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FACULTY OF ARTS AND HUMANITIES

FARMING COMMUNITIES VULNERABILITY TO MALARIA UNDER CLIMATE CHANGE CONDITIONS IN THE BOLE DISTRICT, NORTHERN REGION, GHANA

Thesis No:

Thesis submitted in fulfilment of the requirements for the Master Research Degree
Domain: Humanity and Social Sciences
Mention: Climate Change
Speciality: Human Security
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ABSTRACT

This paper assessed farming communities vulnerability to malaria under climate change conditions in an area of northern region of Ghana, namely, Bole district. The study focused on factors influencing the farming households' vulnerability to malaria especially those related to climate change. It analysed the trend in rainfall and temperature data series; it estimated the direct and indirect cost of malaria care; and it determined the proportion of farming households' income spent on malaria treatment.

Primary data were obtained through questionnaire administration and focus group discussion while temperature and rainfall data were sourced from the Ghana Meteorological Service. Outpatient diagnosis data were obtained from Ministry of Health and health centres.

The result reveals a clear evidence of increasing in temperature patterns during the period under investigation. It also showed an increase of malaria cases during rainy season. A part from increase of temperature, total direct cost of malaria care, number of people comprising the farming household, support for malaria prevention, information about mosquito breeding and development and absenteeism from farm emerged as the main factors influencing the farming households' vulnerability to malaria. Furthermore, malaria care represent a substantial portion of poor farming household income, direct and indirect cost of malaria treatment is negatively affecting the household budget.

The outcome of this study should help the government to reinforce the National Malaria Control Program at the farming household level and to make National Health Insurance Scheme more efficient.

Furthermore, a similar study should be conducted to look at the effects of temperature increase on the direct and indirect cost of malaria treatment over a certain number of years in order to ascertain the real effect of temperature increase on the cost of malaria treatment.

Keywords: Trend analysis, climate change, malaria vulnerability, direct and indirect cost.

RESUME

Ce document a permis d'évaluer la vulnérabilité des communautés agricoles au paludisme sous l'effet du changement climatique au nord du Ghana, plus précisément dans le district de Bolé. L'étude s'est focalisée sur les facteurs influençant la vulnérabilité des ménages agricoles au paludisme, spécialement ceux liés au changement climatique. Il a analysé l'évolution des données de pluie et de température; a estimé le coût direct et indirect du traitement du paludisme; et a déterminé la proportion du revenu des ménages agricoles dépensé pour le traitement du paludisme.

Les données primaires sont collectées au travers de l'administration du questionnaire et le focus group discussion, tandis que les données de température et de pluie sont obtenues au service météorologique du Ghana. Les données sur les consultations médicales sont obtenues au Ministère de la santé et dans les centres de santé.

Les résultats révèlent une nette augmentation dans la série de données de température sur la période considérée. Le nombre de personnes souffrant du paludisme croît pendant la saison pluvieuse. Mise à part la température, lecoût total direct du traitement du paludisme, le nombre de personnes dans le ménage, l'appui pour la prévention du paludisme, la possession d'informations sur la reproduction et le développement des moustiques, l'absentéisme au champ, et l'augmentation de température se sont révélés comme facteurs influençant la vulnérabilité des ménages agricoles au paludisme. De plus, le traitement du paludisme représente une partie considérable du revenu des pauvres ménages agricoles, et son coût direct et indirect impactent négativement le budget des ménages.

L'issue de cette étude devait aider le gouvernement à renforcer le programme national du contrôle du paludisme au niveau des ménages agricoles et à rendre plus efficace l'assurance maladie.

En outre, une étude similaire devait se focaliser sur les effets de l'augmentation de température sur les coûts direct et indirect du traitement du paludisme sur une longue période dans le but d'établir l'effet réel de ce facteur sur le coût du traitement du paludisme.

Mots clés: Analyse des variations, changement climatique, vulnérabilité, paludisme, coûts direct et indirect.

CHAPTER 1

INTRODUCTION

This introductory chapter defines the research problem, highlights the objectives of the study, and poses the research questions. The chapter concludes with the organization of the remaining chapters.

