewer male (49.8%) compared to female (50.2%) household heads. The age of household heads ranged between 15 years and 150 years with a mean age of 45 years. The ages were grouped into three with those aged 15-24 as youth, 25 to 60 as adults and 61 and above as elderly in line with the United Nations categorization. The adult age group constituted the largest group (78.4%) with the 15-24 (6.4%) as the least. The respondents were unevenly distributed across the three localities where the data were collected. Ussher Town had most of the respondents (58.4%) followed by James Town (27.9%) and Agbogbloshie (13.7%) as shown in Table 5.1.

Household size mainly ranged between one to 25 with one to three members being the highest proportion (39.0%) and the least category being seven and above member households (22.8%). The number of sleeping rooms per household was mainly one room (77.8%) while 22.2% had two or more rooms for sleeping. Room density ranged between 0.5 to 15 persons per room. While fewer (29.4%) households had a density up to two persons per room, higher proportion (36.9%) had between 4.5 and 15 room density. Toilet facility used in the household included flush, KVIPs and public toilet. There were also households that had no toilet facilities. The toilet facilities were grouped as flush (8.4%), KVIP and Pit (11.9%), public toilet (77.7%) and those without toilet facility (2.1%) with the highest proportion of households using public toilet. The material used to construct the household wall was mainly burnt bricks and cement (72.8%). The other materials used for wall were wood (18.7%) and stones and landcrete (7.2%).

Table 5.1 Percentage distribution of household background characteristics

Household characteristics		Number	percentage (%)
Experience of flooding	Yes	122	15.7
	No	654	84.3
	Total	776	100
Locality name	Agbogbloshie	107	13.7
	James town	218	27.9
	Ussher town	457	58.4
	Total	782	100.0
Sex	Male	388	49.8
	Female	391	50.2
	Total	779	100.0
Total persons in household	1to3	304	39.0
	4to6	297	38.1
	7+	178	22.8
	Total	779	100.0
Age group	15-24	50	6.4
	25-60	611	78.4
	61+	118	15.1
	Total	779	100.0
Sleeping rooms	One	608	77.8
	Two+	173	22.2
	Total	781	100.0
Room density	Low (upto2)	229	29.4
	Medium (2.5to4)	262	33.7
	High (4.5to15)	287	36.9
	Total	778	100.0
Type of water storage	Covered	335	56.7
	Uncovered	59	10.0
	Sachet	197	33.3
	Total	591	100.0
Toilet facility	No facility	16	2.1
	Flush	65	8.4
	KVIP	92	11.9
	Public	603	77.7
	Total	776	100.0

Table 5.1-Continuation

Material for Floor	Cement/bricks	705	90.9
	Wood	59	7.6
	Earth/local materials	12	1.5
	Total	776	100.0
Material for Wall	Wood	145	18.7
	Burnt bricks/cement	566	72.8
	Natural-stones/landcrete	56	7.2
	Metal sheets	10	1.3
	Total	777	100.0
Disposal of solid waste	Collected	613	78.5
	Refuse container	118	15.1
	Indiscriminately	50	6. 4
	Total	781	100.0
Disposal of liquid waste	Septic	13	1.7
	Community drain	648	83.2
	Indiscriminately	118	15.1
	Total	779	100.0

Source: author with UHPP data, 2013

The floors of structures were mainly cement and bricks (90.9%). Other materials used for the floor were wood (7.6%), earth and local materials (1.5%). Water storage was found to be common in the study communities. Higher proportion (75.6%) of households had water stored for later use. Among those who stored water, 56.7 percent stored it in covered receptacles while 10 percent stored in receptacles without a lid. In addition, 33.3 percent of households stored sachet water, that is, water already packaged in plastic sheets (Table 5.1). Household solid waste was disposed of mainly by collection (78.5%) with a few (6.4%) disposing waste indiscriminately.

5.3 Climate Change, Malaria Risk and Adaptive Capacity Perceptions

Awareness of changing climatic conditions has potential influence on behaviour of households in managing the health risks associated with climatic conditions. Climate change awareness was high in the study communities (Table 5.2). More than half (52.6%) of household heads perceived that climate is changing. Of these 34.6 percent were extremely sure and 50.1 percent were just sure that climate is changing compared to a few who did not

perceive changes in climatic conditions. Knowledge of the effects of climate change on malaria was found to be high as a higher (52.6%) proportion of household heads perceived that climate change is taking place while fewer of them did not know. With the exception of 7.5 percent of the households, most households perceived that they had some level of risk to malaria. Of these, 44.1 percent indicated that they had small risk, 40.1 percent had moderate risk and 8.4 percent had great risk.

Table 5.2 Percentage distribution of climate, risk and prevention/treatment perceptions

Perceptions		Number	percentage %
Observed Climate change	Change	405	52.6
	No change	365	47. 4
	Total	782	100.0
Household Risk of malaria	No risk	58	7.5
	Small	341	44.0
	Moderate	311	40.1
	Great	65	8. 4
	Total	775	100.0

Source: by author with UHPP data, 2013

5.4 Adaptive Capacity of Household

In terms of wealth status as an attribute of adaptive capacity, poor households were in the highest quintile (22.1%), followed by the poorest (20.3%), while the less poor were found in the least quintile (17.9%). With education, few of the respondents (4.1%) had no education. Of those who had some education, a higher proportion of them (46.7%) had JHS/Middle School level education, followed by SHS/SSS and Higher level of education (27.5%). Social capital was almost evenly distributed across the three categories (Low, 33.3%; Average, 33%; High, 33.3%) (Table 5.3).

Table 5.3 Percentage distribution of household adaptive capacity

HH adaptive capacity	Number	percentage
Wealth Status		
Poorest	159	20.3
Poorer	154	19.7
Poor	173	22.1
Less poor	140	17.9
Least Poor	156	19.9
Total	782	100.0
Level of education of HH Head)		
No Education	28	4.1
Primary	148	21.7
JHS/Middle	319	46.7
SSS/SHS and Higher	188	27.5
Total	683	100
Social capital		
Low capacity	225	33.3
Average capacity	226	33.4
High capacity	225	33.3
Total	676	100.0

Source: Author with UHPP data, 2013

5.5 Coping/Adaptation Measures used by Households

Table 5.4 shows that measures used to control malaria incidence varied from barrier methods, vector control and reactive methods. Most households (69.4%) were found not using any coping/adaptation measure against getting malaria compared with 30.6% that used some form of preventive measure. Among those that used some coping/adaptation measures, greater proportion (45.6%) used barrier and vector control methods such as mosquito net and coil and insecticide spray. Other methods used were cleaning of the environment (32.2%), protective clothing (3.9%), medication (4.3%) and combination of two or more measures (23.0%).

Table 5.4 Percentage distribution of coping/adaptation strategies

Coping/adaptation measure used	Number	percentage
Non-use coping/adaptation	543	69.4
Use of coping/adaptation	239	30.6
Total	782	100.0
Type of coping/adaptation measures		
Chemicals/netting)	149	64.8
Use protective clothing	9	3.9
Clean environment	74	32.2
Take medication/treatment	10	4.3
Staying indoors	5	2.2
Total	230	100.0

Source: Author with UHPP data, 2013

5.6 Discussion

The distribution of study participants in the three communities was proportionate to the population size, with high Ussher Town having the largest population, followed by James Town and Agbogbloshie. Sex composition in the study communities is comparable to the national composition with more than half being females (GSS, 2013). It has been indicated that sex composition of household heads is an important factor that impacts on household welfare. The household head is usually primarily responsible for meeting household needs and wellbeing. The household head is, therefore, considered key in analyzing issues at the micro level. The sex of household heads and other household characteristics are, therefore, analyzed to foster understanding of the dynamics and the wellbeing of households. In view of the fact that females are less likely to have less education and generally economically disadvantaged, they are expected to have less capacity to respond to the health needs of their households compared with male-headed households. The average household (4.9) size in the

study communities is larger than the average household size (3.5) in Ghana (GSS, 2015). The average sleeping room density is also high (3.9) given the average sleeping room of 1.3 per household. Larger households reflect higher dependency which may have negative consequences on health and well-being.

Storing water for later use is becoming common especially in settlements where water supply is irregular (GSS, 2015). Beside rainwater, pools and puddles, the mosquito vector readily exploits open water storage containers as larval habitats (Ayele et al., 2012). Depending on how water is stored, it can serve as a breeding site for the mosquito vector, resulting in increasing vector population. Whereas some households cover storage receptacles, some do not, hence enhance the multiplication of mosquitoes.

Public awareness and knowledge of climate change and health risks is important for the adaptation as shown by some studies (Bord et al., 2000; Lorenzoni and O'Connor, 2005). Surveys from the United States, Canada and Malta that assessed public understanding of the links between climate change and human health found that less than half of American respondents believed that they were at risk from climate impacts. Conversely, respondents who were concerned were found to be higher in Canada and Malta (Maibach et al., 2015; Akerlof et al., 2010).

In spite of the relationship between educational attainment and health outcomes, there have been debates in demography about this linkage (Baker et al., 2011). This is largely because a number of epidemiological researches have reported extensive negative associations between education and health after statistically controlling for indicators of socioeconomic status (Mackenbach et al., 2008). However, educational attainment remains one of the core strategies of the UN's development programmes and large development funds continue to target universal access to formal schooling. With education, the United Nations

expects that more people will learn and know, survive and live longer, be able to combat diseases and mothers will be healthier (UNESCO, 2016).

By extension, the high proportion of household heads with education is a good indicator for malaria and awareness and its prevention. It is also likely to facilitate better attitude towards malaria prevention and treatment. In the case of education and malaria incidence in particular, education has also been found as a significant factor that influences the incidence of malaria (Mensah et al., 2004). It has for example been shown that education allows an individual to have access to better economic opportunities, earn a good salary which can possibly influence the person's living conditions, including the residential location and consequently reduce the level of exposure to the malaria vector.

Chapter SIX

Household Socio-demographic Characteristics and Malaria Incidence – A Correlation Analysis

6.1 Introduction

In order to understand the relationship between malaria incidence and influencing factors, an initial assessment of the association between these factors was done. The chapter, therefore, focuses on the association between household background characteristics and incidence of malaria in the study area as shown in Table 6.1. The factors that influence malaria incidence at the household level were grouped into four, namely, household characteristics, perceptions of climate change, coping/adaptation measures and adaptive capacity. Other studies have shown diverse relationships between malaria and socio-economic and geographic factors. These factors include gender, age, family size, economic status and the region where the respondents lived (Somi et al., 2007; Ayele et al., 2012).

6.2 Household Background Characteristics and Malaria Incidence

Generally, malaria incidence was high in the study communities, with 67 percent of households having at least an episode of malaria in the past twelve months. Household background characteristics that were significantly associated with malaria include locality of residence, type of toilet facility used, material of wall and place of solid waste disposal.

The association between locality of residence and malaria was significant ($p< 0.007$). Most Households in Agbogbloshie (76.4%) had malaria in the year before the survey compared with James Town (71.7%) and Ussher Town (62.8%). A similar association was made in a study in two locations in Accra. A cross-sectional study in two urban communities in Accra (Airport West and Kaneshie) found differentials in malaria transmission largely due to location (Brenyah, et al., 2013). Location plays a significant role in the distribution of

malaria parasite and transmission levels evidenced by earlier studies (De Silva and Marshall, 2012; Yarnal, 2007; Yanda, 2005). This affirms a study finding in a village in Ethiopia that assessed the monthly distribution of mosquito densities over a period of one year. A spatial analysis indicated clustering of mosquitoes in different parts of the study area (Ribeiro et al., 1996).

James Town and Ussher Town are drained by the Korle Lagoon. Houses are built close to each other with little or no ventilation and hardly any space left for holding events as well as recreational activities. Some people sleep outside the rooms at night due to congestion in the rooms and when the weather is warm and this is a common practice in James Town and Ussher Town. Most household chores are performed outside the dwellings right by the road side. Most of the trading activities are also undertaken in front of dwellings in the open street at night. Due to its location, Agbogbloshie serves as a safe haven for population from one of the largest informal settlements in the city of Accra. Over the years, the market activities have permeated into the community and continuous movement of people into the community has led to congestion and poor sanitation conditions. Most of the dwelling units in the Agbogbloshie community are made of wood with few block houses. Unlike James Town and Ussher Town, Agbogbloshie has no proper drainage system. The lanes in between dwelling structures are usually blocked with human activities such as cooking and commercial activities, impeding both human and vehicular movements.

Poor sanitation conditions are linked to transmission of diseases such as malaria (WHO, 2016). The association between type of toilet facility and malaria incidence was statistically significant at $p<0.015$. Households that had no toilet facility had highest proportion of malaria incidence (87.5%). About 77.0 percent of households that use flush

toilet facility had malaria compared with those that use KVIP facility (75.3%) and public facility (66.7%).

Higher proportion (78.2%) of households with wooden walls had malaria followed by those who had cement/burnt bricks (65.5%) and landcrete/stones (58.2%) as their wall material. The type of wall that was least associated with malaria was metal sheets with 40% of malaria incidence. In Ayele et al.'s (2012) study, in addition to household socioeconomic factors, material of wall and floor of house were significantly associated with exposure to malaria risk. Alnwick (2000) also observed that malaria afflicts primarily the poor, who tend to live in dwellings that offer little or no protection against mosquitoes. Wooden walls usually have openings or crevices that mosquitoes can slip through into rooms to attack their victims unlike households with cement/burnt bricks. Therefore, wooden structures more often than not offer little or no protection against mosquitoes.

Households that disposed their refuse into containers had higher (78%) incidence of malaria than other means of waste disposal. This was followed by the households that disposed their solid waste indiscriminately (67.3%) and then those that had their waste collected from the home. The differentials in malaria incidence by place of solid waste disposal was found to be significant ($p<0.024$). Solid waste management constitutes one of the most crucial health and environmental problems facing many African cities. It was evident from field observations that while sanitation was generally a problem in the study communities, some households had their solid waste collected on regular basis by registered private waste collection companies. The waste collection initiative is usually accompanied with free supply of bins. These interventions may have contributed to improved sanitation than others. There were also instances where heaps of waste in the study communities are not promptly collected or dumped at unapproved sites. The uncollected or illegally dumped

wastes constitute a disaster for human health in general. The results of a study conducted in Freetown to assess the impact of solid waste disposal on health outcomes found residents suffering from malaria among other health conditions as a result of the location of the dumpsite (Sankoh et al., 2013).

Elderly household heads reported the highest (77.8%) incidence of malaria as compared with the young (68.0%) and the youthful household heads (66.1%).

There was higher incidence of malaria in male headed households (68.4%) than female headed households (65.8%) (Table 6.1). this is in contrast with the expected health outcomes by sex of household head since it has been shown that female headed households tend to be poorer than male-headed households due to low socio-demographic status (Katapa, 2006). In contrast with this observation, the female headed households were slightly better off than their male counterparts.

Household size had a varied association with malaria incidence. The highest (71.3%) malaria incidence was recorded in households which had 4-6 members, followed by households with more than seven members (65.0%). The size of household has influence on household behaviour that may expose them to mosquito bite. This is usually as a result of the high room density or the number of people per room. In the study communities, it is uncommon to find households with large number of people (e.g. more than five people) sharing an average size room resulting in overcrowding in the room. As a result, some household members sleep outside of their rooms at night-usually on the open street. In a study that sought to explore the relationship between socio-economic status and malaria parasites at the household level found that the number of people living in the household was positively associated with malaria parasitemia (Somi et al., 2007).

Table 6.1 Percentage distribution of household background characteristics by malaria incidence

Household characteristics		Malaria incidence		
		Number	percentage	P-Value
Flooding	Yes	121	15.8	0.386
	No	645	84.2	
Locality of Residence	Agbogbloshie	81	76.4	0.007*
	James town	152	71.7	
	Ussher town	285	62.8	
	Total	518	67.1	
Sex of HH	Male	254	65.8	0.145
	Female	262	68.4	
	Total	516	67.1	
Persons in Household	1-3	192	64.2	0.145
	4-6	209	71.3	
	7+	115	65.0	
	Total	516	67.1	
Age group of HH head	15-24	34	68.0	0.484
	25-60	398	66.1	
	61+	84	71.8	
	Total	516	67.1	
Sleeping rooms	One	404	67.2	0.968
	Two+	114	67.1	
	Total	518	67.2	
Room density	Low (upto2)	142	63.4	0.341
	Medium (2.5to4)	179	69.4	
	High (4.5to15)	195	68.2	
	Total	142	63.4	
Type of water storage	Covered	223	67.8	0.253
	Uncovered	38	65.5	
	Sachet	145	74.0	
	Total	406	69.6	
Type of Toilet facility	No facility	14	87.5	0.015*
	Flush	49	76.6	
	KVIP	67	75.3	
	Public	465	66.7	
	Total	40	70.2	

Table 6.1 Continuation

Material of Floor	Cement/Bricks	465	66.7	0.730
	Wood	40	70.2	
	Earth/Local Materials	9	75.0	
	Total	514	67.1	
Material of Wall	Wood	111	(78.2)	0.003**
	Burnt Bricks/Cement	367	(65.5)	
	Natural-Stones/Landcrete	32	(58.2)	
	Metal Sheets	4	(40.0)	
	Total	514	(67.0)	
Place of solid waste disposal	Collected	393	(65.1)	0.024*
	Refuse Container	92	(78.0)	
	Indiscriminately/Drain	33	(67.3)	
	Total	518	(67.2)	

Source: author with UHPP 2013. A correlation analysis of household characteristics and malaria incidence.

Malaria incidence in households with one sleeping room (67.2%) was similar to those with two or more sleeping rooms (67.1%). Higher proportion (69.4%) of households with medium room density had malaria compared with those in households with medium density (68.2%) and low densities (63.4%). Almost the same proportions of households with covered (67.8%) and uncovered (65.5%) types of water storage had malaria. Comparatively, higher proportion (74%) of households that stored sachet water had malaria in the past one year.

There was not much variation of malaria incidence in the material for the roof. While those in the households with cement/bricks roof had 69.1 percent, households with wood/mud roof had 65.7 percent. While households with earth/local material floors had the highest (75.0%) malaria incidence, those with wooden floors (70.2%) and cement/bricks (66.7%) had relatively lower incidence of malaria.

6.3 Adaptive Capacity and Malaria Incidence

In Table 6.2, out of the three indicators of adaptive capacity, none was significantly associated with malaria. With regard to education, while greater proportion (72.7%) of

households with no education and SSS/SHS and higher had malaria, less proportion of those with Middle/JSS/JHS education had malaria. Education has also been found as a significant factor that influences the incidence of malaria (Mensah et al., 2004). It has been shown that education allows an individual to have access to better economic opportunities, earn good salary and enhances one's understanding and appreciation of issues within their proper context. Education has also been found to influence decision making on health. The impact of education on health flows through the attainment of economic resources, such as earnings and wealth, as well as social resources such as access to social networks and support. Individuals with high level of education tend to have greater resources and relatively better socio-economic status for a healthy lifestyle and greater ability to live and work in environments that promote good health.

A study conducted in Ghana among under-five children, found the highest proportion of malaria incidence among children whose mothers had primary education while those with mothers with higher education reported the lowest malaria incidence (Nyarko and Cobblah, 2014). A plausible reason for high malaria incidence among households with higher level of education and no education has to do with the place and time of exposure to mosquito bite.

It has been observed that some people usually experience mosquito bite outside the home and as a result prevention measures used at home may not have any protective effect in protecting them against malaria infection. The less poor (72.7%) and poorer (69.9%) households recorded the highest malaria incidence. However, the least poor (62.1%) households had comparatively low malaria incidence. Higher adaptive capacity resulted in lower levels of malaria incidence.

Table 6.2 Household adaptive capacity by malaria incidence

Adaptive Capacity		Number	percentage	P-value
Wealth Status	Poorest	104	65.8	0.358
	Poorer	107	69.9	
	Poor	114	65.9	
	Less poor	98	72.6	
	Least poor	95	62.1	
	Total	518	67.1	
Level of Education	No education	40	72.7	0.049
	Primary	81	63.8	
	JSS/Middle	204	62.8	
	SSS/SHS and Higher	189	72.7	
	Total	452	67.2	
Social adaptive capacity	Low adaptive capacity	172	66.9	0.584
	Medium	175	68.9	
	High	164	64.6	
	Total	511	66.8	

Source: Author with UHPP data, 2013. Correlation analysis of household adaptive capacity and malaria incidence.

The lower incidence of malaria among the least poor and high social capacity can be attributed to minimum exposure as a result of improved housing and sanitation conditions and partly because of capacity to access coping/adaptation measures. As a result of strong social support enjoyed by these households, they are expected to have the necessary support to help them to prevent malaria. As noted, populations vary in degree of resilience, hence populations that are less economically disadvantaged also have less capacity for adaptation and vice versa (Balbus et al., 2009; National Research Council, 2010; Luber et al., 2014). Cutter et al. (2008) in a climate resilience study, used sense of community, place attachment and citizen participation to denote social capital and the result showed a positive influence of social capital on resilience to disaster. Morgan and Swann (2004) have also used indicators such as trust, participation and reciprocity in measuring social capital. In the case of a study on the relationship between social capital and poverty in Tanzania which use the extent of

associational activity and trust in various institutions and individuals, it was shown that social capital raises household income and in addition, the free flow of information and reduced transaction cost, thereby making available extra money for other needs. It was also found that communities with high levels of social capital had better mental health (Narayan and Pritchett, 1999). In a study intended to understand the relationship between social capital and self-rated health status in Canada, factors such as trust, commitment, identity, participation in clubs and associations and civic participation were used. Although the results generally showed weak relationship between social capital and health, there was a strong positive relationship between some individual elements of social capital such as socialization with work-mates, attendance at religious services and participation in clubs and associations and health, especially among the elderly (Veenstra, 2000).

6.4 Perceptions of Climate Change, Malaria Risk and Malaria Incidence

Generally, perceived malaria risk was significantly associated with malaria incidence ($p<0.000$) as shown in Table 6.3. Households that had high perception of malaria risk had higher malaria incidence compared to those that perceived no risk (42.2%). Those that perceived moderate risk had higher malaria incidence (71.9%), followed by those with small risk (67.2%) and great risk (65.6%). The results provide an indication of households' confirmation of their malaria risks since households that recorded high incidence of malaria also had high perception of malaria risk. Perceptions of illness have influence attitude and behaviour towards disease prevention and management. As a result, wrong perceptions can affect the compliance with prevention and control measures resulting in increasing likelihood of malaria incidence.

Table 6.3 Perceptions by malaria incidence

		Number	percentage	P-Value
Observed change of climate	Observed climate change	272	68.0	0.544
	No change of climate	238	65.9	
	Total	510	67.0	
Household perceived risk to malaria incidence	No risk	24	42.1	0.000***
	Small	227	67.2	
	Moderate	220	71.9	
	Great	42	65.6	
	Total	513	67.1	

Source: Author with UHPP data, 2013. Correlation analysis of household adaptive capacity and malaria incidence.

However, the evidence shows instances where perception does not translate into behaviours that limit malaria incidence. In a study among travellers exiting Zimbabwe, it was found that a traveller's access to health perceived malaria risk did not result in compliance with the use of prophylaxis. These patterns of protective behaviuor and compliance with prophylaxis were inconsistent with a high perception of malaria threat and good knowledge. Moreover, among those who use the prophylaxis, more than a quarter failed to fully comply (Laver et al., 2001).

A higher proportion (68%) of household members who had adequate knowledge on climate change reported having had malaria compared with those that perceived that there is no change in climate (65.9%). There was a significant association between malaria incidence and perception of climate change. Household perception of climate change and malaria linkage is key in understanding the risk since it influences attitudes and behaviour towards the disease and consequently its outcome. In a study among students in Ethiopia, those who knew about climate change were more likely to perceive it as a serious health threat than those who were not aware of it (Nigatu et al., 2014).

6. 5 Coping/Adaptation Measures and Malaria Incidence

Malaria incidence was found to be highest (77.5%) among households that used coping/adaptation measures compared with those that did not use preventive measures as shown in Table 6.4.

Table 6.4 Coping/adaptation measures by malaria incidence

Type of Coping/Adaptation Measure		Number	percentage	P-value
Use of coping/adaptation	No coping/adaptation measure used	335	(62.5)	0.000***
	Used coping/adaptation	183	(77.5)	
	Total	518	(67.1)	
Type of Measure used	Mosquito Net/spray/coil	111	(76.0)	0.652
	Protective clothing	7	(77.8)	
	Clean environment	52	(72.2)	
	Take medication/treatment	7	(70.0)	
	Staying indoors	6	(100.0)	
	Total	183	(76.5)	

Source: by author with UHPP data, 2013.