1.1-Problem statement

There are four parasitic protozoans which cause malaria: *Plasmodium falciparum*,*malariae*, *ovale*,and *vivax*. Of these parasites, *falciparum* is the most dangerous and can cause coma or death. Symptoms include high fever, chills, vomiting, and nausea and they do not appear until 10-15 days after the initial mosquito bite (WHO, 2009).

Malaria, especially common in sub-Saharan Africa, is an infectious disease caused by the parasitic protozoan *Plasmodium*, which can only be transferred by the female *Anopheles* mosquito. Malaria is spread when the mosquito bites into a person who is already infected. The parasites from the blood uptake reproduce in the mosquito and mix with the saliva so that the next time the mosquito bites another person, parasites are transferred (WHO, 2009).

According to the latest estimates (WHO, 2014),198 million cases of malaria occurred globally in 2013 (uncertainty range 124–283 million) and the disease led to 584 000 deaths (uncertainty range 367 000–755 000), representing a decrease in malaria case incidence and mortality rates of 30% and 47% since 2000, respectively. But the burden is heaviest in the WHO African Region, where an estimated 90% of all malaria deaths occur, and in children aged under 5 years, who account for 78% of all deaths.

The number of people dying from malaria has fallen dramatically since 2000 and malaria cases also are steadily declining. Between 2000 and 2013, the malaria mortality rate decreased by 47 % worldwide (WHO, 2014). In the WHO African Region, where about 90 % of malaria deaths occur, the decrease is 54 %; globally, 670 million fewer cases and 4.3 million fewer malaria deaths occurred between 2001 and 2013 than would have occurred had incidence and mortality rates remained unchanged since 2000. Every year, malaria kills approximately 630,000 people – mostly children under the age of five. About 90% of all malaria deaths occur in sub-Saharan Africa, where on average, a child dies of malaria nearly every minute of the day.[1]

A report by the **N**ational **M**alaria **C**ontrol **P**rogramme (NMCP) estimates that, Ghana recorded about 11.3 million cases of Outpatients Department (OPD) malaria in 2013. On the average 30,300 of such cases were seen each day in the county's health facilities. The report highlights that the malaria burden is not felt only in the health sector, but in every aspect of our social and economic life. Currently, there is inadequate funding for malaria control activities with heavy dependence on donor funding. Therefore, calls for the mobilization of more domestic funding from both government and corporate institutions to fight malaria are increasing.

According to UNICEF (2007), 3.5 million people contract malaria every year in Ghana. Approximatively 20,000 children die from malaria every year (25 % of the deaths of children under the age of five); the malaria death rate per 100,000 population, all ages was 74 in 2008[2]and 61.9 per 1000 population in 2010[3].About 80 percent of all sick cases reported at the Mankumah Health Center in the Bole district are observed to be Malaria and Malaria related cases[4].

"Malaria traps the people of Africa, stops adults from earning a living and children from going to school; each year families spend the equivalent of several months' earnings on malaria treatment and prevention, it does not have to be like this, more efforts need to be pursued to combat it ….." said the Nigerian President Olusegun Obasanjo on the First Africa Malaria Summit on 25th April in Nigeria.

According to Konradsen et al.cited by Akazili(2000), apart from health institutional costs, a malaria episode has direct financial consequences for the household involved, because of expenditure on medical consultation, diagnosis, treatment, travel, and special diet for the malaria patient; andmalaria exacts a heavy burden on the poorest and most vulnerable communities. It primarily affects low and lower-middle income countries. Within endemic countries, the poorest and most marginalizedcommunities are the most severely affected (WHO, 2014).They have the highest risksassociated with malaria and the least access to effective services for prevention, diagnosis and

[1]www.one.org,retrieved on 10th March 2015
[2]www.indexmundi.com retrieved on 10th March 2015
[3]www.theguardian.com retrieved on 10th March 2015
[4]www.allafrica.com retrieved on 10th March 2015

treatment. Thus, malaria control and ultimately its elimination is inextricably linked with health system strengthening, infrastructure development and poverty reduction.

Vector-borne diseases are among the diseases that have been linked with climate change (IPCC, WGII,2007). Malaria is probably the deadliest climate sensitive vector-borne disease. The annual economic costs of malaria in Africa in terms of foregone production have been estimated to be about US $12billion (WHO, cited in Egbendewe et al., 2011). However, that estimate is likely low as it neglects costs of treatment, loss of life, and lifelong disabilities that often result from childhood infections.