Among those that used coping/adaptation measures, malaria incidence was highest (100%) in households that stayed indoors, followed by those that used, protective clothing (77.8%) and then mosquito net, coil and spray (76%). Those that use medication as a coping/adaptation measure had lower malaria incidence.

In line with the Dumb Farmer Hypothesis, while some households used coping/adaptation strategies, others did not. Coping/adaptation measures limit or reduce the chances of getting infected or being susceptible to malaria incidence. However, there is differential protection since different types of coping/adaptation measures are used. In contrast however, households that used coping/adaptation were more likely to have malaria as compared with those that did not use any measure. Diverse strategies employed to prevent malaria in Ghana include the use of Insecticide Treated Nets (ITN), mosquito coil, mosquito spray and repellent which are targeted at the vector (Kudom et al., 2013). In spite of the

numerous measures, mosquito net ownership is a key indicator of the success of malaria control measures.

The reason for relatively high malaria incidence among households that use coping/adaptation measures could be explained by the behaviour of people, especially at night. Behavioural factors such as staying outside for long hours expose people to mosquito bites prior to using coping/adaptation measures. The study communities are characterised by outdoor activities at night. This behaviour is explained by the nature of economic activities of the population in the study area, which involves sale of food and other commodities and inadequate sleeping rooms. In a related study in Indonesia, young person's behaviour of regularly going out at night was significantly related with malaria incidence in (Roosihermiatie et al., 2000). There is a potential likelihood of increasing outdoor malaria transmission since widespread use of ITNs minimises indoor malaria transmission (Russell et al., 2011). Moreover, ITN ownership does not always translate into usage or its proper usage. As a result, households with mosquito nets can record high malaria incidence due to non-usage or improper usage of the net.

According to the 2014 Ghana Demographic and Health Survey report, the average number of ITNs per household is 1.3. ITN ownership is generally high as more than half (68%) of households in Ghana have at least an ITN. There is striking difference between urban (60%) and rural (78%) areas with Greater Accra having the least proportion (52.8%) of households with ITN. While 44 percent of the household population slept either under an ITN the night before the survey or in a dwelling with indoor residual spraying (IRS) during the 12 months preceding the survey, in the Greater Accra Region, only 18 percent did so (GSS, 2015).

Another reason for higher risk of malaria incidence among households that used coping/adaptation measures is could be attributable to malaria resistance as a result of long

period of exposure to mosquitoes compared to households that did not use any measures. Resistance to the malaria parasite limits the risk of malaria among those households. As observed by Gallup and Sachs (2001), those constantly subjected to malaria incidence tend to develop a resistance to the disease over time in a form of the sickle cell abnormality.

In summary, malaria incidence in the study communities is high with more than half of the households reporting at least an incident within the year. As has been indicated earlier, malaria incidence is influenced by a constellation of factors at different levels. The analysis showed varying levels of association between household background characteristics and malaria incidence. Although the findings were generally consistent with what other studies have found, there were some variations (Somi et al., 2007; Ayele et al., 2015). In view of the significant association between education as a social capital and malaria incidence, interventions geared towards improving formal education could yield positive results since it has a potential effect on other background characteristics such as place of solid waste disposal and type of toilet facility used that were also found to have significant influence on malaria incidence.

Chapter Seven

Determinants of Household Malaria Incidence-A Multiple Regression Analysis

7.1 Introduction

In this chapter, the relationship between flooding and malaria incidence on one hand and flooding and other household determinants on the other hand are examined to ascertain how they influence malaria incidence. Three models were run for this purpose. The first model assessed the relationship between experience of flooding and malaria incidence. The influence of flooding experience and household socio-demographic characteristics on malaria incidence were examined in the second model. The third model assessed the influence of coping/adaptation measures on malaria incidence by accounting for household socio-demographic characteristics.

7.2 Determinants of Malaria Incidence in the Household

In the first model (Table 7.1), without accounting for any other variable, experience of flooding barely explained the variation in malaria incidence (Nagelkerke r^2=0.001). Households that experienced flooding in their community had higher likelihood (1.205) (P<0.05) of having malaria incidence compared with those that did not.

Table 7.1 Relationship between experience of flooding and malaria incidence

	Model I		
	Coef (B)	S.E.	Exp (B)
Experience of flooding (RC=No)			1.000
Yes	0.187	0.216	1.205
Constant	0.672	0.083	1.959
Model R^2	0.001		

Source: author with UHPP data, 2013

In the second model, the influence of flooding, household background characteristics, perceptions and adaptive capacity on malaria transmission were assessed (Table 7.2). These variables raised the model's explanatory power to 18 percent. The positive effect of flooding on malaria changed after controlling for all the other variables except coping/adaptation. Age of head of household, place of solid waste disposal, type of toilet facility used by the household and malaria risk perceptions had statistically significant relationship with malaria incidence in the household. It was found that a unit change in age of household head resulted in a 1.018 likelihood of having malaria in that household. Households that dumped waste in refuse containers were more than three times (3.251) as likely to have malaria, while those that had their waste collected were 0.639 times less likely to have malaria compared with those that disposed-off refuse indiscriminately. With regard to the type of toilet facility used, households that had no toilet facility were 4.006 times as likely to have malaria as compared with those that used public toilet facilities. Similarly, households that used flush and KVIP toilets were 3.029 and 1.884 times as likely to have malaria as those that used public toilet facilities respectively. Households that perceived that they have no risk were 0.72 times less likely as those that perceived that they had great risk. On the other hand, those that perceived that they had small to moderate risk were more likely (0.272 and 0.078) to have malaria as compared with those that perceived great risk.

Table 7.2 Relationship between experience of flooding, household background characteristics, perception, adaptive capacity and malaria incidence

Background Characteristics	Model II			
	B	S.E.	Sig.	Exp (B)
Experience of flooding (RC=NO)				1.000
Yes	-0.018	0.313	0.953	0.982
Total persons in household	-0.035	0.045	0.445	0.966
Observed climate change (RC=NO)				1.000
Yes	-0.280	0.247	0.257	0.756
Locality name			0.658	
Agbogbloshie	0.132	0.462	0.775	1.141
James Town	0.240	0.265	0.364	1.272
Ussher Town (RC)				1.000
Sex of HH (RC=Male)				1.000
Female	0.261	0.239	0.276	1.298
Age of household head	0.018	0.008	0.032*	1.018
Type of water storage			0.461	
Covered	-0.242	0.249	0.330	0.785
Uncovered	-0.447	0.399	0.262	0.639
Sachet (RC)				1.000
Number of sleeping rooms	0.043	0.148	0.773	1.044
Material of wall			0.265	
Wood	2.115	1.310	0.107	8.287
Burnt Bricks/Cement	1.759	1.313	0.180	5.804
Natural-Stones/Landcrete	1.386	1.341	0.301	3.999
Metal Sheets (RC)				1.000
Place of solid waste disposal			0.007*	
Collected	-0.448	0.478	0.349	0.639
Refuse container	1.179	0.697	0.091	3.251
Indiscriminately/Drain (RC)				1.000
Material for Floor			0.617	
Cement/Bricks	0.161	0.779	0.836	1.175
Wood	-0.251	0.865	0.772	0.778
Earth/Local materials (RC)				1.000
Type of toilet facility			0.023*	
No facility	1.388	0.867	0.109	4.006
Flush	1.108	0.464	0.017*	3.029
KVIP	0.634	0.427	0.138	1.884
Public (RC)				1.000

Table 7.2-Continuation

Perceived malaria risk			0.009*	
No risk	-1.272	0.564	0.024*	0.280
Small	0.241	0.415	0.562	1.272
Moderate	0.075	0.412	0.855	1.078
Great (RC)				1.000
Social capital			0.226	
Low adaptive capacity	0.219	0.598	0.714	1.245
Medium	-0.366	0.378	0.333	0.693
High (RC)				1.000
Wealth quintile			0.289	
Poorest	0.083	0.536	0.877	1.086
Poorer	0.435	0.456	0.340	1.545
Poor	0.600	0.394	0.128	1.822
Less poor	0.674	0.368	0.067	1.963
Least poor (RC)				1.000
Level of education			0.339	
No education	-0.959	0.686	0.162	0.383
Primary	-0.747	0.503	0.138	0.474
JSS/JHS/Middle	-0.586	0.338	0.083	0.557
SSS/SHS and Higher (RC)				1.000
Constant	-1.142	1.688	0.499	0.319
Model R^2 0.176				

Source: by author with UHPP data, 2013

In the third model where coping/adaptation measure was adjusted for, the model R^2 increased further to 20 percent (Table 7.3). Apart from age of household head, place of solid waste disposal, type of toilet facility used, coping/adaptation measure and perceived malaria risk, the rest of the variables in the model had no statistical significant relationship with malaria incidence ($P<0.05$).

Among other factors that were statistically significant, it was found that a unit increase in age of household head increased one's chances of having malaria by 1.019. The finding is consistent with a study in Tanzania. A household assessment of the relationship between socio-economic status and malaria parasite in rural Tanzania found a negative association between malaria parasitemia and age of household head (Somi et al., 2007).

While the odds of having malaria among households that had their solid waste collected was 0.361 less, the odds of dumping waste in refuse containers was 2.251 times more compared with those that dump waste indiscriminately. Households that had no toilet facilities were 3.702 times as likely as those that used public toilet facilities to have malaria incidence. Similarly, those that used flush toilet and KVIP were 2.818 and 1.839 times as likely as those that used public facility to have malaria respectively. The results are consistent with other study findings which show that malaria-causing factors are multi-dimensional. Consistent with a study in a tropical city of Chennai in India, household demographics and housing sanitation and environmental conditions such as age of household head and stagnant water among other factors were significant correlates of malaria (Kumar et al., 2014). In Ayele et al.'s (2013) study in Ethiopia, type of toilet facility was among the factors that had significant relationship with malaria incidence. However, in contrast with this study finding, households that had toilet facilities had lower likelihood of having malaria in Ayele et al.'s study. The findings could possibly be as a result of the nature of flush toilets used by households in the study communities. In the study community, flush toilets are shared by more than one household and in most instances an entire compound house made of several households may have only one flush toilet. Such flush toilets are characterized by insanitary conditions hence, providing niches for breeding of mosquitoes. This condition contributes to the household risk of exposure to mosquito bites and consequently malaria incidence.

Compared with households that perceived that they had great malaria risk, those that were of the perception that they had no malaria risk were 0.692 less likely to have malaria. With regard to those that observed low and moderate risks, they were 1.361 and 1.109 as likely as those that had great risk to have malaria incidence in the household respectively. Risk perception entails perceived probability of being exposed to harm and the assessment of perceived severity of the impacts compared to how harmful other problems or challenges in

life are (Grothmann et al., 2005). Development of risk perceptions are based on several factors including length of time of risk experience, information, previous experience of hazard and its effect (Keller et al., 2006). Risk perception differentials among groups are also influenced by societal set-up and the culture of the people (Ge et al., 2010). Risk perception can serve as a barrier in adaptation as much as it can influence adoption of adaptation as it demonstrates the understanding of the people (Moser and Ekstrom, 2010).

The results on perceptions align with earlier study, which found that populations at higher risk of climate-related health impacts and face higher exposure consider themselves more susceptible (Akerlof et al., 2015). Akerlof et al. (2015) also found that higher risk perceptions are deeply rooted in the sex of the individual, location of residence and income level. Perceptions of risk were influential in the decision to use coping/adaptation measures or not (Spjeldnæs et al., 2014; Akerlof et al., 2015).

Among the relatively few people who used coping/adaptation measures, it was observed that the measures used were mainly anticipatory and aimed at killing or reducing vector population, rendering the vector infective (chemicals and coils) as well as creating a barrier between the vector and human population (ITN, screen). While some households adopted one coping/adaptation measure, others used multiple measures for prevention. Households that used coping/adaptation measures were 0.451 times as likely as those that did not use any measure.

Table 7.3 Influence of coping/adaptation measure, household background characteristics, perceptions and adaptive capacity on malaria incidence

	Model III			
	B	S.E.	Sig.	Exp (B)
Experience of flooding (RC=NO)				
Yes	0.050	0.316	0.875	1.051
Locality name			0.452	
Agbogbloshie	0.054	0.469	0.909	1.055
James Town	0.342	0.272	0.209	1.407
Ussher Town (RC)				1.000
Place of solid waste			0.004**	
Collected	-0.467	0.484	0.335	0.627
Refuse container	1.255	0.703	0.074	3.508
Indiscriminately/Drain (RC)				1.000
Material of wall			0.267	
Wood	2.341	1.306	0.073	0.395
Burnt Bricks/Cement	2.019	1.307	0.122	7.533
Natural-Stones/Landcrete	1.750	1.337	0.190	5.755
Metal Sheets (RC)				1.000
Type of water storage			0.651	
Covered	-0.179	0.253	0.477	0.836
Uncovered	-0.342	0.403	0.396	0.710
Sachet (RC)				1.000
Material for floor			0.669	
Cement/Bricks	0.311	0.777	0.689	1.365
Wood	-0.047	0.869	0.957	0.954
Earth/Local Materials (RC)				1.000
Type of toilet facility			0.040*	
No facility	1.309	0.861	0.128	3.702
Flush	1.036	0.468	0.027*	2.818
KVIP	0.609	0.430	0.157	1.839
Public (RC)				1.000
Coping/Adaptation (RC=NO)				
Yes	-0.796	0.253	0.002*	0.451
Level of education			0.282	
No education	-1.063	0.789	0.178	0.345
Primary	-0.859	0.563	0.127	0.423
JSS/JHS/Middle	-0.718	0.373	0.054	0.488
SSS/SHS and Higher (RC)				1.000
Perceived malaria risk			0.014*	
No risk	-1.176	0.575	0.041*	0.308
Small	0.308	0.419	0.462	1.361
Moderate	0.104	0.416	0.803	1.109
Great (RC)				1.000

Table 7.3- Continuation

Sex of HH (RC=Male)				
Female	0.314	0.244	0.197	1.369
Age of HH	0.019	0.009	0.029*	1.019
Wealth Quintile			0.280	
Poorest	0.197	0.543	0.716	1.218
Poorer	0.498	0.461	0.280	1.646
Poor	0.685	0.401	0.088	1.984
Less poor	0.698	0.374	0.062	2.010
Least poor (RC)				1.000
Total persons in household	-0.042	0.046	0.362	0.959
Observed climate change (RC=NO)				
Yes	-0.389	0.253	0.124	0.677
Number of sleeping rooms	0.015	0.152	0.919	1.016
Social capital			0.372	
Low adaptive capacity	0.101	0.608	0.869	1.106
Medium	-0.345	0.384	0.369	0.708
High (RC)				1.000
Constant	-1.351	1.705	0.428	0.259
Model R^2 0.201				

*p<0.05; ** p<0.01; ***p<0.001
Source: Author with UHPP data, 2013

The impact of interventions on malaria transmission has been noted in several studies in Africa (WHO, 2009; Hightower et al., 2010; Smith et al., 2001; Singh et al., 2013; Brenyah et al., 2013). Implementation of intervention programmes have resulted in decrease in malaria cases in hitherto high burden countries in the African Region, including Madagascar, Sao Tome and Principe, Eritrea, Rwanda and Zambia which showed a decrease in malaria cases up to 50 percent between 2000 and 2009 (Autino et al., 2012). There is evidence of significant reduction in all-cause mortality among young children with the use of ITNs (Alonso et al., 1991; Binka et al., 1997). The WHO (2006) estimated that coping/adaptation (preventive) measures at the population level, such as the use of insecticide treated bed nets, residual household spraying and preventive treatment in pregnancy are

effective in averting disability adjusted life years (DALY) due to malaria. In Ethiopia, it was found that households that used mosquito spray were less affected by malaria.

Evidence shows the protective impact of the use of mosquito nets especially among children. Evidence from Tanzania revealed that children from households which owned mosquito nets and insecticide treated nets were protected from the malaria parasites compared to their counterparts from households without mosquito nets (Somi et al., 2007). The use of mosquito nets has also been found as a protective factor against malaria among under-five children in Ghana (Nyarko and Cobblah, 2004). In a study conducted in Nigeria, households which reported having mosquito bed nets had less malaria cases among children than those without mosquito bed nets (Yusuf et al., 2010). In another study that assessed the impact of malaria interventions on malaria in Africa for a period of 25 years, it was found that in low-transmission settings, 80 percent coverage with insecticide treated nets led to less than one percent parasite prevalence in all age groups.

In addition, in terms of vector control, some studies have shown discrepancy in ITN ownership and use (Singh et al., 2013). In a study conducted in the Kasena-Nankana District in Ghana to understand how local community knowledge about malaria facilitate the use of insecticide treated nets, the results showed that although the people acknowledged the role of insecticide treated nets for nuisance reduction, its usefulness for malaria prevention was minimal (Binka et al., 1996). In another study conducted in Abeokuta in Nigeria, malaria was considered dangerous by almost all respondents in the study (98.5%) and the level of awareness of ITN as a malaria preventive tool was 75.1 percent, yet possession of ITN was 45 percent. Warmer conditions experienced while sleeping under ITN as well as challenges encountered in hanging the net were major setbacks identified in the use of ITN (Idowu et al., 2011).

There are several influential factors for the decision to use malaria coping/adaptation measures and treatment as has been observed in Ghana, Tanzania and in USA. These factors include local beliefs, socio-cultural traditions, awareness of climate change and accessibility to coping/adaptation measures (Spjeldnæs et al., 2014; Brenyah et al., 2013; Leiserowitz, 2010). According to Füssel et.al. (2004), successful planned adaptation to climate change largely hinges on five important factors including awareness of the problem, availability of effective intervention measures, information about the measures, availability of resources to implement the measures and incentives for actually implementing the measures.

It is also important to note that in spite of the benefits derived from using malaria preventive measures, accessibility to these measures remains a major challenge to many households in Africa. Although globally, many people (123 million) were protected from malaria by indoor residual spraying in 2013, in Africa, only Seven percent of the population at risk had their homes regularly sprayed (WHO, 2014). In Africa, in spite of the increase in the proportion of pregnant women who received Intermittent Preventive Treatment in pregnancy (IPTp), a substantial number (15 million pregnant women) did not receive a single dose of IPTp in 2013. Again, accessibility to Rapid Diagnostic Tests (RDTs) and quality-assured Artemisinin-based Combination Therapies (ACTs) have seen an increasing trend in the world. Nevertheless, the levels remain lower within individual countries (WHO, 2014).

It is important to note that beside these household coping/adaptation measures are higher level policies and regulations that influence operational adaptation decisions (Adger, 2004). As a result, in ensuring resilience-building at the individual or household level, there is the need to consider the structural conditions that can limit or facilitate the efficacy of micro-level interventions. In addition, in spite of the benefits of malaria interventions, case management continues to be a pre-dominant strategy for managing malaria in Ghana.

7.3 Impact of Regional (Macro level) Malaria Transmission on Household Malaria Incidence in Accra

This study has assessed malaria outcome at two levels, the macro and micro levels. The macro level analyses provided malaria transmission estimates in Accra over time indicating the trend and pattern as well as the important drivers of malaria transmission. The micro level analyses also helped to identify the important socio-demographic determinants of household malaria incidence. Again, the micro level analyses are also useful in understanding and addressing the question of the extent to which regional level malaria transmission is likely to impact on household malaria incidence by identifying the factors that predisposes or protect households from malaria transmission. This is in view of the fact that actual impact of malaria transmission or malaria burden is borne by individuals and the households they find themselves in. Moreover, it has been observed that effective malaria control must include a comprehensive assessment of factors associated with malaria and the use of malaria and mosquito control tools (Keating, 2005). In addition, it is anticipated that local environmental conditions, socio-demographic circumstances and a range of institutional, technological and behavioural adaptation taken to reduce threats to health would influence the actual impact of climate change on health (IPCC, 2001), especially for vulnerable populations (Confalonieri et al., 2007). Hence, the actual impact of malaria transmission on households required an assessment of how these factors facilitate malaria susceptibility and resilience to malaria.

The macro level malaria transmission trend showed a declining trend of malaria transmission as far as the future of malaria transmission is concerned. At the micro level, the findings showed that household socio-economic factors that are likely to predispose households to malaria incidence include use of flush toilet facility living in households with older heads (Table 7.4). This implies that households that have the conditions described above are less likely to observe the general declining trend of malaria transmission Accra.

The use of flush toilet facility increased household malaria risk by 181%. A unit change in the age of household also increased malaria risk by 1.9 %. On the other, households that use coping/adaptation strategies and perceived that they have no risk of malaria incidence hence, have higher chances of experiencing the observed trend of malaria transmission in Accra. While households that used coping/adaptations strategies risk reduced 45%, those who had no risk perception reduced their risk by 31%.

Table 7.4: Summary of household malaria risk and resilient factors

Household Socio-demographic Factors	**Malaria risk factors**	**Malaria resilience factors**
Coping/adaptation		Coping adaptation
Perceived malaria risk		Perception of no risk
Age of household head	Increasing age	
Type of toilet facility	Use of flush toilets	

Source: by author with UHPP data, 2013

The Ghana malaria control programme has set targets to promote the elimination of malaria in Ghana in line with national and global goals. This study finding suggest that improvement in the socio-demographic status of households and the effective use coping/adaptation strategies can play a major role in achieving these targets, especially in poor urban environments in the face of threatening impact of climate change on malaria. Improved socio-economic status, coupled with effective adaptation strategies at household, community and national levels can therefore promote resilience building in households that face high malaria risk (Githeko, 2001). As noted earlier, resilience constitutes several interdependent attributes existing at different levels (Cutter et al., 2010; Paton, 2005). Resilience building is seen as a function of personal characteristics such as socio-demographic and financial resources and their distribution as well as the existence of community practices such as supportive social networks (Violanti et al., 2000).

In conclusion, the results indicate that although flooding alone has some level of influence on malaria incidence, the influence is not statistically significant. However, among other factors, the effect of flooding on malaria incidence diminishes. It has been observed that flooding or stagnant water caused by heavy rainfall provides breeding grounds for mosquitoes thereby increasing malaria incidence (WHO, 2011). Although the finding affirms the above observation as rainfall provides niches for the breeding of mosquitoes, the lack of consistent effect of flooding is an indication that malaria incidence goes beyond exposure to climatic stimuli, that is, it works through other factors to influence malaria outcome. It is evident that rainfall events with their attendant flooding have become a common phenomenon in recent times (Global Facility for Disaster Reduction and Recovery, 2011; Tschakert et al., 2010). Flooding can have a significant adverse effect on young mosquito larvae, which are either washed away or suffer higher mortality. Flooding results in changes in the breeding conditions for mosquito larvae (Martens et al., 1995; Hassi, 2005). The larvae populations are likely to be washed away during flooding, thus affecting mosquito productivity, population and consequently the transmission of malaria (WHO, 2003). However, where there is accumulation of rainwater after flooding due to poor layout, it serves as a breeding environment for the breeding of mosquitoes. In view of this observation, the effect of flooding on malaria incidence will to a large extent depend on other factors other than flooding.

The findings also show that the factors that predict malaria incidence at the household level are varied and cut across the different household socio-demographic conditions including household background characteristics, perceptions, adaptive capacity and coping/adaptation measures used. The finding shows that among the important factors that influence malaria at the household level are largely related to sanitation and environmental

conditions such as the type of toilet used and place as well as perception and age of household head.

The use of coping/adaptation measures was found to be relatively low in the study area. However, households that used coping/adaptation measures were less likely to have malaria in the household. This finding is attributable largely to the behaviour of the study community, resulting in exposure to mosquito bites before the use of coping/adaptation measures.

Chapter Eight

Summary, Conclusion and Recommendations

8.1 Summary

In the context of the changing population dynamics characterised by increasing urbanization and its consequential effects on population growth and density as well as climate variability and change, the study assessed the influence of climate and socio-demographic factors on malaria transmission at macro (present and future malaria transmission in Accra) and micro (determinants of malaria incidence within the household) levels. The first specific objective was to model the current and future malaria transmission over Accra by accounting for socio-demographic factors. The second was to examine climatic (flooding) and socio-demographic determinants of malaria incidence at the household level and the third, to assess the relationship between coping/adaptation strategies and malaria incidence.

The study employed quantitative methodology with different sources of data. With regard to the first objective which assessed at the macro level (Accra), malaria transmission was estimated by analysing climatic (rainfall and temperature) population data (population growth rate and population density) with the VECTRI software package. The VECTRI was used to analyze malaria transmission using the climate and population data for the baseline period-1984, 2000 and 2010). The future transmission estimations were generated for the periods 2011-2020; 2021-2030 and 2031-2040.

To address specific objectives two and three, household data from the Population Training and Research Capacity for Development (Poptrcd) (Edulink, 3rd round data) were used. The data were generated by interviewing households systematically sampled from 29 enumeration areas (EAs) in Accra (N=782). The data included information on household demographic and socio-economic characteristics as well as health conditions, perceptions and

exposure to a climatic stressor (flooding). Cross-tabulation and binary logistic regression analyses were carried out to assess the socio-demographic determinants of malaria incidence at the household level.

In line with the IPCC's observation of changing climatic conditions in the course of time and non-linear relationship between climate variability/change and malaria transmission, the findings indicate that climatic conditions as well as the population of Accra will not remain the same; there was temporal variability of rainfall and temperature. For example, the trend in population-adjusted malaria transmission showed a significantly declining malaria transmission over time. The findings were found to be more accurate and realistic in view in view of its comparability to the estimates with other methods and in line with the declining malaria incidence in Ghana. In this regard the findings affirm the hypothesis indicating that malaria transmission models with actual socio-demographic factors are more likely to yield accurate malaria transmission levels in a given location. The findings also supported the hypothesis that malaria transmission risk relates inversely with population density since as population density increases, the level of malaria transmission declines. The findings emphasize the significant contribution of socio-demographic factors in the observed malaria transmission trends. There was observed seasonal shift in the peak months of malaria transmission.

At the household level, a bivariate analysis showed varied associations between malaria incidence and different socio-demographic factors (housing conditions: locality of residence, type of toilet facility used, place of solid waste disposal, perceptions - perceived malaria risk, adaptive capacity-education, wealth quintile and social capital and coping/adaptation measures. Generally, place of residence, type of toilet facility used, material of wall used and place of solid waste disposal had significant association with

malaria incidence. Households that had no toilet facility, wooden walls, no education and high education, moderate risk perception and use of coping/adaptation measures had relatively higher levels of malaria incidence. On the other hand, households that live in Ussher Town, use public toilet, use metal sheets as wall for dwelling place as well as those that had no malaria risk perception and did use coping/adaptation measures had lower levels of malaria incidence compared with others.

In the multiple regression analyses, flooding, which was used as a proxy for a climatic stressor in the household, did not have significant influence on malaria in all the models? The findings therefore did not support the hypothesis that there is positive relationship between household experience of flooding and malaria incidence.

The study established a significant relationship between factors such as the type of toilet facility used, perception of risk, coping/adaptation measures and age of household head and malaria incidence. Specifically, the use of flush toilet, the age of household head, having positive risk perception about malaria and the use of coping/adaptation strategies were significant predictors of malaria incidence at the household level. While the use of flush toilet and increasing age of household head facilitated malaria incidence, having positive perception about malaria incidence and the use of coping/adaptation strategies minimised household's chances of having malaria. The use of coping/adaptation measures did minimised household chances of having malaria because households that used coping/adaptation measures had lower likelihood of having malaria compared with those that did not. This emphasizes the importance of the use of coping/adaptation in averting the full impact of malaria transmission at the household level. This therefore confirms the hypothesis that households that use coping/adaptation measures are less likely to have malaria at the household level. A comparison of the study findings with other study outcomes shows some similarities and variations in the predictors of malaria incidence.

This study is timely in that it advances the knowledge on climate and malaria and fills a critical gap in malaria transmission at the local level that accounts for vector interaction with human population in the global climate change and malaria discourse. The study brings to light salient findings with an indication that with advancement of climate change and health science, limiting assessment of health impacts of climate change to only climatic variables can be potentially misleading. The study also serves as a bridge between physical and social science by integrating methodologies from these two domains of study and highlights the benefits to knowledge advancement.

8.2 Conclusion

In spite of climatic influence, socio-demographic conditions remain important in the climate-malaria nexus both at the macro (Accra) and micro (household) levels as was conceptualized. On the question of the current and future malaria transmission outlook in Accra, adjusting for the actual population density and population growth rate resulted in a marked reduction in malaria transmission over Accra compared with the unadjusted rates. Again, socio-demographic factors were also found to be important predictors of malaria incidence at the household level. The study corroborates earlier arguments that socio-demographic factors are far more important than climatic shifts in malaria endemic areas (Yang and Ferreira, 2000).

In addressing the question of the main factors that lead to household malaria incidence in urban poor communities in Accra, the household (micro) level analyses showed that while some of the socio-demographic factors enhance malaria transmission or incidence, others minimise them. In the context of climate variability/change and increasing population being experienced in Ghana and most countries in sub-Saharan Africa, actual malaria risk at the population level will largely depend on socio-demographic characteristics of households

that bear the full brunt of the disease. The findings of the study are consistent with the Smith et al. (2014) and Haines et al. (2006) models on climate and malaria linkage modulated by socio-demographic factors. The findings therefore give credence to incorporating socio-demographic variables into malaria transmission estimation as shown by Smith et al. (2014) and Haines et al. (2006).

It is envisaged that future studies that incorporate levels of immunity of the population to the VECTRI model in the estimation of malaria transmission will further improve malaria transmission estimation.

The findings of the study reflect the conceptual framework for the study to a larger extent. The variations in the findings in relation to other study results could be attributed to varying contextual issues prevailing at different study settings. Further research is however needed to explore the linkage between climate variability/change and malaria transmission/incidence modulated by socio-demographic factors in different climatic zones in the country. Further research in different climatic and socio-demographic settings can result in new insights of current and future malaria transmission/incidence in Ghana.

Although the climatic (flooding) influence was not significant at the household level, some of the modulating factors were significant in influencing malaria incidence. The study findings also affirm the epidemiological and sociological theories that emphasize socio-demographic inequalities in malaria incidence, distribution and control. This emphasizes the fact that the socio-demographic factors that influence malaria incidence are not homogenous but vary across different geographic settings.

On the question of the extent to which socio-demographic factors influence the impact of regional malaria transmission on household malaria incidence in urban poor communities

in Accra, the study found that the use of coping/adaptation strategies and households' perception of malaria risk are important indicators of households experiencing the downward trend in malaria transmission in Accra.

Finally, on the of question of whether coping/adaptation measures currently being used to moderate malaria incidence level have influence on malaria incidence at the household, the findings indicate that indeed they do have effect on malaria incidence as households that used them had lower chances of having malaria. Consistent with the Dumb Farmer hypothesis, some households affected by flooding responded in diverse ways depending on their knowledge, adaptive capacity and socio-demographic characteristics. Relatively fewer households used coping/adaptation measures against malaria incidence though. The findings did support the limiting effect of the use of coping/adaptation measures on malaria incidence.

8.3 Recommendations

Findings from this study have shown that drawing conclusions about climate variability/change effect on malaria transmission will not be complete without considering the vector interaction with human population and accounting for this in transmission estimation. Following the change in malaria transmission trends with the use of actual socio-demographic variables, there is the need for the country to adopt an assessment approach that utilises the actual climatic and socio-demographic variables at the local level in order to have a more precise estimation of malaria transmission. It is proposed that malaria transmission estimates account for socio-demographic influences to minimise the error or inaccuracies in transmission estimation. This is important to guarantee accurate and reliable information for effective decision making at all levels.

As shown, malaria transmission in urban areas varies spatially and highly is focused around vector-breeding sites, which tend to be numerous in areas of lower socio-demographic

status. As urbanization continues and malaria vectors continue to adapt to the urban environment, the role of monitoring and spatial-targeted prevention should be emphasized. To be able to achieve the declining trends observed in the findings, areas of high malaria incidence in Accra must be closely monitored, especially areas of low socio-demographic status.

It was found that sanitation conditions in the household (type of toilet facility used and place of solid waste disposal) contribute extensively to household malaria incidence. Environmental sanitation issues regarding the disposal of refuse and type of toilet facility used should be integrated and prioritised in the malaria control programme. It is suggested that efforts aimed at waste collection at the household level (in homes) must be extended to all households to prevent the creation of niches for the breeding of mosquitoes as a result of indiscriminate disposal and dumping of refuse into public containers which is often not collected prolong period of time.

As a targeted prevention strategy, and to make the use of indoor coping/adaptation measures more effective, equal attention should be given to outdoor measures considering the magnitude of both economic and social outdoor activities in the night across the study area. It is recommended that measures aimed at improving sanitation conditions such as provision of waste bins especially for commercial activities in the night and enforcement of by-laws on sanitation should be encouraged. This is in view of the fact that the use of such measures is predicted by contextual factors in which the intervention programmes are being implemented. It is, therefore, important that these factors are understood for effective malaria prevention and control.

In addition, in spite of the potential limiting effect of the use of coping/adaptation measures, a sizeable number of households were not using any coping/adaptation measures. Consequently, there is need to intensify local level actions such as household distribution and

mounting ITNs to ensure their usage as coping/adaptation measures to sustain reduction in malaria incidence.

It is evident that socio-demographic factors play an important role in malaria transmission and persistence of malaria in Ghana as well as resilience-building against malaria. Hence improvement in socio-demographic conditions through increased economic opportunities can enhance income levels for improved living conditions.

It acknowledged that community factors also play an important role in malaria transmission; the data was however inadequate in accounting for the relevant community level factors and interventions that impact on malaria transmission at the community level. It is therefore recommended that future studies examine the community level factors that contribute to the malaria incidence in the household.

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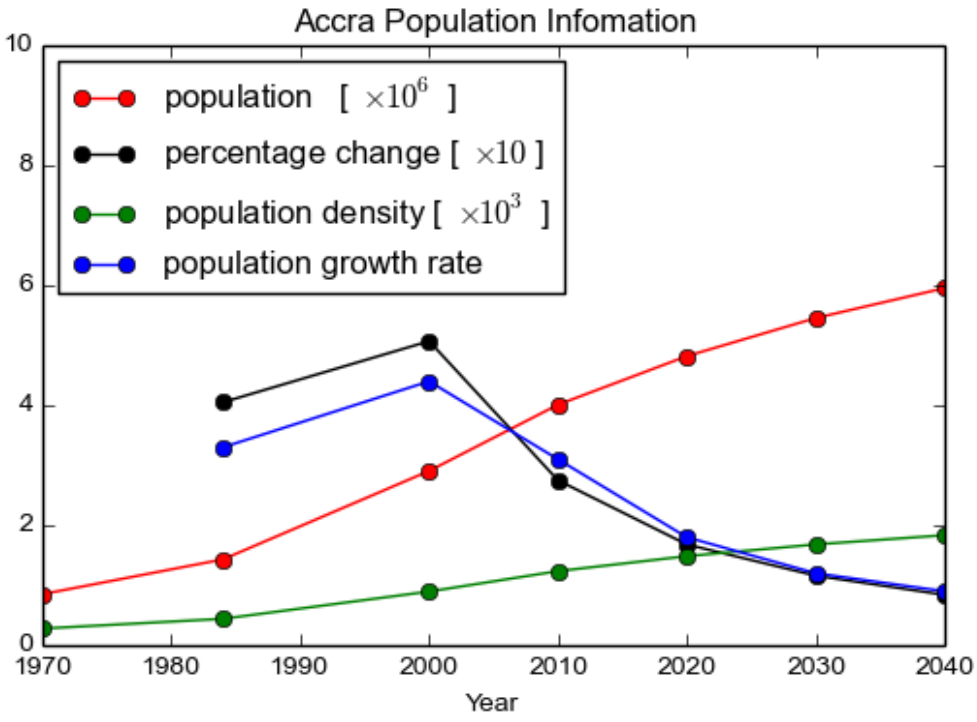
Appendices:

Appendix A: Population Dynamics of Accra (1970-2040)



Appendix B: Individual Questionnaire

POPULATION TRAINING AND RESEARCH CAPACITY FOR DEVELOPMENT (POPTRCD)

URBAN HEALTH AND POVERTY PROJECT

INDIVIDUAL QUESTIONNAIRE

IDENTIFICATION

LOCALITY NAME* _____

E.A. BASE _____

NAME OF HOUSEHOLD HEAD _____

E.A. /EDL NUMBER

……..…….....

STRUCTURAL NUMBER.....

HOUSEHOLD NUMBER

……..…….....

GREATER ACCRA.....

ROUND.....

* **CODES FOR LOCALITY NAME:** 1=AGBOGBLOSHIE 2=JAMES TOWN 3=USSHER TOWN

0	3
0	3

INTERVIEWER VISITS

	1	2	3	FINAL VISIT
DATE	_____	_____	_____	DAY
				MONTH
	_____	_____		YEAR 2013
	_____	_____	_____	INT. CODE
INTERVIEWER'S NAME			_____	RESULT
RESULT*				
Next visit: Date	_____	_____		TOTAL NO. OF VISITS
Time	_____	_____		

NAME AND LINE NO. OF RESP. FROM HH QUEST. _____

RESPONDENT INTERVIEWED IN ROUND 2 **1=YES** **2=NO**

***RESULT CODES:**

1 COMPLETED
2 PARTLY COMPLETED
3 NO HOUSEHOLD MEMBER AT HOME OR NO COMPETENT RESPONDENT AT HOME AT THE TIME OF VISIT
4 ENTIRE HOUSEHOLD ABSENT FOR EXTENDED PERIOD OF TIME
5 POSTPONED
6 REFUSED
7 DWELLING VACANT OR ADDRESS NOT A DWELLING
8 DWELLING DESTROYED
9 DWELLING NOT FOUND
10 OTHER (SPECIFY) _____

LANGUAGE

LANGUAGE OF QUESTIONNAIRE: **ENGLISH** 1

LANGUAGE OF INTERVIEW** _____

NATIVE LANGUAGE OF RESPONDENT** _____

WAS TRANSLATOR USED? (YES=1, NO=2) …… **LANGUAGE CODES: 1 ENGLISH 2 AKAN 3 GA 4 EWE 5 DAGBANI 6 HAUSA 7 OTHER (SPECIFY)_____		
SUPERVISOR NAME_____ ☐☐ DATE _____	FIELD EDITOR NAME_____ ☐☐ DATE_____	KEYED BY ☐☐

INFORMED CONSENT FOR INDIVIDUAL

Population, Health and Poverty in Accra

Principal Investigator: Prof. Francis Dodoo

Address: Regional Institute for Population Studies.
University of Ghana, Legon

My name is …… I am from the Regional Institute for Population Studies (RIPS), University of Ghana. The Institute is currently conducting a survey on population, health and poverty in Ga Mashie and Agbogbloshie in Accra. The purpose of the survey is to understand the relationship between population, health and poverty in Ghana. We will ask you questions about your background and mobility; reproduction; contraception; pregnancy, antenatal and post natal; immunisation; women's work and livelihood; fertility preference; AIDS and other sexually transmitted diseases and general health matters. The information you provide would inform any future intervention programmes and post graduate research teaching and learning in RIPS and other tertiary institutions.

During the interview, I will only ask you questions about you and your household. I will not be conducting any medical exams or tests; I will only be asking questions. We do not believe that there are any risks associated with participation in this study. You are free to decide if you want to be in this research. Your decision will not affect any service(s) and benefits you would normally receive. Your participation is entirely voluntary.

If you agree to be interviewed, your part of the research will last about 60 minutes. In the course of the discussion you may choose not to answer a question or even stop the interview altogether. If you choose to stop the discussion, all the responses you provide will be deleted from the study. However, if you consent to the interview, all the information that you give will remain confidential.

We will protect information about you and your taking part in this research to the best of our ability. You will not be named in any reports. However, the staff of the Institute may sometimes look at your research records.

If you agree to the interview, I will take notes of the conversation between us on paper. Have I explained everything well enough to you? Do you have any questions for me?

After our interview, if you have any concerns regarding the study you may contact any of the following persons: Prof. Francis Dodoo or Prof. Samuel Nii Ardey Codjoe (030-2500274).

This research has been reviewed and approved by the IRB of Noguchi Memorial Institute for Medical Research at the University of Ghana, Legon. An IRB is a committee that reviews research studies in

order to help protect participants. If you have any questions about your rights as a research participant you may contact [Rev. Dr. Ayete-Nyampong, Chairperson, NMIMR-IRB, mobile (0208152360)

CONSENT TO PARTICIPATE IN SURVEY

Please sign/thumb print below if you agree to participate in the study.

The above document describing the benefits, risks and procedures for the Population, Health and Poverty study in Accra has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

Respondent's Signature/Thumbprint…… *Thumbprint*
Date……

Witness' Signature…….....
Date……

Interviewer's Signature…….....
Date……

START TIME FOR INTERVIEW ☐☐☐☐ HOURS MINS

SECTION 1: RESPONDENT BACKGROUND AND MOBILITY

Now, I would like to ask you some background information about yourself.

Q NO.	QUESTION	RESPONSE	SKIP
100.	Sex of respondent 1=FEMALE 2=MALE		
101.	In what month and year were you born? **(CODE 98 FOR MONTH AND/ 9998 FOR YEAR IF DON'T KNOW MONTH AND/YEAR)**	**MONTH** ☐☐ **YEAR** ☐☐☐☐	
102.	How old were you on your last birthday? **COMPARE AND CORRECT 101 AND/OR 102 IF INCONSISTENT**	☐☐	
103.	Have you ever attended school? 1=YES 2=NO	☐	**IF CODE 2 SKIP Q109**
104.	What is the highest level of education you have attained? 0==PRE-SCHOOL 1=PRIMARY 2=MIDDLE/JHS 3= SECONDARY/SHS 4=HIGHER	☐	
105.	What is the highest grade you have completed at that level?	**GRADE** ☐☐	
106.	Are you currently attending school? 1=YES 2=NO	☐	

107. Who contributes/contributed to your school-related expenses? **PROBE: WHO ELSE?**	YES	NO
a. FATHER	1	2
b. MOTHER	1	2
c. OTHER RELATIVES	1	2
d. FRIEND	1	2
e. SCHOOL	1	2
f. TEACHER	1	2
g. NON GOVERNMENTAL ORGANIZATION	1	2
h. RELIGIOUS GROUP	1	2
i. SELF	1	2
j. OTHER (SPECIFY)…….....	1	2

CHECK Q106: IF NOT CURRENTLY ATTENDING SCHOOL GO TO Q108
IF CURRENTLY ATTENDING SCHOOL SKIP TO Q110

108. What were the reasons why you stopped attending school? **PROBE: ANY OTHER? (TICK MOST IMPORTANT √)**	YES	NO	MOST IMPORTANT
a. GOT PREGNANT	1	2	
b. GOT MARRIED	1	2	

	c. TO CARE OF SIBLINGS	1	2		**SKIP TO Q110**
	d. FAMILY NEEDED HELP ON FARM OR IN BUSINESS	1	2		
	e. COULD NOT PAY SCHOOL FEES	1	2		
	f. NEEDED TO EARN MONEY	1	2		
	g. COMPLETED AT THAT LEVEL	1	2		
	h. HAD ENOUGH SCHOOL	1	2		
	i. DID NOT PASS EXAM	1	2		
	j. DID NOT LIKE SCHOOL	1	2		
	k. SCHOOL NOT ACCESSIBLE /TOO FAR	1	2		
	l. PHYSICALLY/MENTALLY CHALLENGED	1	2		
	m. POOR SCHOOL QUALITY	1	2		
	n. EXPELLED	1	2		
	o. FAMILY SEES NO ECONOMIC BENEFIT	1	2		
	p. OTHER (SPECIFY)	1	2		
	…….....	1	2		
	q. DON'T KNOW				

109.	What were the reasons you never attended school? **(PROBE: ANY OTHER?) (TICK MOST IMPORTANT √)**	**YES**	**NO**	**MOST IMPORTANT**	
	a. TO CARE FOR SIBLINGS	1	2		
	b. TOO MANY DOMESTIC/FAMILY RESPONSIBILITIES	1	2		
	c. FAMILY COULD NOT PAY SCHOOL FEES	1	2		
	d. DID NOT LIKE SCHOOL	1	2		
	e. SCHOOL TOO FAR/NOT ACCESSIBLE	1	2		
	f. PHYSICALLY/MENTALLY DISABLED	1	2		
	g. FAMILY SEES NO BENEFIT	1	2		
	h. OTHER (SPECIFY)…… ……..	1	2		
	i. DON'T KNOW	1	2		
110.	Where were you born? Specify name of locality/Country _____ and Region. ***CODES FOR REGION** 01=WESTERN 02=CENTRAL			***REGION** ☐☐	

	03=GREATER ACCRA 04=VOLTA 05=EASTERN 06=ASHANTI 07=BRONG AHAFO 08=NORTHERN 09=UPPER EAST 10=UPPER WEST 11=OTHER		
111.	How many years have you lived in this community in total? **(CODE 99 IF SINCE BIRTH, CODE 15 FOR LESS THAN ONE MONTH IN MONTH AND CODE 98 IF DON'T KNOW)**	**MONTHS** ☐☐ **YEARS** ☐☐ **SINCE BIRT** ☐☐	**IF SINCE BIRTH SKIP TO Q121**
112.	Just before you moved to this community, where did you live? Specify community/Country_____ ___ and record region in which the community is located? ***CODES FOR REGION** 01=WESTERN 02=CENTRAL 03=GREATER ACCRA 04=VOLTA 05=EASTERN 06=ASHANTI 07=BRONG AHAFO 08=NORTHERN 09=UPPER EAST 10=UPPER WEST 11=OTHER	***REGION** ☐☐	
113.	Where did you mostly live during the first 15 years of your life? Specify community/Country_____ _____ and record region in which the community is located? ***CODES FOR REGION** 01=WESTERN 02=CENTRAL 03=GREATER ACCRA 04=VOLTA 05=EASTERN 06=ASHANTI 07=BRONG AHAFO 08=NORTHERN 09=UPPER EAST 10=UPPER WEST 11=OTHER	***REGION** ☐☐	
114.	Why did you move to this community? 01=NO REASON 2=TO LOOK FOR A JOB 3=TO LEARN A TRADE 4=TO ESTABLISH HH 5=TO JOIN PARTNER 6=ACCOMODATION PROBLEM 7=CLOSER TO WORK 8=PROBLEMS WITH FAMILY 9=FAMILY RE-UNION 10=OTHER (SPECIFY).....	☐☐	
115.	Do you ever visit your last community? 1 = YES 2 = NO	☐	**IF CODE 2 SKIP TO Q119**
116.	How many times per year do you visit that community?	**TIMES PER YE...** ☐☐☐	
117.	What is the main reason why you visit that community? 1=VISIT FAMILY 2=VISIT FRIENDS 3=ATTEND FUNCTIONS 4=WORK/TRAINING/SCHOOL	☐	

	5=UTILISE SERVICE 6=OTHER (SPECIFY).....		
118.	Which do you consider your primary residence? 1= CURRENT COMMUNITY 2=PLACE OF BIRTH 3=BOTH EQUALLY (1 AND 2) 4=A DIFFERENT COMMUNITY	☐	

CHECK HH COL 5: USUAL RESIDENT G☐TO Q120				
119.	At the time you moved here, did you 1=MOVE TO JOIN EXISTING HH 2=MOVE WITH OTHERS TO START HH 3=MOVE ALONE 4=WHOLE HOUSEHOLD MOVED 5=OTHER (SPECIFY)_____	☐		
120.	Who made the decision for you to move to this community? **PROBE: ANY OTHER?**	**YES**	**NO**	
	a. SELF	1	2	
	b. SPOUSE	1	2	
	c. SELF AND SPOUSE	1	2	
	d. PARENT(S)	1	2	
	e. CHILD/CHILDREN	1	2	
	f. OTHER RELATIVES	1	2	
	g. EMPLOYER	1	2	
	h. GOV'T RESETTLEMENT	1	2	
	i. OTHER (SPECIFY) _____	1	2	
	j. DON'T KNOW			
121.	Do you plan to move out of this community in the future? 1=YES, JUST MYSELF 3=NOT CERTAIN 2=YES, WHOLE HOUSEHOLD 4=NO 5=OTHER SPECIFY.....	☐		**IF CODE 3 SKIP TO Q126 IF CODE 4 SKIP TO Q125**
122.	Where do you plan to go? 01=WITHIN THE SAME COMMUNITY 02=PART OF SLUM IN ACCRA (SPECIFY) ……	☐☐		