Malaria is transmitted by mosquitos carrying malaria parasites. Its distribution depends on the availability and productivity of mosquito breeding habitat. The availability of the breeding habitat is related to stagnant water that remains after rainfall while productivity of the breeding habitat is a function of the ambient temperature. Rainfall rises the abundance of the breeding habitat while higher temperature increases the malaria risk by shortening the malaria parasites development-cycle.(Hay et al., cited in Egbendewe et al., 2011);the average life span of a mosquito carrying malaria parasites is about 21 days. It takes 19 days for the malaria parasite to mature inside the mosquito at 22 degrees Celsius and 8 days to mature at 30 degrees Celsius. At temperatures less than 50 degrees, adult female shut down for the winter; some of their species find holes where they wait for warmer weather, while others lay their eggs in freezing water and die. The eggs keep until the temperatures rise, and they can hatch.

Apart from the African highlands and the farthest southern and northern African regions, the annual mean temperature on the African continent is above 25 degrees Celsius. Therefore, the projected increase in mean temperature of about 1.4 to 5.8 degrees Celsius under climate change may result in a faster parasite development and a potentially higher incidence of malaria. (IPCC, WGI, 2007).

Africa’s food production systems are among the world’s most vulnerable because of extensive reliance on rainfed crop production, high intra and inter-seasonal climate variability, recurrent droughts and floods that affect both crops and livestock, and persistent poverty that limits the capacity to adapt (Boko et al., cited in IPCC,WGII, 2013).

Agriculture in Africa will face significant challenges in adapting to climate changes projected to occur by mid-century, as negative effects of high temperatures become increasingly prominent under an A1B scenario (Battisti and Naylor; Burke et al., cited in WGII, IPCC, 2013), thus increasing the likelihood of diminished yield potential of major crops in Africa (Schlenker and Lobell; Sultan et al., cited in WGII, IPCC, 2013).Thus, Sub-Sahara African agriculture is very sensitive to climate change (includes temperature rise, precipitation, and extreme events) because it is a rain fed agriculture.

Malaria doesnot just cause illness and deaths around the world; it decreases productivity and increases the risk of poverty for the communities and countries affected. For example, infection rates are highest during the rainy season, often resulting in decreased agricultural production.[5]

A study conducted by Akazili (2000) in northern Ghana, found that while the cost of malaria care was just 1% of the income of the rich households, it was 34% of the income of the poor households; and malaria prevalence is high in rain season which coincides with farming period.

There are comparatively few studies of vulnerability in low and middle income populations of African countries to endemic diseases, though they account for the largest proportion of the citizens (IPCC, WGII, 2013). The adaptive capacity of a country depends on its available resources (financial as well as human).

In Ghana, like most Sub-Saharan African countries, the national economy depends on agriculture which employs a very large proportion of the population. Although malaria is a serious challenge in Ghana, there has been few researches on its economic impact, particularly at the economic sector level. Thus, to better understand the financial burden of malaria to agriculture sector (which is already threatened by climate change) in endemic area like Ghana, it is necessary to estimate the value of all costs associated with seeking health care for malaria. This study intends to contribute to filling this important gap by assessing the economic cost of malaria on farming community under climate change in an area of northern Ghana, namely, Bole district.

[5]www.one.org, accessed on 9th March 2015

1.2-Objectives

1.2.1-Main objective

The overall objective of this study is to develop indicators-based malaria vulnerability assessment in the Bole district in order to assess the changing climate conditions which influence the health security through prevalence and incidence of malaria in the study area.

1.2.2-Specific objectives

More specifically, the present study attempts to:

- Examine the long term trends in rainfall and temperature data for a record period of (1988-2013);
- Determine the climate change-related factors that make farming communities in the Bole District more vulnerable to malaria;
- Estimate the direct and indirect costs of securing health care against malaria by farmers' households;
- Determine the proportion of farmers' household income spent on health security.

1.3-Research questions

This case study strives to answer the following questions:

- What are the long term trends in rainfall and temperature data for the period of 1988 to 2013?
- What climate change-related factors make farming communities in the Bole district more vulnerable to malaria?
- How much do the farmers' households spend directly and indirectly, on securing healthcare per malaria episode?
- What proportion of farmers' household income is spent on malaria treatment because of climate change?