	03=PART OF NON SLUM IN ACCRA (SPECIFY) …….. 04=ANOTHER TOWN (SPECIFY) ……. 05=A VILLAGE (SPECIFY) ……. 06=BOARDING SCHOOL 96=OTHER (SPECIFY)…… ……..				
123.	How soon are you planning to move? **(IF LESS THAN A YEAR, ENTER MONTHS AND CODE 00 FOR YEARS. ENTER 98 FOR BOTH MONTHS AND YEARS IF DON'T KNOW/UNSURE) IF LESS THAN A MONTH CODE 15 IN MONTHS**			**MONTH** ☐☐ **YEARS** ☐☐	
124.	Why do you want to move out? **PROBE: ANY OTHERS? RECORD ALL RESPONSES (TICK MOST IMPORTANT √)**	**YES**	**NO**	**MOST IMPORTANT**	**SKIP TO Q129**
	a. JOB ELSEWHERE	1	2		
	b. NO WORK AVAILABLE HERE	1	2		
	c. RENT TOO HIGH	1	2		
	d. MARRIAGE	1	2		
	e. WHOLE FAMILY MOVING	1	2		
	f. FAMILY PROBLEMS	1	2		
	g. TO ESTABLISH OWN RESIDENCE	1	2		
	h. WAS HERE TEMPORARILY	1	2		
	i. CAN AFFORD BETTER HOUSE	1	2		
	j. TOO MUCH CRIME/DRUGS	1	2		
	k. RETIRED/LOST JOB	1	2		
	l. OTHER (SPECIFY)…… …….	1	2		
125.	What are the main reasons for not wanting to move? **PROBE: ANY OTHERS? REECORD ALL RESPONSES (TICK MOST IMPORTANT √)**	**YES**	**NO**	**MOST IMPORTANT**	
	a. CAN'T AFFORD TO MOVE	1	2		
	b. HAPPY WITH JOB	1	2		
	c. FAMILY LIVES HERE	1	2		
	d. OWN PROPERTY HERE	1	2		
	e. HAVE NOWHERE ELSE TO GO	1	2		
	f. TOO OLD TO MOVE	1	2		
	g. RENT IS CHEAPER	1	2		
	h. JOB RELATED REASONS	1	2		
	i. SECURITY IS GOOD	1	2		
	j. OTHER (SPECIFY)…… ……	1	2		

126.	What is your religion? 01=NO RELIGION 02=CATHOLIC 03=PROTESTANTS 04=PENTECOASTAL/CHARISMATIC 05=OTHER CHRISTIAN 06=ISLAM 07=TRADITIONAL/SPIRITUALIST 08=EASTERN RELIGIONS 96=OTHER (SPECIFY) ……	☐☐	
127.	How often do you pray? 1=AT LEAST ONCE A DAY 2=AT LEAST ONCE A WEEK 3=AT LEAST ONCE A MONTH 4=NEVER	☐	
128.	How important is religion to you? 1=VERY IMPORTANT 2= IMPORTANT 3= INDIFFERENT 4=NOT IMPORTANT 5=NOT IMPORTANT AT ALL	☐	
129.	In the past one (1) month, how often did you attend religious services? **(CODE 998 IF DON'T KNOW)**	☐	
130.	What is your ethnic group? 01=AKAN 02=GA-DANGME 03=EWE 04=GUAN 05=GRUMA 06=MOLE-DAGBANI 07=GRUSSI 08=MANDE 96=OTHER (SPECIFY)….....	☐	
131.	Is your biological mother alive? 1=YES 2=NO 8=DON'T KNOW	☐	**IF CODE 1, 8 SKIP TO Q133**
132.	How old were you when your mother died? **AGE IN COMPLETED YEARS IF DON'T KNOW CODE 98**	☐☐	
133.	Is your biological father alive? 1=YES 2=NO 8=DON'T KNOW	☐	**IF CODE 1, 8 SKIP TO Q135**
134.	How old were you when your father died? **AGE IN COMPLETED YEARS IF DON'T KNOW CODE 98**	☐☐	
135.	Who are you living with? 1= ALONE 2=PARENT(S) 3= SPOUSE/PARTNER 4= CHILD(REN) 5=SPOUSE/PARTNER AND CHILDREN 6=FRIEND 7=SPOUSE/PARTNER &/ CHILD(REN) & OTHERS	☐☐	

	8=SIBLINS 9=GRANDPARENT(S) 10=OTHER (SPECIFY).....……		
CHECK Q131 AND Q133: BOTH PARENTS ☐ IVE GO TO Q 137 ONE OR BOTH DEAD PARENTS DEAD SKIP TO Q136		☐	
136.	Were your parents ever married to each other? 1=YES 2=NO 3=DON'T KNOW	☐	
137.	Are your mother and father currently married to each other? 1=YES, CURRENTLY MARRIED 2=NO, NOT CURRENTLY MARRIED 3=NEVER MARRIED TO EACH OTHER 4=DON'T KNOW	☐	
138.	What is (was) the highest level of education your mother completed? 0=NO EDUCATION 1=PRE-SCHOOL 2=PRIMARY 3=MIDDLE/JHS 4=SECONDARY/SHS 5=HIGHER 8=DON'T KNOW	☐	
139.	What is (was) the highest level of education your father completed? 0=NO EDUCATION 1=PRE-SCHOOL 2=PRIMARY 3=MIDDLE/JHS 4=SECONDARY/SHS 5=HIGHER 8=DON'T KNOW	☐	

140.	What kind of work did/does your father do? …… ……..…… 01=NO OCCUPATION 02=PROFESSIONAL/TECHNICAL 03=MANAGEMENT 04=CLERICAL 05=SALES 06=AGRICULTURE- SELF EMPLOYED 07=AGRICULTURE 08=HOUSEHOLD AND DOMESTIC 09=SERVICE 10=SKILLED MANUAL 11=UNSKILLED MANUAL 12=OTHER (SPECIFY)..... 98=DON'T KNOW	☐☐	
141.	What kind of work did/does your mother do? …….....…… … 01=NO OCCUPATION 02=PROFESSIONAL/TECHNICAL 03=MANAGEMENT 04=CLERICAL 05=SALES 06=AGRICULTURE- SELF EMPLOYED 07=AGRICULTURE 08=HOUSEHOLD AND DOMESTIC 09=SERVICE 10=SKILLED MANUAL 11=UNSKILLED MANUAL 12=OTHER (SPECIFY).....	☐☐	

	98=DON'T KNOW		
142.	Are you currently working? 1=YES 2=NO	☐	**IF CODE 1 SKIP TO Q144**

143.	As you know, some people take up jobs for which they are paid in cash or kind. Others sell things, have small business or work on the family farm or in the family business, others are in school. Are you currently doing any of these things or doing any other work? 1=YES 2=NO	☐	**IF CODE 1, SKIP TO Q146**
144.	What have you been doing for most of the time over the last 12 months? 1=GOING TO SCHOOL /STUDYING 2=LOOKING FOR WORK 3=INACTIVE 4=COULD NOT WORK /HANDICAPPED 8=OTHER (SPECIFY).....	☐	**IF CODE 1 SKIP TO SECTION 2**
145.	Have you done any work in the last 12 months? 1=YES 2=NO	☐	**IF CODE 2, SKIP TO SECTION 2**
146.	During the last 12 months, how many months did you work?	**NO. OF MONTHS** ☐☐	
147.	How long did you do/have you been doing this particular work in the last 12 months? **IF MULTIPLE JOBS ASK ABOUT THE MAIN JOB**	**MONTHS** ☐☐	
148.	How many days do/did you spend on this work each week?	**NO. OF DAYS** ☐	
149.	Do/Did you do this work for a member of your family, for someone else or are you self-employed? 1=FOR FAMILY MEMBER 2=FOR SOMEONE ELSE (govt &private) 3=SELF-EMPLOYED	☐	**IF CODE 1, 2 SKIP TO Q151**
150.	How many paid employees do you have? **IF NOT APPLICABLE CODE 99**	**NO. OF EMPLOYEES** ☐☐	
151.	Do you usually work at home or away from home? 1=HOME 2=AWAY	☐	
152.	How many work days were you away from work in the past month due to your own illness or injury, or that of other family members? **NOT WORKED IN PAST MONTH, CODE 95**	**NO. OF DAYS** ☐☐	
153.	Do you usually work throughout the year, or do you work seasonally, or only once in a while? 1=THROUGHOUT THE YEAR 2=SEASONALLY/PART OF THE YEAR 3=ONCE IN A WHILE	☐	

154.	Does/Did your employment require you to work at night? 1=ALWAYS 2=SOMETIMES 3=NEVER 4=NOT WORKING	☐	
155.	What is your occupation, that is, what kind of work do you mainly do? **NAME OF OCCUPATION**---------- 01=NO OCCUPATION 02=PROFESSIONAL/TECHNICAL 03=MANAGERIAL 04=CLERICAL 05=SALES 06=AGRICULTURE- SELF EMPLOYED 07=AGRICULTURE 08=HOUSEHOLD AND DOMESTIC 09=SERVICE 10=SKILLED MANUAL 11=UNSKILLED MANUAL 12=OTHER (SPECIFY)..... 98=DON'T KNOW	☐☐	**IF CODE 01 SKIP TO Q158**
156.	Do you think the work you are doing now/did fit your skill/qualification? 1=YES 2=NO 3=REQUIRE NO SKILLS	☐	**IF CODE 1 SKIP TO Q163**
157.	Which occupation best fits your skill/qualification? ……..... … **HAVE NO SKILLS, CODE 94**	☐☐	
CHECK 160: IF CODE 1 SKIP TO N☐T SECTION			
158.	Are you paid or do you earn cash or in kind for this work or are you not paid at all? 1=CASH ONLY 2=CASH AND KIND 3=IN KIND ONLY 4=NOT PAID	☐	**IF CODE 3, 4 GO TO SECTION 2**
159.	How much do you earn for this work per month? **RECORD AMOUNT (GH¢) →**	**AMOUNT (GH¢)** …… ……....	
151.	Who mainly decides how the money you earn will be used? 1=SELF 2=SPOUSE/PARTNER 3=SELF AND PARTNER JOINTLY 4=SOMEONE ELSE 5=JOINTLY WITH SOMEONE ELSE 6=PARENT(S)	☐	
166.	On average, how much of your household's expenditures do your earnings pay for: 1=ALMOST NONE 2=LESS THAN HALF 3=ABOUT HALF 4=MORE THAN HALF 5=ALL	☐	

SECTION 2: SHOULD BE ADMINISTERED TO MALE AND FEMALE RESPONDENTS.

SECTION 2: COMMUNITY AND ENVIRONMEMT							
Now I am going to ask you questions about your community and the environment							
201.	When I say the word "community", do you think of an area: 1=WITHIN A FEW MINUTES' WALK FROM YOUR HOME? 2=WITHIN A 10-MINUTE WALK FROM YOUR HOME? 3=MORE THAN 10-MINUTE WALK FROM YOUR HOME?						☐
202.	On a scale of 1 (low) to 5 (high), how much of a problem are the following in your community:	**SCALE**					
	a. DETERIORATION AND POOR SANITATION	1	2	3	4	5	
	b. POVERTY	1	2	3	4	5	
	c. CRIME	1	2	3	4	5	
	d. LACK OF EMPLOYMENT	1	2	3	4	5	
	e. DRUG SELLING OR USE	1	2	3	4	5	
	f. EXCHANGING SEX FOR MONEY	1	2	3	4	5	
	g. UNSAFE SEXUAL PRACTICES	1	2	3	4	5	
	h. INSUFFICIENT HEALTH CARE	1	2	3	4	5	
	i. GROUPS OF TEENAGERS OR ADULTS CAUSING TROUBLE	1	2	3	4	5	
	j. TRUST IN LOCAL POLICE	1	2	3	4	5	
	k. DIFFERENT SOCIAL GROUP WHO DO NOT GET ALONG WITH EACH OTHER	1	2	3	4	5	
	l. THE POLICE NOT PATROLLING THE AREA OR RESPONDING TO CALLS IN THE AREA	1	2	3	4	5	
	m. OTHER (SPECIFY).....	1	2	3	4	5	
203.	For each statement, tell me whether you: **1=STRONGLY DISAGREE 2=DISAGREE 3= AGREE 4=STRONGLY AGREE**	**SCALE**					
	a. THIS IS A CLOSE-KNIT COMMUNITY	1	2	3	4		
	b. PEOPLE IN THIS COMMUNITY ARE WILLING TO HELP EACH OTHER	1	2	3	4		
	c. PEOPLE IN THIS COMMUNITY CAN BE TRUSTED	1	2	3	4		
	d. PEOPLE IN THIS COMMUNITY WATCH OUT FOR EACH OTHER	1	2	3	4		
	e. PEOPLE IN THIS COMMUNITY WOULD WORK TOGETHER IF THERE WAS A SERIOUS PROBLEM						
	f. PEOPLE IN THIS COMMUNITY LOOK OUT MAINLY FOR THE WELFARE OF THEIR FAMILIES AND THEY ARE NOT MUCH CONCERNED WITH						

	COMMUNITY WELFARE.						
204.	How many out of ten adult neighbours do you know by name?	☐☐					
205.	About how many minutes per week would you say you spend talking to neighbours?	**NO. OF MINS.**					

206.	How likely are you to **ask** for help from a neighbour if you needed it **1=VERY LIKELY 2= SOMEWHAT LIKELY 3= NOT VERY LIKELY 4= NEVER**	**SCALE**					
	a. TO BORROW A SMALL AMOUNT OF MONEY	1	2	3	4		
	b. A SMALL AMOUNT OF FOOD	1	2	3	4		
	c. SOMEWHERE TO SPEND THE NIGHT	1	2	3	4		
	d. MEDICINE OR MEDICAL CARE	1	2	3	4		
	e. TO TALK ABOUT SOMETHING WORRYING YOU	1	2	3	4		
207.	How likely do you think you would be able to **receive** help from a neighbour if you asked: **1=VERY LIKELY 2= SOMEWHAT LIKELY 3= NOT VERY LIKELY 4= NEVER**	**SCALE**					
	a. TO BORROW A SMALL AMOUNT OF MONEY	1	2	3	4		
	b. A SMALL AMOUNT OF FOOD	1	2	3	4		
	c. SOMEWHERE TO SPEND THE NIGHT	1	2	3	4		
	d. MEDICINE OR MEDICAL CARE	1	2	3	4		
	e. TO TALK ABOUT SOMETHING WORRYING YOU	1	2	3	4		
208.	How likely are you to **help** a neighbour who needed: **1=VERY LIKELY 2= SOMEWHAT LIKELY 3= NOT VERY LIKELY 4= NEVER**	**SCALE**					
	a. TO BORROW A SMALL AMOUNT OF MONEY	1	2	3	4		
	b. A SMALL AMOUNT OF FOOD	1	2	3	4		
	c. SOMEWHERE TO SPEND THE NIGHT	1	2	3	4		
	d. MEDICINE OR MEDICAL CARE	1	2	3	4		
	e. TO TALK ABOUT SOMETHING WORRYING THEM	1	2	3	4		

209.	How likely are you to get help from a friend or relative **outside** the community if you needed: **1=VERY LIKELY 2= SOMEWHAT LIKELY 3= NOT VERY LIKELY 4= NEVER**	**SCALE**					
	a. TO BORROW A SMALL AMOUNT OF MONEY	1	2	3	4		

	b. A SMALL AMOUNT OF FOOD	1	2	3	4		
	c. SOMEWHERE TO SPEND THE NIGHT	1	2	3	4		
	d. MEDICINE OR MEDICAL CARE	1	2	3	4		
	e. TO TALK ABOUT SOMETHING WORRYING YOU	1	2	3	4		
210.	To what extent do you receive support from other members of this community 1. I receive more than I give out 2. I receive less than I give out 3. I receive just about the same I give out 4. I do not receive any support					☐	
211.	Read each question and enter the most appropriate response. Enter only **ONE** of the following answers for **EACH RESPONSE**: **1=NEVER 2=JUST ONCE OR TWICE** **3=SEVERAL TIMES 4=ALWAYS** **8=DON'T KNOW** a. FEARED CRIME IN YOUR OWN HOME? b. HAD YOUR HOME BEEN BROKEN INTO WITH SOMETHING STOLEN? c. BEEN PHYSICALLY ATTACKED? d. EXPERIENCED DOMESTIC VIOLENCE? e. HAD SOMETHING STOLEN FROM YOU? f. BEEN RAPED? g. FEARED WALKING IN YOUR OWN NEIGHBOURHOOD? h. BEEN A VICTIM OF WITHCRAFT i. RECEIVED THREATS ON YOUR LIFE j. RECEIVED WARNINGS OF PLANNED ARMED ROBBERY OF YOUR HOME					☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐	
212.	How many friends would you say you have close relationship(s) with in this community?					☐☐	

213.	Are you currently a member of any association or group in this community? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q219**
214.	What type of group do you belong to? (Probe: What else?)	**YES**	**NO**
	a. RELIGIOUS (CHURCH, ISLAMIC ETC...)	1	2
	a. MOTHER –TO –MOTHER SUPPORT/MOTHERS' CLUB OR FATHER'S CLUB	1	2
	b. HOME TOWN ASSSOCIATION	1	2

	c. CREDIT ASSOCIATION	1	2
	d. MARKET GROUP/TRADERS ASSOCIATION	1	2
	e. BUSINESS COOPERATIVE	1	2
	f. RECREATIONAL ASSOCIATION (FOOTBALL, BOXING, KEEP FIT ETC)	1	2
	g. OTHER (SPECIFY)..... .	1	2
215.	Did you contribute money or goods to this group(s)? 1=YES 2=NO	☐	**IF CODE IS 2 SKIP Q217**
216.	How much money or goods did you contribute to this group(s) in the past 12 months?		

	Specify amount / type goods								
Money		Ghana cedis					Pesewas		
	GH								
Good									
Good									

217.	How many days of work did you give to this group(s) in the past 12 months? **IF NONE CODE=000**	☐☐☐	
218.	What is the main benefit from joining this group(s)? 1. Improves my current livelihood or access to services 2. Important in times of emergency/need 3. Benefits the community 4. Enjoyment/recreation 5. Spiritual/social status/self-esteem	☐	
219.	Consider the economic status of the residents in your community, where the people at the top (5) have the highest economic standing in the community and people at the bottom (1) have the lowest standing. Which number (1 to 5) best represents where you stand at this time in your life, relative to other people in your **current** community?	☐	
CHECK 111:	**IF NOT SINCE BIRTH GO TO Q22**	**IF SINCE BIRTH SKIP TO Q221**	☐
220.	Thinking in terms of the community, where the people at the top (5) have the highest economic standing in that community and people at the bottom (1) have the lowest standing, where did you stand relative to other people in your **former** community?	☐	
Now I will like to ask you about something boys and girls do in this community			
221.	Sometimes, some girls have sex in order to get money for their family or for themselves. Do you know of your neighbours' daughters who do this? 1=YES 2=NO 98=DON'T KNOW	☐	

222.	Sometimes, some boys have sex in order to get money for their family or for themselves. Do you know of your neighbours' sons who do this? 1=YES 2=NO 98=DON'T KNOW	☐
223.	What is the main cause for your neighbours' daughters or sons having sex in exchange for money? 1=POVERTY 4=PEER PRESSURE/ BAD COMPANY 2= NO FOOD 5=LACK OF SELF DISCIPLINE 3=FAMILY/ MARITAL PROBLEMS 6=OTHER (SPECIFY)……. 8=DON'T KNOW	☐
224.	(a) Now let us talk about sex among teenagers in your community. Out of every ten girls in your community, how many would you say exchange sex for money? (b) What about boys? **IF DON'T KNOW,CODE 98**	**No. of girls** ☐☐ **No. of boys** ☐☐
225.	Do you think that enough is done in this community to prevent young girls and boys from exchanging sex for money? 1=YES 2=NO 8=DON'T KNOW	☐
226.	What do you think is the best way to discourage young girls and boys in this community from exchanging sex for money? 1=FREE EDUCATION 2=INCOME GENERATING ACTIVITIES 3=SKILLS TRAINING 4=EDUCATION CAMPAIGNS 5=REDUCE FAMILY POVERTY 6=OTHER (SPECIFY)…….. 8=DON'T KNOW	☐
227.	Who should be mainly held responsible for the fact that some young girls/boys in your community get into this practice? 0=NOBODY 1=FATHER 2=MOTHER 3=BOTH MOTHER/FATHER 4=THE BOYS/GIRLS THEMSELVES 5=WHOLE COMMUNITY 6=THE GOVERNMENT 7=MEN/WOMEN WHO PAY THEM FOR SEX 8=OTHER (SPECIFY)…… 98=DON'T KNOW	☐

FLOODING

228	What are the effects of flooding on your community? 1=DESTROY HOUSES 2=POLLUTE DRINKING WATER 3=BRING ABOUT DISEASES 4=LOSS OF PROPERTY 5=LOSS OF HUMAN LIVES 6=OTHER (SPECIFY).....	☐	
229	What do you think of the frequency of flooding now compared to the past 30 years? 1=INCREASED 2=DECREASED 3=SAME 98=DON'T KNOW	☐	
230	Are you able to predict if there is going to be flooding? 1=YES 2=NO	☐	**If CODE 2 SKIP TO Q232**
231	How are you able to predict that there is going to be flooding? Explain.....		

232	What are the sources of support after flooding? (Probe: any other) Code* 1=FINANCIAL 2= MATERIAL 3= SOCIAL 4= OTHER (SPECIFY)…….		**Yes**	**No**	**Support received * See code**	**IF CODE 2 to Government option, SKIP TO Q234**
		1. Government				
		2. NGOs				
		3. Religious bodies				
		4. Family/Friends				
		5. Other(Specify)				

233	What support do you want government to provide? 1=FINANCIAL 2=MATERIAL 3=SOCIAL 4=OTHER (SPECIFY).....	☐	
234	Do you receive information from state institutions on flooding and storm? 1=YES 2=NO	☐	

235	What can be done to prevent flooding in this community? (Tick all the apply)		**YES**	**NO**	
		1. AVOID BUILDING IN WATER WAY	1	2	
		2. CLEAN CLOGGED GUTTERS	1	2	
		3. CONSTRUCT WATER CHANNELS	1	2	
		4. OTHER (SPECIFY).....	1	2	

236	Will you consider relocating from this	☐	**If code**

	community because of the trend of flooding? 1=YES 2=NO 8=DON'T KNOW		**2 or 8, skip to next section**
237	Where do you plan going to?	Name of community.....	

SECTION 3: SHOULD BE ADMINISTERED TO MALE AND FEMALE RESPONDENTS.

SECTION 3: REPRODUCTIVE HEALTH

Now I would like to ask you some questions about your reproductive behaviour and reproductive health history. Remember that any information you provide will be kept strictly confidential. You may choose not to answer any of these questions.

301.	Do you listen to any radio shows or watch any TV show that discuss/ show sexual issues and situations? 1=YES 2. NO 8=DON'T KNOW/REMEMBER				☐
302.	In the past 12 months have you watched a pornographic/blue film on TV, at a cinema hall, on a computer or elsewhere? 1=YES 2=NO				☐
303.	How did exposure to the film affect you? …… …… …… ……				
304.	When was the last time you kissed a member of the opposite sex? **CODE 000 – IF NEVER. IF EVER, WRITE NUMBER OF MONTHS AGO 98=DON'T KNOW**				☐☐☐
305.	When was the last time you fondled or were fondled by a member of the opposite sex? **CODE 000 – IF NEVER. IF EVER, WRITE NUMBER OF MONTHS AGO 998=DON'T KNOW**				☐☐☐
306.	Who would you talk to if you have problems about sex or sex concerns?		**YES**	**NO**	**MOST LIKELY**
		a. FATHER	1	2	a
		b. MOTHER	1	2	b

		c. HUSBAND/WIFE/PARTNER	1	2	c	
		d. BROTHER	1	2	d	
		e. SISTER	1	2	e	
		f. UNCLE	1	2	f	
		g. AUNT	1	2	g	
		h. GRANDPARENT	1	2	h	
		i. STEPMOTHER/ FATHER	1	2	i	
		j. OTHER RELATIVES	1	2	j	
		k. FRIEND	1	2	k	
		l. SCHOOL TEACHER	1	2	l	
		m. RELIGIOUS LEADER	1	2	m	
		n. COUNSELOR	1	2	n	
		o. MEDICAL PERSON	1	2	o	
		p. NO ONE	1	2	p	
		q. OTHER (SPECIFY)	1	2	q	

307.	Have you ever had sex? 1=YES 2= NO	☐	**IF CODE 2 SKIP TO Q335**
308.	How old were you when you had your first sexual intercourse?	☐☐	
309.	What was the main circumstance of your first sexual experience? 1. WAS PHYSICALLY FORCED INTO IT 2. IT WAS AN EXPRESSION OF MY/OUR LOVE 3. WAS PRESSURED INTO IT (FORCED BUT NOT PHYSICALLY) 4. WAS TRICKED INTO HAVING SEX 5. WANTED TO KNOW HOW IT FEELS 6. WANTED TO BE LIKE SOME OF MY FRIENDS 7. NEEDED MONEY 8. IN MARRIAGE 9. VOLUNTARY 10. OTHER (SPECIFY)…….	☐☐	
310.	In what setting did you have the first sexual intercourse?		

☐☐

	1. PARENTS' HOUSE 2. PARTNER'S HOUSE 3. FRIEND'S HOUSE 4. HOTEL 5. IN A CAR 6. THE BUSH 7. SCHOOL CLASSROOM 8. SCHOOL DORMITORY 9. A TOILET/BATHROOM 10. A BACKYARD 11. THE STREET 12. AN ABANDONED BUILDING 13. OWN HOUSE 14. AT THE BEACH 15. OTHER (SPECIFY)……		
311.	How old was the person you had your first sexual intercourse with?	☐☐	
312.	How was this person related to you? 1. HUSBAND/WIFE 2. FATHER/MOTHER 3. TOTAL STRANGER 4. STEPMOTHER/FATHER 5. STEPSIBLING 6. FAMILY FRIEND 7. BOYFRIEND/GIRLFRIEND 8. UNCLE/AUNT 9. COUSIN 10. OTHER RELATIVE 11. HOUSE GIRL /HOUSE BOY 12. NEIGHBOUR 13. CLASSMATE 14. TEACHER 15. RELIGIOUS LEADER 16. OTHER (SPECIFY)……	☐	
313.	Were you given gifts or favours in return for your first sexual experience? 1=YES 2=NO	☐	

CHECK 309 IF FORCED/PRESSURED/TRICKED CONTINUE, IF OTHERWISE SKIP TO NEXT SECTION

I am sorry to bring up these memories which may or may not be painful or embarrassing to you, but could you please tell me if the person you had your first sexual encounter has done any of the following to you as well.

314. Did the person (adult or an older child) ask or demand you to.....

	Q304a				Q304b
	YES	**NO**	**WON'T ANSWER**	**DON'T REMEMBER**	**MOST PAINFUL/ EMBARR**

						ASSING
	A) LOOK AT HIS/HER GENITALS ?	1	2	3	8	A
	B) UNDRESS AND SHOW HIM/HER YOUR GENITALS ?	1	2	3	8	B
	C) WATCH HIM/HER MASTURBATE ?	1	2	3	8	C
	D) UNDRESS WITH ANOTHER CHILD AND FONDLE EACH OTHER IN FRONT OF HIM/HER ?	1	2	3	8	D
	E) BE FONDLED (CARESSES, RUBS, KISSES ON THE WHOLE BODY AND/OR YOUR GENITALS) ?	1	2	3	8	E
	F) FONDLE HIM/HER (CARESSES, RUBS, KISSES ON THE WHOLE BODY AND/OR HIS/HER GENITALS) ?	1	2	3	8	F
	G) LOOK AT PORNOGRAPHIC PICTURES, DRAWINGS, FILMS, VIDEOTAPES OR MAGAZINES ?	1	2	3	8	G
	H) BE NAKED AND TO EXPOSE YOUR GENITALS FOR PICTURE TAKING OR FILMING ?	1	2	3	8	H
	I) ALLOW HIM/HER TO HAVE FULL SEXUAL INTERCOURSE WITH PENETRATION?	1	2	3	8	I
	J) ALLOW HIM/HER TO HAVE HIS/HER FINGERS OR AN OBJECT INSERTED INTO YOUR PRIVATE PART?	1	2	3	8	J
315.	If you were subjected to one (or more) situation/s described in question above, how many times it happen to you with this person?				☐☐	
316.	After this experience, did you feel……					

	YES	**NO**	**DON'T REMEMBER**
A. RESPONSIBLE FOR WHAT HAPPENED	1	2	8
B. THREATENED OR IN DANGER	1	2	8
C. EMBARRASSMENT OR SHAME	1	2	8
D. OTHER (SPECIFY) ……	1	2	8

317.	Did you discuss the experience with anyone? 1=YES 2=NO	☐	**IF CODE 2,**

			SKIP TO Q320

318.	Who did you discuss the experience with?			
		YES	**NO**	
	A. FATHER	1	2	
	B. MOTHER	1	2	
	C. BROTHER/SISTER	1	2	
	D. GRANDPARENT	1	2	
	E. OTHER FAMILY MEMBER	1	2	
	F. SCHOOL NURSE	1	2	
	G. DOCTOR	1	2	
	H. FRIEND	1	2	
	I. OTHER (SPECIFY)	1	2	
319.	How did this person you told react to you? Were you ……..			
		YES	**NO**	
	A. HELPED	1	2	
	B. NOT BELIEVED	1	2	
	C. ASKED TO KEEP IT A SECRET	1	2	
	D. TOLD NOT TO DO ANYTHING ABOUT IT	1	2	
	E. OTHER (SPECIFY)	1	2	

ABORTION AND UNINTENDED PREGNANCIES			
320.	Sometimes a girl becomes pregnant when she/her partner does not want her to. Have you ever been pregnant/made someone pregnant when you did not want to become pregnant/make someone pregnant? 1=YES 2=NO 3=NEVER BEEN PREGNANT/MADE SOMEONE PREGNANT	☐	**IF CODE 2, 3 SKIP TO Q323**
321.	How many times has this occurred?	**No.of Times** ☐☐	
322.	The last time this happened, did you want it then, later or not at all? 1=THEN 2=LATER 3=NOT AT ALL	☐	
323.	Have you ever had an abortion/ made someone undergo an abortion? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q325**

324.	How many times have you had an abortion/made someone undergo abortion?	**No. of Times**	
CHECK 100: IF FEMALE (CODE 1) GO TO Q325 IF MALE (CODE 2) SKIP TO Q335			
325.	Now I would like to ask about all the births you had during your life. Have you ever had a live birth? 1=YES 2=NO		**IF CODE 2 SKIP TO Q335**
326.	How many of these children are alive? **IF NONE, RECORD '00'.**		**IF CODE 00 SKIP TO Q331**
327.	a) How many sons live with you? b) And how many daughters live with you? **IF NONE, RECORD '00'.**	**SONS AT HO** **DAUGHTER AT HOME**	
328.	Do you have any sons or daughters to whom you have given birth who are alive but do not live with you? 1=YES 2=NO		**IF CODE 2 SKIP TO Q330**
329.	How many sons are alive but do not live with you? And how many daughters are alive but do not live with you? **IF NONE, RECORD '00'.**	**SONS ELSEWHERE** **DAUGHTER ELSEWHER**	

330.	Sometimes it happens that children die. This may be very painful to talk about and I am sorry to ask you about painful memories, but it is important to get the right information. Have you ever given birth to a child who was born alive but later died? 1=YES 2=NO **NOTE: PROBE: ANY BABY WHO CRIED OR SHOWED SIGNS OF LIFE BUT SURVIVED ONLY A FEW HOURS OR DAYS?**		**IF CODE 2, SKIP TO Q332**
331.	a) In all, how many boys have died? b) And how many girls have died? **IF NONE, RECORD '00'.**	**BOYS DEAD** **GIRLS DEA**	
332.	**SUM ANSWERS TO Q341, Q343 AND Q345 AND ENTER TOTAL.**		

	IF NONE, RECORD '00'.		
CHECK Q346: Just to make sure that I have this right: you have had in TOTAL _____ children during your life. Is that correct? 1=YES Q 2=NO→**PROBE AND CORRECT Q341, Q343, Q345, Q346 AS NECESSARY**			
CHECK 339: ONE OR MORE BIRTHS GO D Q347		**NO BIRTH SKIP Q329**	
333.	Now I would like to ask you about some current events in your life. Are you/your partner currently pregnant? 1=YES 2=NO 8=UNSURE		**IF CODE 2, 8 SKIP TO Q335**
334.	For how many months have you/ your partner been pregnant?	**MONTH**	
CHECK 340: CHILDREN	**HAS LIVING CHILDREN**	**NO LIVING**	
335.	**HAS LIVING CHILDREN**: If you could go back to the time you did not have any children and could choose exactly the number of children to have your whole life, how many would that be? **NO LIVING CHILDREN**: If you could choose exactly the number of children to have in your whole life, how many would that be? **PROBE FOR A NUMERIC RESPONSE** OTHER (SPECIFY)……..…96		

SECTION 4: SHOULD BE ADMINISTERED TO BOTH MALE AND FEMALE RESPONDENTS.

SECTION 4: CONTRACEPTION			
Now I would like to talk about family planning – the various ways or methods that a couple can use to delay or avoid a pregnancy. **CIRCLE CODE 1 IN 401 FOR EACH METHOD MENTIONED SPONTANEOUSLY. IF NO MORE METHOD IS KNOWN, PROCEED TO Q402 AND ASK WHICH METHODS SHE HAS USED. PROMPT FOR MORE RESPONSES AND CIRCLE ALL MENTIONED.**			
Q. NO	**QUESTIONS AND FILTERS**	**RESPONSE**	**SKIP**
401.	Which ways or methods have you heard of? **PROBE: ANY OTHER METHOD?**	**YES** / **NO**	
	a. PILL	1 / 2	
	b. IUD	1 / 2	

	c. INJECTIONS	1	2	
	d. IMPLANTS	1	2	
	e. DIAPHRAGM/FOAM/JELLY	1	2	
	f. MALE CONDOM	1	2	
	g. FEMALE CONDOM	1	2	
	h. FEMALE STERILIZATION	1	2	
	i. MALE STERILIZATION	1	2	
	j. NATURAL METHODS	1	2	
	k. WITHDRAWAL	1	2	
	l. LACTATIONAL AMENORRHEA (LAM)	1	2	
	m. OTHER (SPECIFY)…… …	1	2	
402.	Have you/your partner ever used anything or tried in any way to delay or avoid getting pregnant? 1=YES 2=NO			**IF CODE 2, SKIP TO Q404**
403.	Which methods have you/your partner ever used? **PROBE: ANY OTHERS?**	**YES**	**NO**	
	a. PILL	1	2	
	b. IUD	1	2	
	c. INJECTIONS	1	2	
	d. IMPLANTS	1	2	
	e. DIAPHRAGM/FOAM/JELLY	1	2	
	f. MALE CONDOM	1	2	
	g. FEMALE CONDOM	1	2	
	h. FEMALE STERILIZATION	1	2	
	i. MALE STERILIZATION	1	2	
	j. NATURAL METHODS	1	2	
	k. WITHDRAWAL	1	2	
	l. LACTATIONAL AMENORRHEA (LAM)	1	2	
	m. OTHER (SPECIFY)…… ……	1	2	

CHECK Q403: RESPONDENT NOT STERILIZED SKIP TO NEXT CHECK

RESPONDENT STERILIZED SK TO Q408

CHECK 367: YOU/YOUR PARTNER NOT PREGNANT OR UNSU GO TO Q404

YOU/ YOUR PARTNER PREGNANT SK TO Q408

404.	Are you/your partner currently doing something or using any method to delay or avoid getting pregnant? 1=YES 2=NO		**IF CODE 2 SKIP TO Q409**

405.	Which method are you/your partner using?	**YES**	**NO**	
	a. PILL	1	2	**IF ONLY CODE 1 FOR I, j, k SKIP TO Q407**
	b. IUD	1	2	
	c. INJECTIONS	1	2	
	d. IMPLANTS	1	2	
	e. DIAPHRAGM/FOAM/JELLY	1	2	
	f. MALE CONDOM	1	2	
	g. FEMALE CONDOM			
	h. FEMALE STERILIZATION	1	2	
	i. MALE STERILIZATION	1	2	
	j. NATURAL METHODS	1	2	
	k. WITHDRAWAL	1	2	
	l. OTHER (SPECIFY)…….....	1	2	
406.	Where did you obtain (METHOD) the last time? **(WRITE THE NAME OF THE PLACE AND AREA. PROBE TO IDENTIFY THE TYPE OF SOURCE AND ENTER THE APPROPRIATE CODE) – SPECIFY NAME OF PLACE AND AREA.** **PUBLIC SECTOR.....** 11=GOVERNMENT HOSPITAL/POLYCLINIC 13=FAMILY PLANNING CLINIC 12=GOVERNMENT HEALTH CENTRE 14=MOBILE CLINIC **MEDICAL PRIVATE SECTOR.....** 21=PRIVATE HOSPITAL OR CLINIC 22=PRIVATE DOCTOR 23=MOBILE CLINIC 24=FP/PPAG CLINIC 25=PHARMACY/DRUG STORE 31=FRIENDS/RELATIVES 96=OTHER (SPECIFY)----------			**SKIP TO Q408**

407.	What reasons do you have for not using an artificial method of contraception to avoid pregnancy? **(PROBE: ANY OTHER REASONS?) RECORD ALL MENTIONED.**	**YES**	**NO**	**MOST IMPORTANT**
	a. NOT MARRIED	1	2	
		1	2	

	b. INTEND TO MARRY	1	2		
	c. NOT INTEND TO MARRY				
	d. FERTILITY RELATED REASONS	1	2		
	e. OPPOSITION TO USE	1	2		
	f. LACK OF KNOWLEDGE	1	2		
	g. METHOD RELATED REASON	1	2		
	h. OTHER (SPECIFY)……..				
408.	Have you obtained family planning services from any facility or healthcare person in the last 12 months? 1=YES 2=NO				

SECTION 5: SHOULD BE ADMINISTERED TO ONLY FEMALE RESPONDENTS.

SECTION 5: CHILD HEALTH, NUTRITION AND FOOD SECURITY			
CHECK Q359: ONE OR MORE BIRTHS SINCE SEPTEMBER 20 GO TO Q501 NO BIRTHS SINCE NOVEMBER 2011 SKIP TO N T SECTION			
ENTER THE LINE NUMBER, NAME AND SURVIVAL STATUS OF THE LAST BIRTH BORN SINCE SEPTEMBER 2008 IN THE TABLE; ASK ALL THE QUESTIONS IN THIS SECTION IN REFERENCE TO THIS BIRTH.			
Now I would like to ask you some more questions about the health of your last child born since September 2008			
Q. NO	**QUESTION**	**RESPONSE**	**SKIP**
501.	LINE NUMBER FROM Q347	LAST BIRTH Line number	
502.	FROM Q347: AND Q351:	Name …….. DEAD ALIV	

ENTER LINE NUMBER, NAME AND SURVIVAL STATUS OF EACH BIRTH SINCE SEPTEMBER 2008 IN THE TABLE. ASK QUESTIONS ABOUT ALL OF THESE BIRTHS, BEGINING WITH THE LAST BIRTH. (IF THERE ARE 2 OR MORE BIRTHS USE ADDITIONAL QUESTIONNAIRES).			
Q.NO	**QUESTION AND FILTER**	**RESPONSE**	**SKIP**
CHECK 351 AND 352 IF VE GO TO NEXT TO LAS IRTH IF DEAD TO NEXT SECTION			**SKIP**
503.	LINE NUMBER FROM Q347	**LAST BIRTH** Line number NAME…… ….....	

504A.	Has (NAME) been ill with a fever at any time in the last 2 weeks? 1=YES 2=NO 8=DON'T KNOW	☐	**IF CODE 2, 8, SKIP TO Q505**
504B.	Did you seek medical advice or treatment for the fever? 1=YES 2=NO	☐	
505.	Has (NAME) been ill with a cough at any time in the last two weeks? 1=YES 2=NO 8=DON'T KNOW	☐	**IF CODE 2, 8, SKIP TO Q507**
506.	Did you seek medical advice or treatment for the cough? 1=YES 2=NO	☐	
507.	Has (NAME) had diarrhoea in the last two weeks? 1=YES 2=NO 8=DON'T KNOW	☐	**IF CODE 2,8, SKIP TO Q513**
508.	Was there any blood in the stools? 1=YES 2=NO 8=DON'T KNOW	☐	
509.	On the worst day of the diarrhoea, how many bowel movements did (NAME) have? **IF DON'T KNOW, ENTER 98**	**NO. OF BOWEL MOVEMENTS** ☐☐	
510.	Was anything given to treat the diarrhoea? 1=YES 2=NO 8=DON'T KNOW	☐	**IF CODE 2, 8, SKIP TO Q512**

511. What was given to treat the diarrhoea? **ANYTHING ELSE? CIRCLE ALL MENTIONED**	**YES**	**NO**
a. PILL OR SYRUP	1	2
b. INJECTION	1	2
c. INTRAVENOUS FLUID	1	2
d. HOME REMEDIES/ HERBAL MEDICINES	1	2
e. A FLUID MADE FROM A SPECIAL PACKET CALLED ORALITE OR ORS?	1	2
f. THIN WATERY PORRIDGE MADE FROM MAIZE, RICE OR WHEAT?	1	2
g. SOUP?	1	2
h. HOMEMADE SUGAR-SALT-WATER SOLUTION?	1	2
i. OTHER (SPECIFY)……..	1	2

	.....			

512.	Did you seek medical advice or treatment for the diarrhoea? 1=YES 2=NO		

CLIMATE VARIABILITY AND HOUSEHOLD FOOD SECURITY

I am going to read some statements that people have made about their food situation after the most extreme climatic event e.g. floods in October 2011. For these statements, please tell me whether the statement was: often true, sometimes true or never true for you or your household few months afterwards

Response codes **1=often (always) true** **2=sometimes true** **3=never true**

98=don't know **00=refused to answer**

No.	Question		ANS.
513.	"After the extreme climatic event e.g. floods we couldn't prepare the kind of foods we would want to eat for good health" Was that *often true, sometimes true* or *never true* for your household?		
514.	"After the extreme climatic event e.g. floods we were worried that our food would run out before we could get more" Was that *often true, sometimes true* or *never true* for your household?		
515.	"After the extreme climatic event e.g. floods the food that we bought just didn't last and we didn't have money to get more" Was that *often true, sometimes true* or *never true* for your household?		
516.	"After the extreme climatic event e.g. floods We *couldn't afford to eat balanced meals."* Was that often true, sometimes true, or never true for your household?		
517.	"After the extreme climatic event e.g. floods we were not able to feed our under 5 years old children the kinds of food we feel they needed to be healthy" Was that *often true, sometimes true* or *never true* for your household?		
518.	"After the extreme climatic event e.g. flood Did adults in your household ever reduce the amount of food they ate or skip meals because there wasn't enough food? 1=YES 2=NO		**IF CODE 2 SKIP TO Q520**
519.	How often did this happen a month after the extreme climatic event? 1=almost every day 2=2-3 days in a week 3=once a week or less 8=don't know		
520.	"After the extreme climatic event e.g. floods did your **children under 5 years old ever** eat less meals than usual because there wasn't enough food in the house? 1=YES 2=NO		**IF CODE 2 SKIP TO Q522**
521.	How often did this happen in the months afterwards? 1=almost every day 2=2-3 days in a week 3=once a week or less 8=don't know		
522.	"After the extreme climatic event e.g. flood, did any of the **children under 5 years old** *ever not eat for a whole day* because there wasn't enough food? 1=YES 2=NO		**IF CODE 2 SKIP Q524**

523.	How often did this happen in the months after? 1=almost every day 2=2-3 days in a week 3=once a week or less 8=don't know	☐

CLIMATE VARIABILITY AND LIVELIHOODS			
NO.	**QUESTION**	**RESPONSE**	
524.	Has your household experienced any extreme climatic conditions over the past 5 years in this community? **1=YES 2=NO**	☐	**IF CODE 2 SKIP TO Q534**

Which of the following extreme climatic events have your household experienced in the past 5 years?		How would you rate the impact of this event on you or other household members on the following*					
		Livelihood (Income generation Activity)	Health	Food situation			
				Accessibility	Affordability	Availability	Safety
	Q525	**Q526**	**Q527**	**Q528**	**Q529**	**Q530**	**Q531**
FLOODS							
DROUGHTS							
TROPICAL STORM							
HIGH TEMPERATURE							
SEA LEVEL RISE							
BEACH EROSION							
CHANGES IN RAINY AND DRY SEASONS							
HIGH TEMP.							
HIGHER SEA WATER TEMP.							

CODE FOR Q525-Q531* 1=VERY SEVERE 2=SEVERE 3=SOMEWHAT SEVERE 4=NOT SEVERE 5=NOT ALL SEVERE 6=NO IMPACT

532.	When did you experience the most recent extreme climatic event in this community?	(Month/Year) (_ _ _ _/ _ _ _ _)
533.	What was the most recent extreme climatic event you experienced? 1=Tropical Storm 2=Floods 3=High temp 4= Sea level rise 5=Other (sp.	☐

IMPACT OF EXTREME CLIMATIC EVENT ON LIVELIHOODS (Assets)

	Physical		
534.	Did the extreme climate cause any damage to your property? 1=YES 2=NO	☐	**If CODE 2 SKIP TO Q536**
535.	What was the extent of damage caused by the most extreme climatic event to your property? 0= Not Applicable 1=Slightly damaged 2=Moderately damaged 3=Severely damaged		

Property	Response
House/Shelter	
Furniture	
TV	
Working place	
Fridge / freezer	
Other	
Other	

536.	Some caregivers indicate that the most recent extreme climatic event affected their household assess to certain facilities, to what extent did you agree to the impact on your household for each of the following facilities

	1=Strongly disagree 2=disagree 3=Neutral 4=Agree 5=strongly agree 0=Not applicable	**Facility** / **Response** Health center Schools Market Other _____ Other_____	
537.	Did the extreme climate event affect your household access to water? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q539**
538.	What was your source of water for the household during the extreme climatic event (Floods) 1=INDOOR PLUMBING 8=BOLEHOLE 2=PRIVATE OUTSIDE STANDPIPE/TAP 9=DUGOUT/POND/LAKE/DAM 3=RIVER/STREAM 10=WATER VENDOR 4=INSIDE STANDPIPE 11=PROTECTED WELL 5=PUBLIC STANDPIPE 12=PIPE IN NEIGHBORING HOUSEHOLD 6= RAIN WATER/ SPRIN 13=UNPROTECTED WELL 7=WATER TRUCK/TANKER 14=SACHET/BOTTLED WATER 15=OTHER SPECIFY_____		☐
539.	Did the extreme climate event affect your household sanitary facilities? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q541**
540.	How did the extreme climatic affect your household sanitary facilities? …… …… …… ……..		
	Social		
541.	Did you or someone in your household relocated from the house or community because of the extreme climatic event (floods)? 1=YES 2=NO		☐
542.	Did your child (ren) under 5 years have to be taken care of by another someone else in your community because of the extreme climatic event (floods)? 1=YES 2=NO		☐
543.	Did you have to receive and form of help from a friend /relatives/ group because of the extreme climatic event (floods)? 1=YES 2=NO	☐	**IF CODE IS 2 SKIP TO Q546**
544.	Did you receive help from the following?	**Individual /**	1=YES

		Relative	
		Friend	
		Government organization	
		Non-governmental	
		Other Specify	

545. What type of help did you receive from individuals (Relatives and friends)

Type of help	1=YES
Money	
Food	
Medicine / health care	
Shelter	
Discussed about the event	
Other sp	

546. Did you give any help to a friend / a group you belong to /relative after the extreme climatic event i.e. flood. 1=YES 2=NO ☐ **IF CODE 1 SKIP TO Q548**

547. What type of help did you give to individuals (Relatives and friends)

Type of help	1=YES
Money	
Food	
Medicine / health care	
Shelter	
Discussed about the event	
Other sp	

	Human	RESPONSE
548.	Did you get injured or fall Sick during or immediately after the extreme climatic event e.g. flood? 1=YES 2=NO ☐	**IF CODE IS 2 SKIP TO Q550**

549. What was the main sickness you experience during or following the extreme climatic event (floods)?

Health condition	1=YES 2=NO
Malaria	
DIARRHOEA	
SKIN RASH	
COUGH/DIPHTHERIA	
Other Specify_____ _	

550. Did any **ADULT** member of your household get injured or fall sick during or immediately after the extreme climatic event e.g. flood? 1=YES 2=NO ☐ **IF CODE IS 2 SKIP TO Q552**

551. What was the main sickness you experience during or following the extreme climatic event (floods)?

Health condition	1=YES 2=NO
Malaria	
DIARRHOEA	
SKIN RASH	
COUGH/DIPHTHERIA	
Other	

		Specify_____ _		
552.	Did any **CHILD UNDER FIVE** in your household get injured or fall ill during or immediately after because of the extreme climatic event e.g. flood? 0=NO 1=YES		☐	**IF CODE 2 SKIP TO Q554**
553.	What was the main sickness or injury experience by the under 5 year old children during or following the extreme climatic event (floods)?			
		Health condition	1=YES 2=NO	
		Malaria		
		DIARRHOEA		
		SKIN RASH		
		COUGH/DIPHTHERIA		
		Other Specify_____ _		
554.	Did the extreme climatic event (flood) affect your ability to work? 0=NO 1=YES			☐
555.	Did the recent extreme climatic event affect the way you care for your **under 5 year old child / children**? 1=YES 2=N0		☐	**IF CODE 2 SKIP TO Q557**
556.	To what extent do you agree the extreme climatic event (flood) affected your provision care to your under 5 year old child(ren)?			