1.4-Hypothesis

While the frequency of malaria in the study area may be related to socio-ecological system, the change in rainfall and temperature patterns could be the major determinant of farming households, and communities' vulnerability to malaria. Analyzing trend in rainfall and temperature and understanding the conditions which influence malaria episode in the study area should be reliable information to pinpoint local hotspots of malaria vulnerability. . The hypothesis for this study was stated in the null form as:

Ho = there is no significant relationship between rainfall and temperature trends and vulnerability to malaria in the study area.

1.5-Thesis structure

Chapter one examines the background information, the problem statement, the objectives, the significance of the study and its objectives. Chapter two is a literature review on the economic cost of malaria, focusing on the global situation, and that of Ghana, specifically with regard to the study area. Chapter three covers the area of the study, the research methodology and the data collection. Chapter four presents the expected results and chapter five summarizes and concludes the study.

CHAPTER II

LITERATURE REVIEW

This chapter briefly describes the global malaria situation and reviews literature on the economic cost of malaria; it examines also approaches used in estimating the economic costs of malaria.

2.1-Global malaria situation

Oaks et al. (1991) mentioned that malaria is present in 90 countries inhabited by some 2,400 million people (40% of the world's population). One of the most significant causes of ill-health in Africa is malaria which causes over a million deaths and 300-500 million episode of acute illness globally each year (Lennox, 1991).

2.2-Mortality and morbidity implications of malaria

Malaria has economic impact on national Gross Domestic Product, the local community, the household and the individual. Generally, the costs imposed by malaria are high through increased mortality and high morbidity.

The impact of mortality varies with the age distribution of death which, in turn, varies by ecological zones. (Over et al., cited in Akazili 2000, p. 22). In Africa and other regions, where malaria is highly endemic and malaria deaths occur primarily among infants and young children, the effect of mortality is different, than it is in areas of low to moderate endemicity where malaria deaths occur among the primary breadwinners or caretakers (Conly cited in Akazili, 2000, p. 22). Substantial secondary effects are attributable to adults deaths as surviving household members adjust to the loss of those with primary responsibility for the well-being of the others. Arguably, the loss of an adult imposes tremendous economic loss on survivors.

2.3-Economic impact of malaria

2.3.1-Impact on productivity and output

Previous studies of economic cost of malaria done by Van Dine et al. (cited in Akazili, 2000, p. 23) have focused on the direct cost or indirect effects on household budget and productivity. Bhombore et al., cited in (Akazili, 2000, p. 23) estimated that households in India with malaria cleared only 40% as much land for crops as similar households without malaria.

It is generally believed that the quality of labor is affected by malaria morbidity both during acute attacks and as a result of cumulative effects of the illness (Shepard et al., 1990).Even though an acute attack may not be severe enough to prevent work, the debility may reduce the quality productivity and output. In addition, malaria may affect output quality through an influence on the systems of production and decision about crops.

The effects of malaria was demonstrated by Conly (in Akazili, 2000, p 23) among rural farmers in Paraguay. Under threat of malaria, they shifted their work input from tobacco and other lucrative cash crops to less labor-critical and less valuable crops. Shepard et al. (in Akazili 2000, p. 24) highlighted that the assessment of the overall effects of malaria on productivity and direct economic losses can be analyzed at the macroeconomic and microeconomic levels.

2.3.2-Macroeconomic effects

Howard (in Akazili, 2000, p. 24) estimated the cost of malaria to the United States to be high as $100,000,000 per year. The recent First Africa Malaria summit held in April 2000, noted that between 1965 to present day, malaria has reduced the economic growth rates of African nations by 40%.

According to Nabarro (2000) of Roll Back Malaria Program-WHO, the current total economic cost of malaria in Africa is $ 2 billion a year. In a cross-country econometric estimation of the effects of malaria on national income, Asante and Asenso-Okyere (2003, p. 25) concluded that countries with substantial level of malaria grew 1.3% less per person per year for the period 1965-1990. The study also confirmed that a 10% reduction in malaria was associated with 0.3% higher growth in the economy. Also, Sachs and Malaney (in Asante and Asenso-Okyere, 2003, p.25) have also observed that where malaria prospers most, humans have prospered least.