Activity/resource	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
Time spent with child					
Provision of food					
Provision of school fees					
Provision of shelter					
Other(sp)_____ __					
Other (sp)_____					

	Financial		
557.	Did the recent extreme climatic event affect your main income generating activity (IGA)? 1=YES 2=No	☐	**IF CODE 2 SKIP TO Q559**
558.	How did the recent extreme climatic event affect your main IGA? 1= Reduced my income 4=Stopped my IGA 2=Increased my income 5=Bought it to a halt 3=Income remained the same 6=Other (sp)_____		☐
559.	Did you have to use any savings or sell any property you had for the		☐

	upkeep of the house? 1=YES 2=NO	
560.	Did the extreme climatic event make you go for a loan from a relative/ neighbor or organization? 1=YES 0=NO ☐	**IF CODE 2 SKIP TO Q562**
561.	What was the main purpose of the money borrowed? 1=To buy food 4= For health care 2=To restore damage to property 5= Other (sp)____ 3=For my Income generation activity	☐
562.	If this climatic condition e.g. flooding is to continue every year, what type of decision will you make concerning livelihood? 1= I will migrate 4=Do not know 2=Go for a wage labor work 5=Other (sp.)_____ 3=Do other kinds of work	☐
563.	In your opinion who in your household was the most affected by the extreme climatic event mentioned in **Q525** above? 1=Men 2=Women 3= Children	☐
564.	Give reason for who you believe is the most affected in your household? --- --- ---	☐

SECTION 6: SHOULD BE ADMINISTERED TO BOTH MALE AND FEMALE RESPONDENTS.

SECTION 6: MARRIAGE, SEXUAL ACTIVITY AND PARTNER'S BACKGROUND				
I would like to ask you some questions about marriage and will like to assure you that all information given me will be treated with strict confidentiality. You also have the right not to answer a question and it would not affect you in any way. Do I have your consent to continue the interview?				
Q. NO	**QUESTIONS AND FILTERS**		**RESPONSE**	**SKIP**
601.	OBSERVE PRESENCE OF OTHERS AT THIS POINT	**YES**	**NO**	
	a. CHILDREN UNDER 10	1	2	
	b. HUSBAND/PARTNER	1	2	
	c. OTHER MALES	1	2	
	d. OTHER FEMALES	1	2	
602.	Are you currently married or living with a partner? 1=YES, CURRENTLY MARRIED 2=YES, LIVING WITH A PARTNER 3=NO, NOT IN UNION		☐	**IF CODE 1, 2 SKIP TO Q607**
603.	Do you currently have a regular sexual partner, a casual sexual partner, an occasional sexual partner, or no sexual partner at all? 1=REGULAR SEXUAL PARTNER 2=OCCASIONAL SEXUAL PARTNER 3=NO SEXUAL PARTNER 4=CASUAL SEXUAL PARTNER		☐	**IF CODE 3, 4 SKIP TO Q605**

604.	How long have you been in this relationship? **IF LESS THAN A YEAR, RECORD IN MONTHS AND ENTER 00 FOR YEAR**	**MONTH** ☐☐ **YEARS** ☐☐	
605.	Have you ever been married or lived with a man/woman? 1=YES EVER MARRIED 2=YES LIVED WITH A MAN/WOMAN 3=NO	☐	**IF CODE 3, SKIP TO Q610**
606.	What is your marital status now? 1=WIDOWED 2=DIVORCED 3=SEPERATED	☐	
607.	How long have you been married/living with your present spouse/partner? **IF LESS THAN A YEAR, RECORD MONTH AND ENTER 00 FOR YEARS**	**MONTHS** ☐☐ **YEARS** ☐☐	
608.	Has any bridewealth been negotiated in this marriage? 1=YES 2=NO (PLEASE EXPLAIN) …… …… …… …… ……..	☐	**IF CODE 1, SKIP TO Q610**
609.	If yes, how much of it has been paid? 1= NOTHING PAID 2= PARTIALLY PAID 3= COMPLETELY PAID	☐	
610.	What does bridewealth entitle one to? …… …… …… ……		
CHECK Q606: IF WIDOWED, DIVORCED OR SEPARATED SKIP ☐ Q614			
611.	Is your spouse/partner living with you now or is he/she staying elsewhere? 1=LIVES WITH HIM/HER 2=STAYING ELSEWHERE	☐	
612.	Does your spouse/partner have any partner besides yourself? 1=YES 2=NO 8=DON'T KNOW 4=N/A (MALES)	☐	**IF CODE 2, 8 SKIP TO Q614**
613.	How many other spouses/partners does he have? **IF DON'T KNOW, CODE 98 IF N/A (MALES) CODE 00**	**NUMB** ☐☐	

614.	Have you been married or lived with a man/woman only once, or more than once?	☐	

	1=ONCE 2=MORE THAN ONCE		
CHECK Q602: CURRENTLY MARRIED OR LIVING WITH PARTNER GO TO Q615 **NOT IN UNION SK TO Q617**			
615.	**CHECK 401: MENTIONED CONDOM OR DID NOT MENTION CONDOM** **MENTIONED CONDOM:** The last time you had sex with (your husband/the man you are living with), was a condom used? 1=YES 2=NO **IF DON'T KNOW, ENTER 8** **DID NOT MENTION CONDOM:** Some men use a condom, which means that they use a rubber sheath on their penis during sexual intercourse. The last time you had sex with (your husband/ the man you are living with), was a condom used? 1=YES 2=NO **IF DON'T KNOW, ENTER 8**		
616.	Sometimes a man/woman may have sex with another person because circumstances force him/her to do so, or simply because they like the other person. Have you had sex with anyone other than your spouse/partner in the last 12 months? 1=YES 2=NO		
617.	When was the last time you had sexual intercourse with someone other than (your spouse/partner you are living with)?	**DAYS AG** **WEEKS A** **MONTHS**	
618.	Was a condom used at that time? 1=YES 2=NO **IF DOES NOT KNOW, CODE 8**		
619.	How long has this been going on? **IF RELATIONSHIP HAS ENDED, CODE 00**	**No of months**	
620.	Now I need to ask you some questions about sexual activity in order to gain better understanding of some family planning issues. When was the last time you had sexual intercourse (if ever)? **IF NEVER ENTER 00 (IN NEVER); IF LESS THAN ONE DAY, ENTER 00 (IN DAYS AGO); IF BEFORE LAST BIRTH, ENTER 96 (IN BEFORE LAST BIRTH)**	**NEVER** **DAYS AGO** **WEEKS AGO** **MONTHS AG** **YEARS AGO** **BEFORE LAST BIRTH**	
CHECK Q620: LESS THAN 12 MONTHS SINCE LAST EX GO TO Q621 **12 MONTHS OR LONGER SINCE LAST SEX SK TO NEXT CHECK**			
621.	In the last 12 months, how many persons have you had sex with? **IF DON'T KNOW, CODE 98**	**NO. O PERSONS**	
CHECK Q602: CURRENTLY MARRIED OR LIVING WITH PARTNER GO TO Q622			

NOT IN UNION SKIP TO NEXT SECTION			
622.	Now, I am going to read you a series of statements. After I read each statement, please tell me whether you agree with the statement, disagree with it, or have no opinion one way or the other. **1=AGREE 2=DISAGREE 3=NO OPINION** a. If I ask my partner to use a condom, he/she would get angry or violent. b. If I ask my partner to use a condom, he/she would think i'm having sex with other people. c. My partner might be having sex with someone else.	☐ ☐ ☐	

623.	Would your spouse/partner refuse your using contraceptives if you wanted to? 1=YES 2=NO 8=DON'T KNOW	☐	
624.	What would you do if he/she refused while you think you need the contraception? 1= I WOULD STILL USE IT 2=I WOULD NOT USE IT 3=I DON'T KNOW WHAT I WOULD DO 6=OTHER (SPECIFY)…….....	☐	

PARTNERS'S BACKGROUND			
Now I would like to ask you questions about your partner's background and women's work and livelihood. Remember all information will be treated strictly confidential.			
CHECK 602 AND 605: CURRENTLY MARRIED/LIVING WITH [ ]'ARTNER GO TO Q625 **FORMERLY MARRIED/ LIVED WITH A PARTNER S[ ] TO NEXT SECTION** **NEVER MARRIED AND NEVER IN A UNION SKI[ ]O NEXT SECTION**			
625.	How old was your spouse/partner on his last birthday? **IF DON'T KNOW CODE 98**	☐☐	
626.	Is your spouse/partner much younger, a little younger, about the same age, a little older or much older than you? 1=MUCH YOUNGER 2=A LITTLE YOUNGER 3=ABOUT THE SAME AGE 4=A LITTLE OLDER 5=MUCH OLDER	☐	
627.	What was the highest level of education he/she attended? 0=NO EDUCATION 1=PRE-SCHOOL 2=PRIMARY 3=JSS/MIDDLE 4=SSS/SECONDARY 5=HIGHER 8=DON'T KNOW	☐	**IF CODE 0,1, 8, SKIP TO**

			Q629
628.	What was the highest educational level he/she completed at that level? **IF DON'T KNOW, CODE 98**	☐☐	
629.	What is (was) your spouse/partner's occupation? That is, what kind of work does (did) he/she mainly do? NAME OF OCCUPATION..... .... 01=NO OCCUPATION 02=PROFESSIONAL/TECHNICAL/MANAGEMENT 03=CLERICAL 04=SALES 05=AGRICULTURE- SELF EMPLOYED 06=AGRICULTURE 07=HOUSEHOLD AND DOMESTIC 08=SERVICE 09=SKILLED MANUAL 10=UNSKILLED MANUAL 11=OTHER (SPECIFY)..... 98=DON'T KNOW	☐☐	

SECTION 7: SHOULD BE ADMINISTERED TO BOTH MALE AND FEMALE RESPONDENTS

SECTION 7: GENERAL PHYSICAL HEALTH AND RELATED ISSUES		
DIARRHOEA		
701.	How many times did you have diarrhoea within the past five years?	☐☐
702.	In your opinion, what do you think about the incidence of diarrhoea over the past five years? 1. INCREASING 2. DECREASING 3. REMAINS THE SAME	☐
703.	In your opinion, does diarrhoea incidence in your community increase with the number of rainy days? 1=YES 2=NO 8=DON'T KNOW	☐
704.	Do you take any measure to prevent diarrhoea anytime it rains? 1=YES 2=NO 8=DON'T KNOW	☐
705.	Which specific measures do you take? …… …… …… ……	
MALARIA		
Briefly explain Malaria to Respondent Malaria is caused by a bite from an infected female *Anopheles* mosquito which introduces the protists		

(a type of microorganism) through saliva into the circulatory system. In the blood, the protists travel to the liver to mature and reproduce. Malaria causes symptoms that typically include fever, feeling cold, and headache, bitter taste in the mouth, etc.

706.	How many times did you have malaria within the past five years?	☐☐
707.	In your opinion, what do you think about the incidence of malaria over the past five years? 1. INCREASING 2. DECLINING 3. REMAINS THE SAME	☐
708.	Which of the following rainy situations has your community experience over the past five years? 1. INCREASING NUMBER OF RAINY DAYS EACH YEAR 2. DECREASING NUMBER OF RAINY DAYS EACH YEAR 3. SAME NUMBER OF RAINY DAYS PER YEAR	☐
709.	In your opinion, does malaria incidence in your community increase with the number of rainy days? 1=YES 2=NO 8=DON'T KNOW	☐
710.	Do you take any measure to prevent malaria anytime it rains? 1=YES 2=NO 8=DON'T KNOW	☐
711.	Which specific measures do you take? …… …….. …… ……	

712.	Indicate whether or not the following can cause malaria.	**YES**	**NO**
	a. DRINKING DIRTY WATER	1	2
	b. WITCHCRAFT	1	2
	c. STANDING WATER	1	2

713.	When was the last time you or any member of your household had malaria? 1=LESS THAN A WEEK AGO 2=A WEEK AGO 3=TWO WEEKS AGO 4=THREE WEEKS AGO 5=A MONTH AGO 6=MORE THAN A MONTH AGO

714.	How many times did you or any member of your household suffer from malaria in the past one year?	☐☐		
715.	If you or any member of your family ever had malaria, which of the following symptoms did you experience?	**YES**	**NO**	
	a. FEVER	1	2	
		1	2	
		1	2	

	b. FEELING COLD/CHILLS/SHIVERING	1	2	
	c. BODY ACHES/JOINT PAINS/WEAKNESS	1	2	
	d. BITTER TASTE	1	2	
	e. LOSS OF APPETITE	1	2	
	f. VOMITING	1	2	
	g. HEADACHE	1	2	
	h. NAUSEA	1	2	
	i. VAGUE FEELING/RESTLESSNESS	1	2	
	j. SLEEPLESSNESS	1	2	
	k. PALE LOOKING	1	2	
	l. PERSPIRATION	1	2	
	m. YELLOWISH PALM			
	n. DELIRIUM (BAD BREATH)			
	o. YELLOW EYE BALL			
716.	How many days on the average do you experience the symptoms of malaria before you begin any treatment?			
717.	When you have malaria, which of the following treatments do you seek first? 1. HERBAL TREATMENT (SELF-PRESCRIBED) 2. TRADITIONAL MEDICINE MAN 3. DRUG STORE/PHARMACY 4. PRIVATE CLINIC/HOSPITAL 5. PUBLIC/GOVERNMENT HOSPITAL OR HEALTH POST 6. FAITH HEALER			
718.	If you ever visited the pharmacy for malaria drugs, how much on the average do you spend on it?	AMOUNT IN GH₵		PESEWAS
719.	If your first treatment option is not a visit to a hospital or health post, how long after you start self-medicating do you decide to visit the hospital?			
720.	Which of the following is the most common breeding site of mosquitoes in your area? 1. RUNNING DIRTY WATER 2. GARBAGE/TRASH 3. STANDING CLEAN WATER 4. STANDING DIRTY WATER 5. RUNNING CLEAN WATER 6 PLANTS/VEGETATION AROUND THE HOUSE 8. NO IDEA/DON'T KNOW			
721.	When you are sick of malaria, how many days on the average does it take you to fully recover?			

722.	Do you know any individual who died from malaria within the last year? 1 = YES 2 = NO	☐	

723.	Within the last month, how many days did you take the following preventive measures against malaria? a. USE OF SMOKE TO DRIVE AWAY MOSQUITOES b. MOSQUITO COILS c. MOSQUITO SPRAY d. MOSQUITO REPELLING CREAM e. USE OF FAN f. COVERING OF BODY WITH CLOTHES g. MOSQUITO NET h. MOSQUITO PROOF WINDOWS i. OTHERS (SPECIFY)…….	# of days within last month A B C D E F G H I	
724.	If someone uses the following preventive measures each day of the month, how will you rate his/her chances of suffering from malaria? Please use the following scale: 1= VERY HIGH (AT LEAST 1 IN 2), 2=HIGH (AROUND 1 IN 4), 3= QUITE POSSIBLE (1 IN 10), 4= MODERATELY LOW (1 IN 20), 5=VERY LOW (AT MOST 1 IN 100) **Practice** a. USE OF SMOKE TO DRIVE AWAY MOSQUITOES b. MOSQUITO COILS c. MOSQUITO SPRAY d. MOSQUITO REPELLING CREAM e. USE OF FAN f. COVERING OF BODY WITH CLOTHES g. MOSQUITO NET h. MOSQUITO PROOF WINDOWS	**Indicate chance (use scale)** a b c d e f g h	
725.	What is your health insurance enrolment status? 1. Currently enrolled in the NHIS 2. Previously enrolled in the NHIS 3. Never enrolled in the NHIS 4. Different health insurance scheme (specify).....	☐	
726.	What is the distance from your residence to your regular hospital?	DISTANCE IN KM.....	

		..	
727.	On the average, how much is the return transportation cost to the hospital?	AMOUNT GH₵	PESEWAS
728.	How long do you usually wait at the hospital before you are able to see a doctor?	MINUTE	
729.	How much on the average do you spend at the hospital when you seek malaria treatment?	AMOUNT GH₵	PESEWAS
730.	Have you been hospitalized within the last one year as a result of malaria? 1 = YES 2 = NO		

731.	**Discount Rates Using Matching and Choice Experiment** This part of the questionnaire involves making some choices between two alternatives. Please think carefully before you answer. A Suppose your District Assembly wants to implement project **A** or **B** in your District. The two projects cost the same amount of money. Which of the following project will you vote for? Project **A** would increase your income once by GHS100 by the end of this month (i,e., September) Project **B** would increase your income once by GHS 200 at the end of 6 months (i.e., February) B If you are to quote a value for alternative **B** that will make you exactly as happy as choosing alternative **A,** what value will that be? And vice versa.	VALUE.....	
732.	**The Risk Experiment** We would now like to know how you would choose between savings from different malaria prevention programs. There are equal chances (50%) of good or bad outcomes from the program. (Exemplify with a coin that is tossed: head representing bad outcome and tail representing good outcome). 1 = TOOK THE RISK (chose the coin toss) 2=DID NOT TAKE THE RISK		

(chose the expected mean)

	Bad outcome GHȻ	Good outcome GHȻ	Expected mean GHȻ	Risk Taking
Choice set 1	10	10	10	
Choice set 2	9	18	13.50	
Choice set 3	8	24	16	
Cho ice set 4	6	30	18	
Choice set 5	2	36	19	
Choice set 6	0	40	20	

The Contingent Valuation Experiment

Suppose the ministry of health is considering reducing malaria incidence in your community. The ministry will use a chemical called Fenthion (82.5% w/v). Fenthion is a compound with quick killing action on larvae with long residual effect. The chemical is mainly applicable to polluted water in ditches, ponds, swamps, septic tanks and other mosquito breeding sites that are not used as drinking water by humans or domestic animals. The frequency of application is once a week and it is expected that this will reduce malaria incidence by 20%. This may have to be decreased or increased on the preliminary observations in index breeding places depending upon the residual effect of the larvicide. Note that the chemical will kill the larvae at location where it has been applied but will not kill mosquitoes that already exist in the community or may travel from other communities.

The cost involved in praying the chemicals include the cost of the chemical, hand compression sprayer, water to be mixed with the chemical, and labour time. Government does not have the budget to support this initiative. Your community may have to support it by contributing either labour, time, money or both time and money.

733.	Will you be willing to contribute money or your time or both to support such an initiative? 1= YES 2 = NO	☐	**IF YES SKIP TO Q735**
734.	If NO, please explain why.....		**SKIP Q738**

CHECK 34: IF CODE 1 ANSWER 35 ☐ D SKIP TO Q736 ☐ IF CODE 2 ANSWER Q7 ☐ IF CODE 3 ANSWER Q736 & Q737

735.	If you are willing to contribute time, what is the maximum amount of time you are willing to contribute each month?	AMOUNT OF TIME (in ☐☐	**IF 'TIME ONLY' SKIP TO Q738**
736.	If you are willing to contribute money, what is the maximum amount that you are willing to contribute each month? The donation is supposed to be given directly to an official from the ministry of health who will visit your house each month to collect it.	AMOUNT IN GH₵ ☐☐☐☐☐☐	
737.	This question is about trust: If you pay money for such an initiative, how do you rate the chances that the money will be used for the intended purpose? 1. VERY HIGH (AT LEAST 1 IN 2), 2. HIGH (AROUND 1 IN 4), 3. QUITE POSSIBLE (1 IN 10), 4. MODERATELY LOW (1 IN 20), 5. VERY LOW (AT MOST 1 IN 100)	☐	
738.	**THE CHOICE EXPERIMENT** An anti-malaria drug (e.g., artesunate-amodiaquine) is either manufactured in Ghana, imported from India or Belgium, among other countries. A test on samples of the drug reveals varying degrees of active ingredients and, consequently, cures rates depending on which of the three countries produced it. Suppose some of the samples had cure rates which were 5% and 10% lower than the expected rate. In addition, the retail price of the drug ranges from GHS 2.00 to GHS 5.00. A decision to purchase the drug has to take into consideration the place of manufacture, the cure rate, and the price. Do you have any questions regarding the preceding narrative? **(PROMPT)** Before we go to questions regarding your actual choice, please review the attributes.		

Attribute	Level
Change in cure rate	*-5%* *-10%*
Country of Origin	*Belgium* *India* *Ghana*
Prices	*GHS 2.00* *GHS 3.00* *GHS 5.00*

For each of the following tables, please indicate your choice.

Choice Set 1

	Option 1	Option 2	Option 3 (Opt out)

Origin	Indian Brand	Ghana Brand	
Change in cure rate	-10%	-5%	
Price	GHÇ3.00	GHÇ3.00	

Choice Set 2

	Option 1	Option 2	Option 3 (Opt out)
Origin	Ghana Brand	Ghana Brand	
Change in cure rate	-5%	-10%	
Price	GHÇ3.00	GHÇ2.00	

Choice Set 3

	Option 1	Option 2	Option 3 (Opt out)
Origin	Belgium Brand	Gha na Brand	
Change in cure rate	-10%	-5%	
Price	GHÇ3.00	GHÇ3.00	

Choice Set 4

	Option 1	Option 2	Option 3 (Opt out)
Origin	Indian Brand	Belgium Brand	
Change in cure rate	-10%	0%	
Price	GHÇ3.00	GHÇ5.00	

739.	On which of these occasions did you wash your hands yesterday? ***Probe only once***	**MENTIONED**	**NOT MENTIONED**	**WITH SOAP**	
	A = DID NOT WASH HANDS YESTERDAY	1	2	A	
	B = BEFORE PREPARING FOOD	1	2	B	
	C = BEFORE EATING FOOD	1	2	C	
	D = BEFORE FEEDING CHILD	1	2	D	
	E = BEFORE PRAYER	1	2	E	
	F = AFTER CLEANING THE CHILD'S BOTTOMS	1	2	F	
	G = AFTER COMING FROM WASHROOM	1	2	G	
	H = AFTER EATING	1	2	H	
	I = AFTER FEEDING CHILD	1	2	I	
	J = AFTER PREPARING FOOD	1	2	J	
	K = AFTER CLEANING HOUSE	1	2	K	
	L = WASH HANDS AND FACE	1	2	L	
	M = HAVING/GIVING BATH	1	2	M	
	N = CLEAN UTENSILS	1	2	N	
	O = WASHING CLOTHES	1	2	O	
	P = OTHER (SPECIFY)_____	1	2	P	

SECTION 8: SHOULD BE ADMINISTERED TO BOTH MALE AND FEMALE RESPONDENTS.

SECTION 8: NON-COMMUNICATION DISEASES, LIFE STYLE AND RISK FACTORS					
SECTION 8A: CHRONIC NON-COMMUNICABLE DISEASE CONDITIONS					
Now we are going to talk about chronic non-communicable disease conditions					
801.	Have you ever heard of any of the following:	**YES**	**NO**	**Sources of information***	
	a. HEART DISEASE (ANGINA, ABNORMAL HEART RHYTHM)?	1	2		**IF NO TO ALL SKIP TO Q810**
	b. STROKE?	1	2		
	c. DIABETES?	1	2		
	d. CHRONIC LUNG DISEASE (CHRONIC BRONCHITIS OR EMPHYSEMA)?	1	2		
	e. HYPERTENSION (HIGH BLOOD PRESSURE)?	1	2		
	f. CANCER OR A MALIGNANT TUMOR (BREAST, PROSTATE, ETC.)?	1	2		

	g.ASTHMA?	1	2		
	h.ARTHRITIS?	1	2		
	i. KIDNEY DISEASE?	1	2		
	j. LIVER DISEASE?	1	2		

802. From which sources of information did you hear about the diseases above? Any other source? **PROBE: ANY OTHER? RECORD ALL RESPONSES IN SPACE PROVIDED IN Q801**

1= TV	7= SCHOOLS/TEACHERS
2=RADIO	8= COMMUNITY MEETINGS
3= NEWSPAPERS/MAGAZINES	9= FRIENDS /RELATIVES
4= PAMPLETS/POSTERS	10= WORK PLACE
5= HEALTH WORKERS	11= DRAMA/PERFORMANCE
6= MOSQUES/CHURCHES	96= OTHER (specify).....