2.3.3-Microeconomic impact of malaria

The microeconomic effect of malaria concerns households and individuals.

Etting et al. (1994) have estimated that over a quarter of a very poor household’s income can be absorbed in the cost of malaria treatment.

The malaria treatment cost includes cost of drugs, special food, transportation, services and other related costs. Substantial cost is also incurred in terms of opportunity cost of labor lost due to the illness, as each bout of malaria causes its victim to forego on average of 12 days of productive output (Shepard, 1991). However, based on a study in Nepal,Mills (1991) argued that an average of 5 days of productivity is lost per non-fatal disability of malaria episode. This view seems more realistic.

Quoet al (in Akazili, 2000, p.26) demonstrated that the average number of days per non-fatal disability of malaria episode, regardless of its severity varies considerably from 3 to 20 days. Amongst the poorest countries of Sub-Saharan Africa, households have spent between $ 2 and $ 25 on malaria treatment and between $0.20 and $ 15 on prevention each month (Leighton and Foster, 1993). Treatment costs of malaria for small farmers have been estimated to be as high as 5% of total expenditure in Kenya and 13% in Nigeria.

In the neighboring Burkina Faso, Sauerborn et al. (1991) found the total cost of malaria in 1985 to be $ 7,390 which was approximately 1% of total production. The cost averages $ 1.15 per capita. Each case of malaria costs on average $ 5.96, the equivalent of over 19 days of per capita output. Average direct cost was $1.35 per case, representing over 11 days of average per capita cash income. Over 28% of the total cost of malaria was borne directly by the community in the form of out-of-pocket payments of treatment and current loss of adult production due to malaria morbidity.

Shepard et al. (1991) presented a framework for measuring the economic impact of malaria and illustrated it using data from Rwanda, Burkina Faso, Chad and the Congo. The conclusion of the study was that in 1987, a case of malaria cost $9.84 ($1.83 in direct costs and $8.01 in indirect costs) and this was equivalent to 12 days of output. It was predicted that by 1995, the average cost of malaria case would rise to $16.40 due to increasing severity, chloroquine and other related drug resistance.

Etting et al. (1994) estimated the indirect cost of malaria on the basis of days of work lost to be $2.13 for Malawi households. The direct cost of seeking treatment was $0.21 per child case and $0.63 for adults. These costs can be a substantial percentage of household income, especially for poor households whose ability to consume other health and non-health goods could be adversely affected.

2.4-Approches to estimating the economic cost of malaria

Shepard et al. (1990) mentioned that the ideal approach in estimating the general economic cost of illness, including malaria, is the willingness to pay for malaria treatment. Lipsey et al. (1990) said that economic theory suggest the value of a consumption good should be determined according to the Willingness To Pay (WTP) method; this approach simply asks: "how much money would a sick person be willing to pay to get better or how much a healthy person would pay to avoid getting ill"? Despite the theoretical soundness of this approach, Shepard et al. (1991) noted that it has not been widely applied due to its practical constraints.

According to Sauerborn et al. (1991) and Ettling et al. (1994), the estimation of the direct cost of malaria entails basically the summation of cash expenditure on treatment and prevention. The major components of direct cost in many studies are often drugs and transport, but direct cost on special food is often erroneously left in the estimation of direct cost. This may lead to underestimation.

The estimation of indirect cost is more delicate than direct cost as it takes into account the estimation of time loss to productivity; but other researchers have estimated the value of time loss due to malaria by dividing the market value of the agricultural output by the amount of person-time used to produce it; this factor is then multiplied by the average number of days a person is sick with malaria (Sauerborn et al., 1991).

Ettling et al. (1994) used different approach by estimating the value of time by dividing the average household income by the mean number of adults per household and assuming a six-day work-week; but this type of estimation requires accurate income data (which is difficult to obtain in developing countries) and a clear definition of economically active population.

Conly (1975) and Audibert (1986) cited by Akazili (2000) have calculated the indirect cost of malaria by estimating its effects on agriculture output at households' level; but their approaches require very comprehensive data collection, and methodological difficulties have to be overcome (difficulties related to the isolation of the impact of malaria on agricultural yield, making it necessary to control for a host of other factors that could explain the differences in the output). Korandsen et al. (1997) used the more comprehensive approach in a study in Sri Lanka: the evaluation of the indirect cost is based on the opportunity cost of labor days lost (wages forgone as a result of malaria). In this way, the value of labor days lost is not necessarily seen as measure for the loss of production but more as an indication of potential income lost and a possible financial cost of replacing labor for the sick person. Again, in this way, the opportunity cost provided an estimate of the income forgone per day by the inability to work due to the sickness or caretaking.

2.5-Malaria and its link to climate

Egbendewe et al. (2011), using semi-parametric econometric model has shown that a marginal change in temperature and precipitation levels would lead to a significant change in the number of malaria cases for most African countries by the end of the century.

Shahin Mia et al. (2011) mentioned that climate is the most influential driving force of malaria and changes in climate factors substantially affect reproduction, development, distribution and seasonal transmissions of malaria. Alonso et al. (2001) demonstrated that the influence of temperature on malaria development appears to be non-linear and is vector-specific.

Paaijmans et al.(2010) highlighted that increased variations in temperature, when the maximum is close to the upper limit for vector and pathogen, tend to reduce transmission, while increased variations of mean daily temperature near the minimum boundary increase transmission. Analysis of environmental factors associated with the malaria vectors*Anopheles gambiae*and *Anopheles funestus*in Kenya found that abundance, distribution, and disease transmission are affected in different ways by precipitation and temperature (Kelly-Hope et al., 2009).

There are lag-times according to the lifecycle of the vector and the parasite: a study in central China reported that malaria incidence was related to the average monthly temperature, the average temperature of the previous two months, and the average rainfall of the current month (Zhang et al., 2012). The strongly non-linear response to temperature means that even modest warming may drive large increases in transmission of malaria, if conditions are otherwise suitable (Alonso et al., 2011; Pascual etal., 2006). On the other hand, at relatively high temperatures modest warming may reduce the potential of malaria transmission (Lunde etal., 2013).

CHAPTER III

MATERIALS AND METHODS

This chapter presents the methodology of the study. The main headings of the chapter are the conceptual and theoretical frameworks, geographical area of the study, research design, population, sample size and sampling procedures, data type, data source, and methods of data collection and data analysis.

3.1-The area of the study

3.1.1- Localization

The Bole District is located at the extreme western part of the northern region of Ghana (Figure 1). It covers an area of about 4800 km^2 which is 6.8% of the total landmark of the northern region. It has a population of about 61,593; composed of 50.3% of males and 49.6% of females (Ghana Statistical Service, 2010 PHC) and a growth rate is about 2.9 % per annum. The population is sparse with a density of about 13 per km2. The district capital is the only urban centre in the district. There are 148 communities, one town council and five area councils. The households are predominantly headed by males.

3.1.2-Hydrography-vegetation-climate.

The main drainage system in the district is surface water. Surface water sources in the district comprise many small streams and the Black Volta, 38 dugouts and 6 dams, which are used for livestock, domestic and subsistence irrigation activities. The vegetation is predominantly guinea savannah with grasses intersperse with short trees. The largest tree area is the Bui National Park. The district experiences a unimodal rainfall pattern which ranges between 800mm and 1200mm per annum and somewhat erratic in nature.
The rains begin around May and end in October. The rainfall is seasonal and is characterized by a single maximum. The mean annual rainfall is about 1.100mm. The average rainfall is very small. June, July and August generally record the heaviest rainfall and also the greatest number of raining days.The district experiences extremes of temperature. The daily and annual range of temperature is wide. The coldest nights in the year are experienced in the months of December, January and

February. During these months the air becomes dry and the atmosphere becomes hazy and one cannot see clearly due the fine dust in the air.

Figure 1: Map showing the target area of study.

3.1.3-Health

The district health services are divided into four sub-districts, namely Bole, Tinga, Jama and Bamboi. Each sub-district has an operational area served by a health facility. There is a District Hospital located in Bole. The Catholic Church is running a Primary Health Care program in Bole township. Malaria is the number one cause of outpatient attendances in the district accounting for of all reported cases from 2008 to 2014 (see table 1). Due to the erratic and unpredictable rainfall pattern in the district, a number of small dams and ponds are constructed in the district to serve people and livestock as well as for vegetable production. These water collections serve as potential breeding grounds for mosquitoes.