803. Have you ever been told/diagnosed by a medical professional that you have any of these conditions?

	YES	NO	
a. HEART DISEASE (ANGINA, ABNORMAL HEART RHYTHM)?	1	2	**IF NO IN ALL SKIP TO Q810**
b. STROKE?	1	2	
c. DIABETES?	1	2	
d. CHRONIC LUNG DISEASE (CHRONIC BRONCHITIS OR EMPHYSEMA)?	1	2	
e. HYPERTENSION (HIGH BLOOD PRESSURE)?	1	2	
f. CANCER OR A MALIGNANT TUMOR (BREAST, PROSTATE, ETC.)?	1	2	
g. ASTHMA?	1	2	
h. ARTHRITIS?	1	2	
i. KIDNEY DISEASE?	1	2	
j. LIVER DISEASE?	1	2	

804. The first time you were told/diagnosed (disease(s) from **Q803**) did you seek advice or treatment? ☐
1=YES 2=NO

IF CODE 2 SKIP TO Q810

805. Where did you seek advice or treatment? Any other place or person? **MENTION RESPONSES TO RESPONDENT AND RECORD ALL RESPONSES**

	YES	NO
a. GOVERNMENT HOSPITAL	1	2
b. GOVERNMENT HEALTH CENTRE	1	2
c. GOVERNMENT DISPENSARY	1	2
d. MISSION HOSPITAL/CLINIC	1	2
e. OTHER PRIVATE HOSPITAL/CLINIC	1	2

	f. PHARMACY	1	2	
	g. PRIVATE DOCTOR	1	2	
	h. MOBILE CLINIC	1	2	
	i. COMMUNITY BASED DISTRIBUTOR	1	2	
	j. COMMUNITY HEALTH WORKER	1	2	
	k. SHOP	1	2	
	l. HERBALIST/TRADITIONAL PRACTITIONER	1	2	
	m. HERBAL CLINIC	1	1	
	n. FETISH PRIEST	1	1	
	o. CHINESE MEDICINE	1	1	
	p. CHURCH /FAITH HEALING	1	1	
	q. RELATIVE/FRIEND	1	2	
	r. OTHER (SPECIFY).....	1	2	
	s. DOES NOT KNOW	1	2	

806.	Are you taking any medication or therapy for the condition (Check for condition in Q803)... during the last **two weeks**?			
		Yes	**No**	
	a. HEART DISEASE (ANGINA, ABNORMAL HEART RHYTHM)?	1	2	
	b. STROKE?	1	2	
	c. DIABETES?	1	2	
	d. CHRONIC LUNG DISEASE (CHRONIC BRONCHITIS OR EMPHYSEMA)?	1	2	
	e. HYPERTENSION (HIGH BLOOD PRESSURE)?	1	2	
	f. CANCER OR A MALIGNANT TUMOR (BREAST, PROSTATE, ETC.)?	1	2	
	g. ASTHMA?	1	2	
	h. ARTHRITIS?	1	2	
	i. KIDNEY DISEASE?	1	2	
	j. LIVER DISEASE?	1	2	

807.	Are you taking any medication or therapy for the condition (Check for condition in Q803)... during the last **12 month**?			
		Yes	**No**	
	a. HEART DISEASE (ANGINA, ABNORMAL HEART RHYTHM)?	1	2	
	b. STROKE?	1	2	
	c. DIABETES?	1	2	
	d. CHRONIC LUNG DISEASE (CHRONIC BRONCHITIS OR EMPHYSEMA)?	1	2	
	e. HYPERTENSION (HIGH BLOOD PRESSURE)?	1	2	

	f. CANCER OR A MALIGNANT TUMOR (BREAST, PROSTATE, ETC.)?	1	2	
	g. ASTHMA?	1	2	
	h. ARTHRITIS?	1	2	
	i. KIDNEY DISEASE?	1	2	
	j. LIVER DISEASE?	1	2	

808.	During the past 4 weeks, how much did illness interfere with your normal work (including both work outside the home and housework)? 0=NOT AT ALL 1= A LITTLE BIT 2=MODERATELY 3= QUITE A BIT 4= EXTREMELY	☐

CHECK 803: IF NO TO ALL GO TO Q8(☐ IF AT LEAST ONE YE ☐ KIP TO Q810

809.	Do you think your chances of getting any of the following diseases is **1=SMALL 2=MODERATE 3=GREAT 4=NO RISK AT ALL**	
	a. HEART DISEASE (ANGINA, ABNORMAL HEART RHYTHM)?	a
	b. STROKE?	b
	c. DIABETES?	c
	d. CHRONIC LUNG DISEASE (CHRONIC BRONCHITIS OR EMPHYSEMA)?	d
	e. HYPERTENSION (HIGH BLOOD PRESSURE)?	e
	f. CANCER OR A MALIGNANT TUMOR (BREAST, PROSTATE, ETC.)?	f
	g. ASTHMA?	g
	h. ARTHRITIS?	h
	i. KIDNEY DISEASE?	i
	j. LIVER DISEASE?	j

SECTION 8B: PHYSICAL ACTIVITY AND BODY SHAPE

Please describe your physical activity at work

810.	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like (carrying or lifting heavy loads, digging or construction work) for at least 10 minutes continuously 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q813**
811.	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Days ☐☐	
812.	How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours ☐☐ Minutes ☐☐	
813.	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking (or carrying light loads) for at least 10 minutes continuously? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q816**

814.	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours ☐☐ Minutes ☐☐	
Please describe your physical activity when you travel to and from places			
815.	Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q819**
816.	In a typical week, on how many days do you walk or cycle for at least 10 minutes to get to and from places?	Days ☐☐	
817.	How much time do you spend walking or cycling for travel on a typical day?	Hours ☐☐ Minutes ☐☐	
Please describe your physical activity during your recreational activities			
818.	Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate (like running or football) for at least 10 minutes continuously? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q822**
819.	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (leisure) activities?	Days ☐☐	
820.	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours ☐☐ Minutes ☐☐	
821.	Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking, (cycling, swimming, volleyball) for at least 10 minutes continuously? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q826**
822.	Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking, (cycling, swimming, volleyball) for at least 10 minutes continuously? 1=YES 2=NO	☐	
823.	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities?	Days ☐☐	
824.	How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?	Hours ☐☐ Minutes ☐☐	
Please describe your physical activity on a usual day (sedentary behaviour)			
825.	How much time do you usually spend sitting or reclining on a typical day? *This question refers to the day time.*	Hours ☐☐ Minutes ☐☐	
SECTION 8C: BODY SHAPE			
BODY SHAPE – QUESTIONS FOR WOMEN ONLY			

826.	We want to ask some questions about body shape. For the following questions, you can choose one of the pictures below. Under each picture is a number. Please use this number for your answer. Place an **X** under one of the numbers below:	1	2	3	4	5	6	7	8	9
	a. Which picture do you most look like right now?									
	b. Which picture would you most prefer to look like?									
	c. Which picture is most like other women your age?									
	d. Which picture do you think most of the men around you would prefer women to look like?									
BODY SHAPE – QUESTIONS FOR MEN ONLY										
827.	We want to ask some questions about body shape. For the following questions, you can choose one of the pictures below. Under each picture is a number. Please use this number for your answer. Please put an **X** under one of the numbers below:	1	2	3	4	5	6	7	8	9
	a. Which picture do you most look like right now?									
	b. Which picture would you most prefer to look like?									
	c. Which picture is most like other men your age?									
	d. Which picture do you think most of the men around you would prefer men to look like?									

Section 9D: DIETARY PATTERNS				
828.	How often do you or someone else in your home prepare your meals at home? 1=NEVER 2=1 DAY/WEEK 3=EVERYDAY 4=WEEKENDS 5=3-4 DAYS/WEEK 6=ONLY ON SUNDAYS 7=2-3 DAYS/WEEK 8=ONLY ON SATURDAYS 9=OTHER SPECIFY_____	☐	**IF CODE 1 SKIP TO Q837**	
829.	If you cook your meals, what kinds of cooking methods do you use? (Check **all** that apply)	**YES**	**NO**	
	a. FRYING	1	2	
	b. STEAMING	1	2	
	c. BAKING	1	2	

	d. GRILLING/BARBEQUE	1	2	
	e. BOILING	1	2	
	f. ROASTING	1	2	
830.	Which method do you use **most often**? 1=FRYING 2=Roasting 3=STEAMING OVER WATER, WITHOUT OIL 4=STEWING 5=BAKING 6=GRILLING/BARBEQUE 7=BOILING			
831.	How often do you add salt to your meals at the table? 1=NEVER 2=RARELY 3=OCCASIONALLY 4=VERY OFTEN			
832.	Do you do anything on a regular basis to control your salt intake? 1=YES 2=NO			**IF CODE 2 SKIP TO Q835**
833.	What do you mainly do? 1=AVOID/MINIMIZE CONSUMPTION OF PROCESSED FOODS 2=LOOK AT THE SALT OR SODIUM LABELS ON FOOD 3=DO NOT ADD SALT AT THE TABLE 4=DO NOT ADD SALT WHEN COOKING 5=USE SPICES OTHER THAN SALT WHEN COOKING 6= AVOID EATING OUT 7= OTHER (SPECIFY) _____			
834.	What types of cooking oil do you usually use for frying/stewing at home? 1=PALM OIL 2= VEGETABLE OIL 3=SOYA BEAN OIL 4=OLIVE OIL 5=GROUNDNUT OIL 6= COCONUT OIL 7=PALM KERNEL OIL 8=LARD/ANIMAL FAT 9=CORNFLOUR OIL 10=SUNFLOWER OIL 11=DO NOT USE OIL AT ALL			
835.	At what time of day do you usually eat your biggest/heavy meal? 1=MORNING 2=MIDDAY/AFTERNOON 3=EVENING			

SECTION 8E: PSYCHOSOCIAL HEALTH

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks.

1=NONE OF THE TIME 2=A LITTLE OF THE TIME 3=SOME OF THE TIME 4=MOST OF THE TIME 5=ALL OF THE TIME

836.	a. DID YOU FEEL FULL OF LIFE AND BOUNCE?	A	
	b. HAVE YOU BEEN A VERY NERVOUS PERSON?	B	
	c. HAVE YOU FELT SO UNHAPPY AND NOT YOURSELF THAT NOTHING COULD CHEER YOU UP?	C	

	d. HAVE YOU FELT CALM AND PEACEFUL?	D
	e. DID YOU HAVE A LOT OF ENERGY?	E
	f. HAVE YOU FELT DOWNHEARTED AND LETDOWN?	F
	g. DID YOU FEEL WORN OUT?	G
	h. HAVE FELT TIRED?	H
	i. HAVE YOU BEEN A HAPPY PERSON?	I
	j. HAVE YOU FELT WORTHLESS	J
	k. HAVE YOU FELT HOPELESS?	k

837.	In life people may/may not be content with life in general, I would like to ask about you? Do you feel content? 0=NOT AT ALL 1= A LITTLE BIT 2=MODERATELY 3= QUITE A BIT 4= EXTREMELY	☐
838.	How do you see your health? 0=POOR 1=QUIT GOOD 2=GOOD 3=VERY GOOD 4 EXCELLENT	☐

839. GENERAL LIFESTYLE

840.	Have you ever consumed any of these drinks that contain alcohol	**YES**	**NO**	**IF CODE 2, SKIP TO Q846**
	a. BEER/GUINNESS	1	2	
	b. WINE (NOT COMMUNION WINE)	1	2	
	c. AKPETESHIE	1	2	
	d. BRUKUTU	1	2	
	e. PITO	1	2	
	f. PALMWINE	1	2	
	g. GIN, WHISKEY OR OTHER SPIRITS	1	2	
	h. IRISH CREAM, AMARULA OR OTHER LIQUERS	1	2	
	i. LOCAL BITTERS (EG. AGYA APPIAH ETC…)	1	2	
	j. OTHER (SPECIFY)……..	1	2	
841.	Have you consumed alcohol in the last 30 days? 1=YES 2=NO	☐		**IF CODE 2 SKIP TO 844**
842.	Now think from now to this same time yesterday did you consume alcohol? 1=YES 2=NO	☐		
843.	How old were you when you first drunk alcohol? DON'T KNOW…….....…98	**AGE** ☐☐		
844.	How often in the past month have you had so much alcohol that you were really drunk? 1=NO, NEVER 2=NO, WAS NOT DRUNK IN PAST MONTH 3=YES, ONCE 4=YES, 2 TO 3 TIMES 5=YES, 4 TO 10 TIMES 6=YES, MORE THAN 10 TIMES 8=OTHER (SPECIFY).....	☐		

845.	Have you ever smoked tobacco or used smokeless tobacco? 1=YES 2=NO	☐	**IF CODE 2 SKIP TO Q849**
846.	Do you currently use (smoke, sniff or chew) any tobacco products such as cigarettes, cigars, pipes, chewing tobacco or snuff? 1=YES, DAILY 2=YES, BUT NOT DAILY 3=NO, NOT AT ALL	☐	**IF CODE 3 SKIP TO Q849**
847.	For how long have you been smoking or using tobacco daily? **1=..... Years 2=..... Months** **[For interviewer: If less than one month- enter "00" for years and "00" for months]**		
848.	Have you ever tried any kind of drug? 1=YES 2=NO	☐	**IF CODE 2 END SESSION**
849.	What have you tried? PROBE: what else?		

	YES	NO
a. PILLS	1	2
b. MARIJUANA/WEE	1	2
c. COCAINE	1	2
d. PETROL SNIFFING	1	2
e. GLUE SNIFFING	1	2
f. PAINT SNIFFING	1	2
g. OTHER (SPECIFY)……..	1	2
h. DON'T KNOW	1	2

850.	How old were you when you first tried one of these things? 98=DON'T KNOW	**AGE** ☐☐

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

Do you have any question or comments for me?

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WE HAVE COME TO THE END OF THE INTERVIEW, THANK YOU VERY MUCH FOR TAKING YOUR TIME TO ANSWER THESE QUESTIONS.

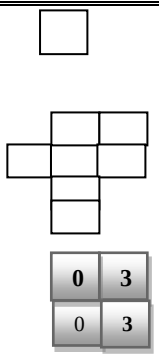
Appendix C: Household Questionnaire

REGIONAL INSTITUTE FOR POPULATION STUDIES
UNIVERSITY OF GHANA

POPULATION TRAINING AND RESEARCH CAPACITY FOR DEVELOPMENT (POPTRCD)

URBAN HEALTH AND POVERTY PROJECT

HOUSEHOLD QUESTIONNAIRE

IDENTIFICATION	
LOCALITY NAME*_____ E.A. BASE_____ NAME OF HOUSEHOLD HEAD_____ E.A. /EDL NUMBER ……..……..... …. STRUCTURE NUMBER..... HOUSEHOLD NUMBER ……..…….....…..... GREATER ACCRA..... ROUND..... ..... * **CODES FOR LOCALITY NAME:** 1=AGBOGBLOSHIE 2=JAMES TOWN 3=USSHER TOWN	

INTERVIEWER VISITS				
	1	2	3	FINAL VISIT

DATE INTERVIEWER'S NAME RESULT*	_____ _____ _____	_____ _____ _____	_____ _____ _____	DAY MONTH YEAR 2 0 1 3 INT. CODE RESULT
Next visit: Date Time	_____ _____	_____ _____		TOTAL NO. OF VISITS

*__RESULT CODES:__
1 COMPLETED
2 PARTLY COMPLETED
3 NO HOUSEHOLD MEMBER AT HOME OR NO COMPETENT RESPONDENT AT HOME AT THE TIME OF VISIT
4 ENTIRE HOUSEHOLD ABSENT FOR EXTENDED PERIOD OF TIME
5 POSTPONED
6 REFUSED
7 DWELLING VACANT OR ADDRESS NOT A DWELLING
8 DWELLING DESTROYED
9 DWELLING NOT FOUND
10 OTHER (SPECIFY)_____

TOTAL PERSONS IN HOUSEHOLD

TOTAL ELIGIBLE WOMEN

TOTAL ELIGIBLE MEN

LINE NO. OF RESP. TO HOUSEHOLD QUEST.

HH INT. IN 1=YES ROUND 2 2=NO

LANGUAGE

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

SUPERVISOR NAME_____ DATE_____	FIELD EDITOR NAME_____ DATE_____	KEYED BY

INFORMED CONSENT FOR HOUSEHOLD

Population, Health and Poverty in Accra

Principal Investigator: Prof. Francis Dodoo

Address: Regional Institute for Population Studies.
University of Ghana, Legon

My name is …… I am from the Regional Institute for Population Studies (RIPS), University of Ghana. The Institute is currently conducting a survey on urban health and poverty in Ga Mashie and Agbogbloshie in Accra. The purpose of the survey is to understand the relationship between urban health and poverty in Ghana. We will ask you questions about general characteristics of your household and members of your household: the composition, age and sex, educational attainment, etc. The information you provide would inform any future intervention programmes and teaching and learning in RIPS and other tertiary institutions.

During the interview, I will only ask you questions about you and your household. I will not be conducting any medical exams or tests; I will only be asking questions. We do not believe that there are any risks associated with participation in this study. You are free to decide if you want to be in this research. Your decision will not affect any service(s) and benefits you would normally receive. Your participation is entirely voluntary.

If you agree to be interviewed, the interview will last about 45 minutes. In the course of the discussion you may choose not to answer a question or even stop the interview altogether. If you choose to stop the discussion, all the responses you provide will be deleted from the study. However, if you consent to the interview, all the information that you give will remain confidential.

We will protect information about you and your taking part in this research to the best of our ability. You will not be named in any reports. However, the staff of the Institute may sometimes look at your research records. If you agree to the interview, I will take notes of the conversation between us on paper. Have I explained everything well enough to you? Do you have any questions for me?

After our interview, if you have any concerns regarding the study you may contact any of the following persons: Prof. Francis Dodoo or Prof. Samuel Nii Ardey Codjoe (030-2500274).

This research has been reviewed and approved by the IRB of Noguchi Memorial Institute for Medical Research at the University of Ghana, Legon. An IRB is a committee that reviews research studies in order to help protect participants. If you have any questions about your rights as a research participant you may contact [Rev. Dr. Ayete-Nyampong, Chairperson, NMIMR-IRB, mobile 0208152360]

CONSENT TO PARTICIPATE IN SURVEY

Please sign/thumb print below if you agree to participate in the study.

The above document describing the benefits, risks and procedures for the Population, Health and Poverty study in Accra has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

Respondent's Signature/Thumbprint…… .....
Date……

Thumb

Witness' Signature …….
Date……

Interviewer Signature…….....
Date……

START TIME FOR INTERVIEW

HOURS MINS ☐☐☐☐

HOUSEHOLD SCHEDULE

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

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

02		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	02	02	02
03		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	03	03	03
04		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	04	04	04
05		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	05	05	05
06		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	06	06	06
07		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	07	07	07
08		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	08	08	08
09		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	09	09	09
10		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	10	10	10
11		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEA RS	11	11	11
12		☐☐	M F 1	YES NO 1	YES NO 1	☐☐	IN YEA RS	12	12	12

			2	2	2					
13		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEARS ☐☐	13	13	13
14		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEARS ☐☐	14	14	14
15		☐☐	M F 1 2	YES NO 1 2	YES NO 1 2	☐☐	IN YEARS ☐☐	15	15	15

TICK HERE IF CONTINUATION SHEET USED ☐ NUMBER OF ELIGIBLE WOMEN ☐☐ NUMBER OF ELIGIBLE MEN ☐☐

*** CODES FOR Q3 RELATIONSHIP TO HEAD OF HOUSEHOLD:**

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

****CODES FOR Q7**

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

LINE NO.		**EDUCATION (IF AGE 3 OR OLDER & IF ATTENDED SCHOOL)**			**IF AGE 15 OR OLDER MARITAL STATUS**	**ETHNICITY**	**RELIGION**
	Has (NAME) ever attended school? **NO→16**	What is the highest level of education (NAME) attended?*	What is the highest grade (NAME) completed at that level?**	Is (NAME) still in school?	What is the marital status of (NAME)? ***	What is the ethnic group of (NAME)? ****	What is the religion of (NAME)? *****
	(12)	**(13)**	**(14)**	**(15)**	**(16)**	**(17)**	**(18)**
01	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECI	☐☐
02	YES NO	☐	☐☐	YES NO	☐	☐☐	☐☐

	1 2			1 2		96=OTHER SPECIF	
03	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY.....	☐☐
04	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
05	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
06	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
07	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
08	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
09	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
10	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
11	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
12	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
13	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
14	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIFY	☐☐
15	YES NO 1 2	☐	☐☐	YES NO 1 2	☐	☐☐ 96=OTHER SPECIF.	☐☐

Just to make sure that I have a complete listing:

1) Are there any other persons such as infants or children that we have not listed? YES ☐ ☐
   → ENTER EACH IN TABLE NO
2) In addition, are there any other people such as domestic servants, lodgers or friends who usually live here? ☐ ☐
   YES → ENTER EACH IN TABLE NO

3) Are there any guests or temporary visitors staying here, or anyone else who slept here last night that I have not listed? ☐ ☐
YES → ENTER EACH IN TABLE NO

4) Are there any persons who used to live in your household but have moved out in the past (SKIP ONE ROW) ☐
1 year? ☐
YES → ENTER EACH IN TABLE NO

HOW MANY?

***CODES FOR Q13**
0=PRE-SCHOOL
0=NEVER MARRIED
1=PRIMARY
1= LIVING TOGETHER
2=JHS/MIDDLE
2= MARRIED
3=SHS/SECONDARY
3= SEPARATED
4=HIGHER
4=DIVORCED
8=DON'T KNOW
5= WIDOWED

****EDUCATION GRADE**
00=LESS THAN 1 YEAR
98=DON'T KNOW

******CODES FOR Q14 ***CODES FOR Q16 Q17**
01=AKAN
02=GA-DANGME
03=EWE
04=GUAN
05=GURMA
06=MOLE-DAGBANI
07=GRUSI
08=MANDE
96=OTHER (SPECIFY)

RECORD ADJACENT TO TO THE CODE ABOVE.

*******CODES FOR Q18**
01= NO RELIGION CHRISTIAN
02= CATHOLIC
03= PROTESTANTS
07=TRADITIONAL/SPIRITUALIST
04= PENTECOASTAL/CHARISMATIC
05=OTHER
06=ISLAM
08=EASTERN RELIGIONS (ECKANKA , HINDU)
96=OTHER
(SPECIFY).....
.....

LINE NO.	FOR VISITORS AND USUAL RESIDENTS	VISITORS ONLY	FOR FORMER RESIDENTS/VISITORS ONLY	OCCUPATION	PopTRCD 2011
	FOR VISITORS: How long has (NAME) been staying here?** **FOR USUAL RESIDENTS** How long has (NAME) lived in this household? **(USE CODES	Where did (NAME) come from? **USE CODES**	**ONLY IF '2' IS CIRCLED IN BOTH COLS. 5 & 6** How long did (NAME) live here before moving	What is (NAME) current occupation? That is what kind of work does (NAME)	Was (NAME) a member of this household during the **2011 EDUL** survey? 1=YES **Q28** 2=NO

	BELOW)**	**BELOW)***	out?**	mainly do?	
	(19)	**(20)**	**(21)**	**(22)**	**(23)**
01	☐	☐	☐	☐☐	☐
02	☐	☐	☐	☐☐	☐
03	☐	☐	☐	☐☐	☐
04	☐	☐	☐	☐☐	☐
05	☐	☐	☐	☐☐	☐
06	☐	☐	☐	☐☐	☐
07	☐	☐	☐	☐☐	☐
08	☐	☐	☐	☐☐	☐
09	☐	☐	☐	☐☐	☐
10	☐	☐	☐	☐☐	☐
11	☐	☐	☐	☐☐	☐
12	☐	☐	☐	☐☐	☐
13	☐	☐	☐	☐☐	☐
14	☐	☐	☐	☐☐	☐
15	☐	☐	☐	☐☐	☐

***CODES FOR Q20**
1= WITHIN THE SAME COMMUNITY
2= ANOTHER COMMUN IN ACCRA
3= ANOTHER TOWN
4= RURAL
5= BOARDING SCHOOL
8=DON'T KNOW

****CODES FOR Q19 AND Q21**
1= DAY
2= WEEKS
3=MONTHS
4= YEARS
5=SINCE BIRTH
8=DON'T KNOW

*****CODES FOR Q22**
01=NO OCCUPATION
02=PROFESSIONAL/ TECHNICAL
03=MANAGEMENT
04=CLERICAL
05=SALES
06=AGRICULTURE-SELF EMPLOYED
07=AGRICULTURE
08=HOUSEHOLD AND DOMESTIC
09=SERVICE
10=SKILLED MANUAL
11=UNSKILLED MANUAL
12=STUDENT
98=DON'T KNOW
96=OTHER (SPECIFY).....

	(24)	**(25)**	**(26)**	**(27)**
	Was there any person(s) who was a member of your	Please give me the name(s) of that	What is the reason for	Where did [NAME] go

	household during **2011 PopTRCD (EDULINK)** survey but currently not a member now? **1=YES 2=NO** **SKIP TO Q28** ☐	person(s)	[NAME]'s absence?****			to?*****		
		a. …… …… …						
		b. …… ……						
		c. …… …… …						
		d. …… …… ..						