Table 1: Top ten causes of OPD consultations in Bole District-Cases reported (2012-2014)

	2012		2013		2014	
No	**DISEASES**	**CASES**	**DISEASES**	**CASES**	**DISEASES**	**CASES**
1	Malaria	58,562(60.7%)	Malaria	74,750(53.8%)	Malaria	69,302(44.6%)
2	Upper Resp. Tract Infection	12,260(12.8%)	Upper Resp. Tract Infection	15,515(11.2%)	Upper Resp. Tract Infection	8,618(11.1%)
3	Diarrhoeal diseases	6805(7.1%)	Diarrhoeal diseases	9,846(7.1%)	Diarrhoeal diseases	6,801(8.8%)
4	Skin diseases and ulcers	4,317(4.5%)	Skin diseases and ulcers	6,356(4.6%)	Skin diseases and ulcers	3,193(4.1%)
5	Rhumatism and join pains	2,300(2.4%)	Rhumatism and join pains	3,657(2.6%)	Rheumatism and join pains	2,519(3.2%)
6	Acute Eye Infection	1,448(1.5%)	Acute Eye Infection	2,472(1.8%)	Acute Eye Infection	1,520(2.0%)
7	Hypertension	1,250(1.3%)	Intestinal worms	2,419(1.7%)	Pneumonia	2,495(1.6%)
8	Anemia	1,168(1.2%)	Typhoid fever	2,198(1.6%)	Intestinal worms	1,038(1.3%)
9	Pneumonia	1,073(1.1%)	Acute Eye Infection	2,180(1.6%)	Anemia	827(1.1%)
10	Acute Ear Infection	1,011(1.1%)	Pneumonia	1,715(1.2%)	Pneumonia	805(1.0%)
	All other diseases	5,942(6.2%)	All other diseases	18,043(13%)	All other diseases	23,356(30.1%)
	Total	95,654(100%)		138,951(100%)		77,515(100%)

Source of data: Bole district hospital, 2015

3.1.4- Economic activities

Bole district is one the most popular in the Northern region of Ghana. Agriculture is the predominant economic activity in the district with over 75% of the work force engaged in it. Administratively, the district has three (3) agricultural zones and fourteen (14) operational areas. Agriculture in the district covers food crops (maize, millet, sorghum, rice, groundnuts, cowpea, bambara groundnut, yam and cassava), cash crops (cashew, shea, mango and dawadawa), livestock (cattle, sheep, goats, pigs, guinea fowl, local and exotic fowls), fisheries and bee keeping with emphasis on mechanization, value addition and organized marketing.

3.2-Methods

The chapter examines the methods that were used in executing this study: the framework for estimating the economic cost.

3.2.1-Conceptual Framework of the Study

Empirical studies on vulnerability have shown that one factor may lead to vulnerability in one specific area for certain period and may create hindrance for other locations. In the light of this, it is difficult to develop one and unified vulnerability model in vulnerability assessment process for all specific locations.