****CODES FOR Q26		*****CODES FOR Q27
01 = EMPLOYMENT 02 = LOOKING FOR WORK 03 = SCHOOL 04 = VISIT FAMILY 05 = VISIT FRIENDS 06 = MARRIAGE/COHABITATION	07 = PERSONAL REASONS 08 = ESCAPE VIOLENCE OR POLITICAL PROBLEMS 09 = PRISON 10 = HOSPITAL /CLINIC 11 = NURSING HOME/OLD PERSONS HOME 12 = DIED _ go to Next HH member 96= OTHER (SPECIFY)……	1 = DIFFERENT HOUSEHOLD IN SAME COMMUNITY/LOCALITY/ NEIGHBOURHOOD 2 = RURAL AREA IN DIFFERENT PART OF THE COUNTRY 3 = CITY/URBAN AREA IN DIFFERENT PART OF THE COUNTRY 4 = ANOTHER COUNTRY 8 = DON'T KNOW

CHRONIC NON-COMMUNICABLE DISEASE CONDITIONS

LINE NO.	Has (Name) ever been told by a health professional that he/she has had a **stroke**? 1. YES 2. NO ➔ **Q35**	Has (Name) been taking any medications or other treatment for it during **the last 2 weeks?** 1. YES 2. NO	Has (Name) been taking any medications or other treatment for it during **the last 12 months?** 1. YES 2. NO	Has (Name) ever been diagnosed with high blood pressure (**hypertension**)? 1. YES 2. NO ➔ **Q38**	Has (Name) been taking any medications or other treatment for it during **the last 2 weeks?** 1. YES 2. NO **(Other treatment might include weight loss program or change in eating habits.)**	Has (Name) been taking any medications or other treatment for it during **the last 12 months**? 1. YES 2. NO **(Other treatment might include weight loss program or change in eating habits.)**
	(32)	**(33)**	**(34)**	**(35)**	**(36)**	**(37)**
01	☐	☐	☐	☐	☐	☐
02	☐	☐	☐	☐	☐	☐

03	☐	☐	☐	☐	☐	☐
04	☐	☐	☐	☐	☐	☐
05	☐	☐	☐	☐	☐	☐
06	☐	☐	☐	☐	☐	☐
07	☐	☐	☐	☐	☐	☐
08	☐	☐	☐	☐	☐	☐
09	☐	☐	☐	☐	☐	☐
10	☐	☐	☐	☐	☐	☐
11	☐	☐	☐	☐	☐	☐
12	☐	☐	☐	☐	☐	☐
13	☐	☐	☐	☐	☐	☐
14	☐	☐	☐	☐	☐	☐
15	☐	☐	☐	☐	☐	☐

CHRONIC NON-COMMUNICABLE DISEASE CONDITIONS							
LINE NO.	Has (Name) ever been diagnosed with **<u>diabetes</u>** (high blood sugar)? (Not including diabetes associated with a pregnancy) 1. YES 2. NO ➔ **Q41**	Has (Name) been taking insulin or other blood sugar lowering medications during **<u>the last 2 weeks</u>**? 1. YES 2. NO	Has (Name) been taking insulin or other blood sugar lowering medications during **<u>the last 12 months?</u>** 1. YES 2. NO	Has (Name) ever been diagnosed with any other chronic non-communicable disease apart from conditions mentioned in **(Q32, Q35, and Q38 - Stroke, hypertension and diabetes)** 1. YES 2. NO ➔ **Q45**	If Yes in **Q41**, please specify: ***(Interviewer, record all mentioned)****	Has (Name) been taking any medication or therapy for the condition during **<u>the last 2 weeks</u>**? 1. YES 2. NO	Has (Name) been taking any medication or therapy for the condition during **<u>the last 12 months?</u>** 1. YES 2. NO
	(38)	**(39)**	**(40)**	**(41)**	**(42)**	**(43)**	**(44)**

01							
02							
03							
04							
05							
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							

Code For Q42*
1=ARTHRITIS
2=ANGINA (coronary heart disease)
3=ASTHMA
4=CANCER
5=DEPRESSION
6= OTHER (SPECIFY)……………………………….

HOUSEHOLD CHARACTERISTICS

NO.	QUESTION	RESPONSE
45	What is the main source of water supply for your household? 1=INDOOR PLUMBING 8=BOLEHOLE 2=PRIVATE OUTSIDE STANDPIPE/TAP	

9=DUGOUT/POND/LAKE/DAM

3=RIVER/STREAM 10=WATER VENDOR

4=INSIDE STANDPIPE
11=PROTECTED WELL

5=PUBLIC STANDPIPE 12=PIPE IN NEIGHBORING HOUSEHOLD

6= RAIN WATER/ SPRIN
13=UNPROTECTED WELL

7=WATER TRUCK/TANKER
14=SACHET/BOTTLED WATER

15=OTHER

SPECIFY_____

46 How much water does your household use in a day?

UNIT	QUANTITY
Litres	
Gallons	
Buckets	
Other…… ……..	

47 Please complete the following table relating to your household water use (by the individuals who fetch water)

Individual	Age	Occupation	Estimated hourly income /wage	Water source	Round trip time to water source	Time spent at the source	Quantity of water collected per trip	Price per quantity indicated	Number of trips per week

48	How regular is the flow of water from your main source of water supply? 1=DAILY 2=WEEKLY 3=FORTNIGHTLY D=MONTHLY		
49	How is the main water source system operated? 1= SELF 2=COMMUNITY OPERATED AND MANAGED 3=NGO 4=COMMUNITY WATER AND SANITATION AGENCY 5=GHANA WATER COMPANY LTD 6=OTHER SPECIFY		
50	If you have an indoor plumbing system, does the household pay a regular bill for this water supply? 1=YES 2=NO 3=NO INDOOR PLUMBING		**If code 2 or 3 skip to 52**
51	How much was the last bill? (Only your part if joint meter or shared bill)	Amount in GH₵	
52	How much did your household pay to a private water vendor, water from neighbouring standpipe, or any other source in the last 2 weeks	Amount in GH₵	
53.	Did your household sell any water to someone else? 1=YES 2=NO		**If code 2, skip**

			to 55
54	How much did your household receive from the water sold in the last 2 weeks? Don't know=999.98	Amount in GH₵	
55	Do you store water in your house so as to use it for more than one day? 1=YES 2=NO		**If code 2, skip to 61**

NO	**Question**	**Response**	**SKIP**
56	How do you mainly store your drinking water? *Codes below*		**IF CODE, 1,3,5,7, 8 9 SKIP to 59**
57	If container has a lid, does the lid screw on or attach tightly to the container? 1=YES 2=NO		
58	Does the container have a spigot or small mouth or tap for dispensing water? =YES 2=NO		
59	Do you do anything to make this water safe to drink? 1=YES 2=NO 8=DON'T KNOW		**IF CODE 2 OR 8, SKIP to 61**
60	What do you usually do to make the water safe to drink? *Codes below*		
61	What kind of toilet facility does your household use? *Codes below*		
62	Do you share the above mentioned toilet facility with other households?		

	1=YES 2=NO		
63	Do you have a refuse bin in your household? 1=YES 2=NO		
64	Who **usually** disposes of the household solid waste? 1=ADULT WOMAN 2=ADULT MAN 3=FEMALE CHILD (UNDER 15 YEARS) 4=MALE CHILD (UNDER 15 YEARS)		
65	Where do you dispose of household solid waste? 1=COLLECTED AT HOME BY A PRIVATE COMPANY 4=COMMUNITY DRAIN 2=COLLECTED AT HOME BY A GOVERNMENT AGENCY 5=TRUCK PUSHERS (KAYA BOLA) 3=REFUSE CONTAINER 6=INDISCRIMINATELY 7=OTHER……		
66	Do you pay for disposing of household solid waste? 1=YES 2=NO		**IF CODE 2, SKIP to 68**
67	How much do you pay monthly?		
68	How do you dispose household liquid waste (waste water from bathing, preparation of food, cooking and other personal and domestic activities)? 1=SEPTIC TANK 2=COMMUNITY DRAIN 3=BACK OF HOUSE 4=INDISCRIMINATELY 5=OTHER (SPECIFY)……		
69	What is the main source of cooking fuel for this household? *codes below*		

70	Does your household have……. ?		**1=YES 2=NO**		**1=YES 2=NO**
		CAR		WASHING MACHINE	
		BICYCLE		TELEVISION	
		BOAT/CANOE		RADIO	
		TRUCK		TELEPHONE	
		AN OUTBOARD MOTOR		CLOCK	
		REFRIGERATOR		ELECTRIC/GAS STOVE	
		FREEZER		SOFA	
		GENERATOR		SEWING MACHINE	
		IRON		ELECTRIC FAN	
		COMPUTER		FISHING NET	

Codes: Question 56	**Codes: Question60:**	**Codes: Ques.61**	**Codes: Q69**
1=OVERHEAD TANK 2=PLASTIC/STEEL CONTAINER WITH LID 3=PLASTIC/STEEL CONTAINER WITHOUT LID 4=EARTHEN WARE POT WITH LID 5=EARTHEN WARE POT WITHOUT LID 6=ALUMINIUM BUCKET WITH LID 7=ALUMINIUM BUCKET WITHOUT LID	01=BOIL 02=ADD BLEACH, CHLORINE, OR ALLOY 03=STRAIN THROUGH A CLOTH 04=SOLAR DISINFECTION 05=LET IT STAND TO SETTLE 06=WATER TABLETS	1=NO FACILITY (BUSH/BEACH/FIELD) 2=WATER CLOSET (W.C)/FLUSH TOILET 3= KVIP 4= PIT LATRINE 5=BUCKET/PAN 6=PUBLIC TOILET (W.C,KVIP, PIT LATRINE,BUCK	01=NONE/NO COOKING 06=CHARCOAL 02= WOOD 07=CROP RESIDUE 03=GAS 08=SAW

8=BASIN(PLASTIC/ALUMINIUM/ENAMEL 9=SACHET 10=OTHER	07=ALUM 08=CAMPHOR 09=OTHER (SPECIFY)…… ….. 98= DON'T KNOW	ET/PAN) 96=OTHER (SPECIFY)…… ……	DUST 04=ELECTRICITY 09=ANIMAL WASTE 05=KEROSENE 96=OTHER (SPECIFY)……

71	How many rooms does this household occupy? (*count living, dining, bedrooms but not bathrooms ,toilet & kitchen*)	☐☐
72	How many of the rooms are designed primarily for sleeping?	
73	How many household members sleep outside the designated sleeping rooms? **CODE 00 IF NO HOUSEHOLD MEMBER SLEEPS OUTSIDE**	☐☐
74	Who owns this dwelling? 1=OWNED BY HH MEMBER 5=PRIVATE EMPLOYER 2=BEING PURCHASED (e.g., Mortgage) 6=OTHER PRIVATE AGENCY 3=RELATIVE NOT HH MEMBER 7=PUBLIC/GOVERNMENT OWNERSHIP 4=OTHER PRIVATE INDIVIDUAL 96=OTHER (SPECIFY)_____	☐
75	What is the present holding/tenancy arrangement of this dwelling? 1=OWNING 2=RENTING 3=RENT FREE 4=PERCHING 5=SQUATTING 6=OTHER (SPECIFY)_____	☐

HOUSEHOLD OBSERVATION

76	What type of dwelling does this household occupy? ***Record observation*** 01=SEPARATE HOUSE 04=ROOMS 07=KIOSK	☐☐

	02=SEMI-DETACHED HOUSE 05=SEVERAL HUTS/ BUILDING 08= CONTAINER 03=FLAT/APARTMENT 06=TENT 09= ATTACHED TO SHOP 10= COMPOUND HOUSE 96=OTHER (SPECIFY)_____	
77	What is the main material of the floor? ***Record observation*** 01=EARTH/SAND 04=WOOD 10=VINYL TILES 07=WOOLEN CARPET 02=BURNT BRICKS 05=WOOD PLANKS 08=LINOLEUM/RUBBER CARPET 03=CEMENT/CONCRETE 06=TERRAZO 09=CERAMIC TILES/PORCELAIN GRANITE/MARBLE 10=VINYL TILES 11=STONE	☐☐
77	What is the main material of the roof? **RECORD OBSERVATION** 01=THATCH/PALM LEAF/SOD 06=ROOFING SHINGLES 02=RUSTIC MAT 07=ASBESTOS/SLATE ROOFING SHEETS 03=CARDBOARD 08=PALM/BAMBOO 04=METAL SHEETS 09=WOOD 05=BRICK TILES 10=CEMENT 96=OTHER (SPECIFY)....	☐☐
78	What is the main material of the wall? **RECORD OBSERVATION** 01=CANE/PALM/TRUNKS 08=MUD BRICKS 02=BAMBOO WITH MUD 09=STONE WITH MUD 03= WOOD 10= PLYWOOD 04=CARDBOARD 11=BAMBOO 05=LANDCRETE BLOCKS/CONCRETE 12=CEMENT 06=BURNT BRICKS 07=METAL SHEETS/SLATE/ASBESTOS 96=OTHER (SPECIFY).....	☐☐

79	**INCOME EVALUATION QUESTION (IEQ)** Taking into account your own situation with respect to the physical characteristics of your family and job you would call your net-income (including gifts from family and friends, and tips) per year	

	GHANA CEDIS
MORE THAN WHAT YOU NEED (IF IT WERE ABOVE)	
JUST WHAT YOU NEED (IF IT WERE BETWEEN)	
BARELY WHAT YOU NEED (IF IT WERE BETWEEN)	
LESS THAN WHAT YOU NEED (IF IT WERE BETWEEN)	
MUCH LESS THAN WHAT YOU NEED (IF IT WERE BELOW	

80	Who is the primary source of income for this household? 1=HEAD OF HOUSEHOLD 3=BOTH SHARED EQUALLY (HEAD AND SPOUSE) 2=PARTNER/SPOUSE 4= A DIFFERENT MEMBER OF THE HOUSEHOLD 6=OTHER(SPECIFY).....	☐
81	How much can you rely on relatives outside of your household or friends for financial support if you need it**?** 1=A LOT 2=SOMETIMES 3=A LITTLE 4=NOT AT ALL	☐

NO	**Question**		**Response**	
82	Who manages sanitation resources in your community?		**YES**	**NO**
		AMA/SUB-METRO	1	**2**
		UNIT COMMITTEE	1	**2**
		LOCAL WATER/SANITATION COMMITTEE	1	**2**
		COMMUNITY DEVELOPMENT	1	**2**

		COMMITTEE		
		NGO	1	**2**
		TRADITIONAL LEADER(S)	1	**2**
		RELIGIOUS ORGANISATION(S)	1	**2**
		PRIVATE INDIVIDUAL(S)	1	**2**
		PRIVATE ORGANISATION	1	**2**
		OTHER……	1	**2**
		DON'T KNOW	1	**2**
83	What are the major environmental challenges that you face in this community		**YES**	**NO**
		1. FLOODING	1	**2**
		2. POOR SANITATION	1	**2**
		3. POLLUTION	1	**2**
		4. HIGH TEMPERATURE (HEAT)	1	**2**
		5. SEA LEVEL RISE	1	**2**
		6. OTHER (SPECIFY)……	1	**2**
84	Which is the most challenges environmental issue mentioned in Ques.78 above?			
85	What are the most common diseases in this community that are associated with these		**YES**	**NO**
		1. DIARRHOEA	1	**2**

	environmental challenges?	2. MALARIA	1	**2**
		3. CEREBRO-SPINAL MENINGITIS	1	**2**
		4. SKIN RASH	1	**2**
		5. COUGH/DIPHTHERIA	1	**2**
		6. OTHER (SPECIFY)	1	**2**
			1	**2**
86	What is the most common disease mentioned in Ques.80 in this community that is associated with environmental challenges?			
87	What is the distance from your house to the nearest standing water or open gutter? *Distance in meter*			
88	When was the last time you or any member of your household had diarrhoea? 1=LESS THAN A WEEK AGO 2=A WEEK AGO 3=TWO WEEKS AGO 4=THREE WEEKS AGO 5=A MONTH AGO 6=MORE THAN A MONTH AGO			
89	How many times did you or any member of your household have diarrhoea within the past month?			
90	Did you or the member of your household seek advice or treatment for the diarrhoea (from any source)? 1=YES 2=NO			**If code 2 SKIP to Q. 93**
91	Where did you first seek advice or treatment for the diarrhoea? 1=HOSPITAL/CLINIC 2=PHARMACY/DRUG STORE 3= HERBAL MEDICINE (SELF PRESCRIPTION)			
92	How many days after the diarrhoea began did you first seek advice or treatment?			
93	The last time the youngest child (**under 5 years**) passed stool,			

	what was done to dispose of the stool? **CHECK HH ROSTER IF THERE IS A CHILD UNDER 5 YEARS** 1=CHILD USED TOILET/LATRINE 2=PUT/RINSED INTO TOILET OR LATRINE 3=PUT/RINSED INTO DRAIN OR DITCH 4=THROWN INTO GARBAGE 5=BURIED 6=LEFT IN THE OPEN 7=OTHER (SPECIFY)……..... 8=DON'T KNOW	

Household level conditions and adaptive capacity

94	Have you noticed any change in climate (Rainfall and Temperature) for past 30 years? 1=YES 2= NO	☐	**IF CODE 2 SKIP TO Q99**

95 What changes have you noticed?

	1=YES 2=NO
Getting more rainfall than before	
Less rainfall than before	
Rainfall becoming erratic/unpredictable	
Increased in temperature	
Decrease in temperature	
Don't know	

93	how sure are you that the pattern of rainfall and temperature are changing? 1=Extremely sure 2=Sure 3=Somewhat sure 4=Not at all sure	☐

94	How worried are you about the changing pattern of rainfall and temperature? 1=Very worried 2=Somewhat worried 3=Not worried 4=Not at all worried	
95	What in your opinion causes these changes in rainfall and temperature? 1=Cars and trucks 4=Toxic wastes 2=Burning fuel for heat and electricity 5=Aerosol spray cans 3=Deforestation 6=Volcanic eruptions 7=Cow rearing	
96	Which of the above mentioned factors contribute most to changes in rainfall and temperature? 1=Cars and trucks 4=Toxic wastes 2=Burning fuel for heat and electricity 5=Aerosol spray cans 3=Deforestation 6=Volcanic eruptions 7=Cow rearing	
97	What in your opinion, what is the effect of changing pattern of rainfall and temperature on the one's chances of getting malaria? 1=It promotes the breeding of mosquitoes 2=It increases one's chances of getting malaria 3=It does not affect incidence of malaria 4=Other, specify……	
98	In your opinion, what actions can be taken to reduce the effect of changing pattern of rainfall and temperature on the incidence of malaria? 1=Use of mosquito net 2=Use mosquito coil/repellent 3=Clean our environment 4=Desilting chocked gutters 5=Other, specify …….	
99	Indicate which of the following reflects your household's capacity to prevent and treat malaria	

	1=My household has adequate capacity to prevent the incidence of malaria 2=My household has inadequate capacity to prevent the incidence of malaria 3=My household has adequate capacity to treat malaria 4=My household has inadequate capacity to prevent and treat malaria	
100	The last time you or any member of your household was diagnosed of malaria, were you made to undergo a laboratory test for confirmation 1 = YES 2 = NO	☐
101	If household members do not seek treatment from health facility, what reason do they have for not seeking treatment from health facility 1= I believe the herbs are effective 2=Lack of money 3=Delays/long queue in the hospital 4=Treat rom the facility not effective 5=Other, Specify_____	☐
102	Considering your household's condition as well as the prevailing conditions in your community, how would you rate your household risk or vulnerability to the incidence of malaria on a scale of 1-5? 0=No Risk 1=Small 2=Moderate 3=Great	
103	During the last rainy season (May to July) did your community experience any flooding? 1 = YES 2 = NO ☐	**IF CODE 2 SKIP TO Q108**
104	How many times did you experience it within the season?	☐☐

	1=It promotes the breeding of mosquitoes 2=It increases one's chances of getting malaria 3=It does not affect incidence of malaria 4=Other, specify……	
105	If flooding occurred in your community during the last season, how many days did it take for the area to completely dry up?	
106	If flooding occurred in your community during the last season, how would you rate it: 1= MILD 2= MODERATE 3=SEVERE	
107	How often is your house affected by flooding in a year? 1=Once a year 2=Two or more times a year 3=Not affected at all	
108	What in your opinion causes malaria? *(tick those mentioned)*	

1. Bites from infected mosquitoes	
2. Dirty environment	
3. Too much exposure to sunlight	
4. Eating oil rice	
5. Bites from mosquitoes	
6. Other specify	

109	On the average how much do you spend on the treatment of each episode of malaria?	Amount in GHC
110	The last time you or any member of your household was sick of malaria, how much did you or the person spend on malaria medication?	Amount in GHC

111	Are the windows in the house covered with mosquito-proof screens/net? 1 = YES 2 = NO	☐	
112	On average, how much does your household spend on the following each month? 1=MOSQUITO COILS 2=MOSQUITO SPRAY 3=MOSQUITO REPELLING CREAM	Amount in GHC	
113	What is the total amount of money you and the members of your household spend on health related issues each month, on the average?	Amount in GHC	
114	How often do you receive health related information or assistance in this community? (from any source) 1=At least once a year 2=More than once a year 3=Not at all	☐	IF CODE 3 SKIP TO Q116
115	What is the main source of the information? 1=TV 5=MOSQUES/CHURCHES 9=WORK PLACE 2=RADIO 6=SCHOOLS/TEACHES 10=DRAMA /PERFORMANCE 3=NEWSPAPER 7=COMMUNITY MEETING 11=OTHER (SPECIFY_____ 4=PAMPLETS/POSTERS 8=FRIENDS/ RELATIVES	☐	

	Is there any institution you turn to for help	Mention the kind of	Specify amount in monetary	Have you received any support from	How wo

	when you have health related problems in this community? *(Tick all that apply)*	support received. *Codes below**	terms or specify type of kind	organisation in the past one year?	uld you rate the support received? *Codes below* **
	(116)	**(117)**	**(118)**	**(119)**	**(120)**
Community based organization					
Private organization					
Government agency					
Other					

Codes for Q117	**CodesQ120**
1=Monetary	1=Able to meet all the need of household at the time
2=In kind	2=Somewhat able to meet the need of household?
3=Moral/psychological	3=Not helpful at all

HOUSEHOLD AND FAMILY SUPPORT NETWORKS AND TRANSFERS

The next questions are about your family and friends, specifically those not living with you in this household. Families and friends sometimes help one another in a variety of ways, and each type of help or support can be important. Part of our survey involves finding out how they do that. We

would now like to ask some questions about your family and friends who do not live with you, and the different ways in which you help or support each other. The next questions are about help received by your household in the last 12 months.			
121.	Has any member of the household received any financial credit/loan within the past one year? 1 = YES 2 = NO	☐	
122.	In the last 12 months, has anyone in the household **received** any financial or in-kind support from your family (children, siblings or parents), relatives (other kin) and friends who do not live with you? 1=YES 2=NO 8=DON'T KNOW	☐☐	**IF CODE 2 OR 8 SKIP TO Q126**
123.	What type of assistance did your household receive? 1=MONEY ONLY 2=KIND ONLY (Specify)…… 3=BOTH MONEY AND KIND ……	☐	
124.	What is/are the main purpose(s) of the support? a. General and household upkeep b. Education c. Medical care d. Business and work related e. Social events f. Other	☐ ☐ ☐ ☐ ☐ ☐	
125.	About how much would this assistance amount to over the last 12 months in Ghana Cedi (**GH¢**) ***(if in kind impute and estimate the value)***	**GH ¢** 0 0 0 0 0 0	
126.	In the last 12 months, has your household **provided** any financial aid or in-kind support to any of your children, grandchildren and/or other family (and those of your spouse) who do not live in this household? 01=YES 02=NO 8=DON'T KNOW	☐☐	**IF CODE 2 OR 8 SKIP TO Q130**
127.	What type of assistance did your household provide? 1=MONEY ONLY 3=BOTH MONEY AND KIND 2=KIND ONLY (Specify)…… ……	☐	
128.	What is/are the main purpose(s) of the support provide? a. General and household upkeep b. Education c. Medical care d. Business and work related e. Social events f. Other	☐ ☐ ☐ ☐ ☐ ☐	
129.	Can you give an approximate total amount for this for the last 12 months in Ghana Cedis (**GH¢**) ***(if in kind impute***	**GH ¢** 0 0 0 0 0 0	

	and estimate the value)	
130.	During the past year, did you or someone in your household provide help to a relative or friend (adult or child), because this person has a long-term physic or mental illness, or disability, or is getting old and weak? 1=YES, physical illness 2=YES, mental illness 3= YES, DISABILITY 4= YES, GETTING OLD AND WEAK 3=NO	☐

FOOD SITUATION AND EXPENDITURE

Was there a day in the previous 30 days when you or any member of the household did not have enough food to eat? ☐

0=No 1=Between 1-5 days 2=Between 6-10 days 3=More than 10 days

Please indicate whether your household bought cooked food (breakfast, lunch and dinner) from street vendors for each of the days within the past week.

DAY	BREAKFAST	LUNCH	DINNER
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Sunday			

Please indicate the total expenditure your household made on cooked food (breakfast, lunch and dinner) from street vendors within the past week.

BREAKFAST	LUNCH	DINNER