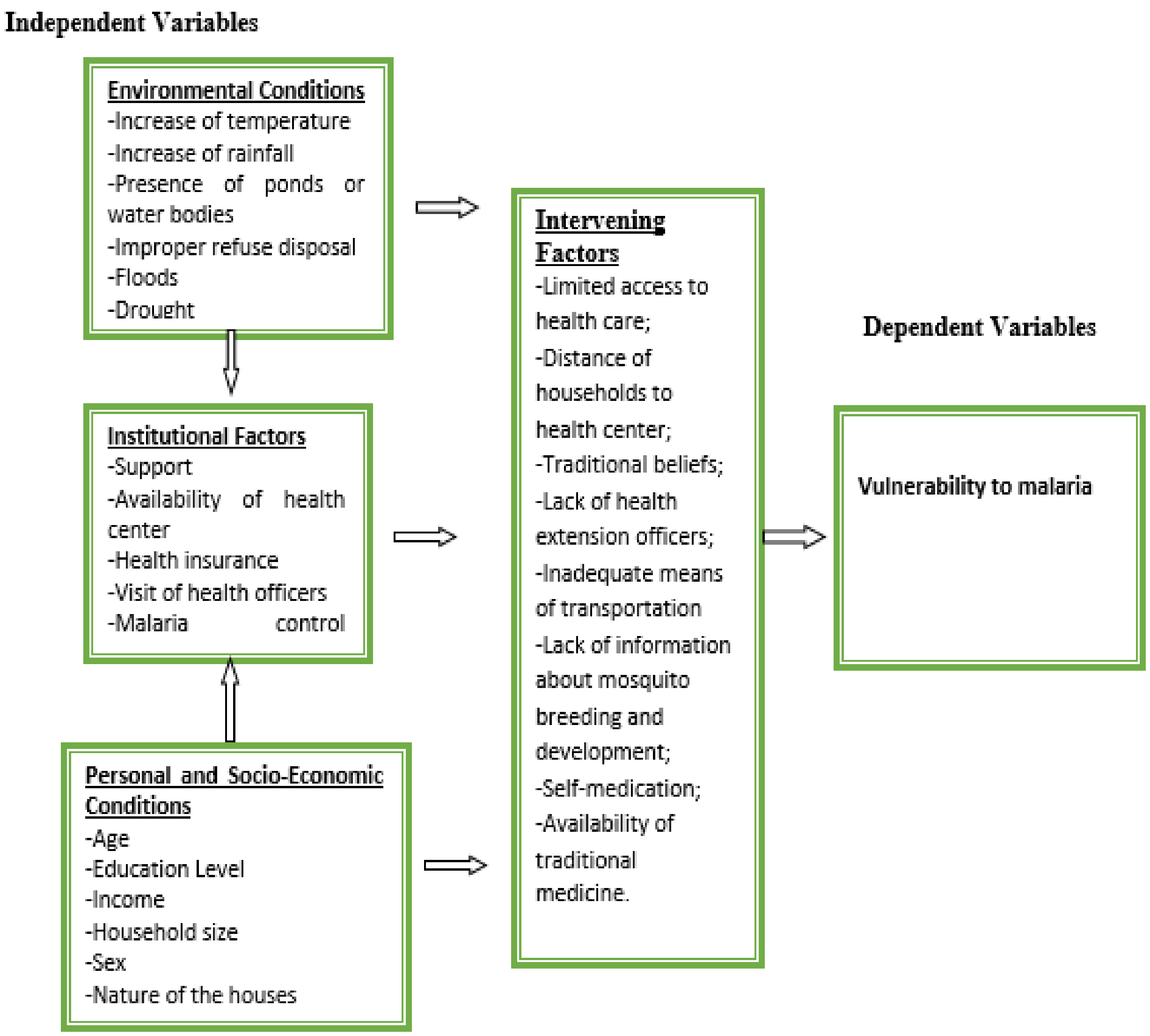


Figure 2: Conceptual framework of the study.

Many studies are conducted extensively on the role of climatic factors in the epidemiology of malaria due to its global public health importance. But one of the critical factors influencing the vulnerability of human health to climate change is the extent to which the health and socio-economic systems are robust enough to cope with the demand (WHO 2003). Apart from the independent variables which are predictors of farmers' vulnerability to malaria, there are intervening variables (problems) which also contribute significantly to the vulnerability assessment to malaria. Hence, this conceptual framework shows the most important independent and intervening variables expected to influence the vulnerability to malaria in the study area. The arrows indicate the expected relationship between the variables in the conceptual framework (Figure 2).

- **Description of Variables**
- **Variables used for the Socio-Demographic Characteristics of Respondents**

The socio-demographic characteristics of farmers in the study sites were described, using descriptive statistics. Saunders et al. (2007) reported that descriptive statistics is a generic term for statistic that can be used to describe variables. It is against this background that this study also employed descriptive statistics to describe the socio-demographic characteristics. The characteristics were age, marital status, educational level, family size and income of the respondents, using frequencies and percentages. Statistical Package for Social Sciences (SPSS) and the Microsoft excel were used to analyse the data.

- **Variables used for the climatic factors impact analysis**

The dependent variable of the model is the malaria attack frequency of the household, while exogenous variables are rainfall, temperature and other socio-economic characteristics.

- **Dependent variable**

The malaria attack frequency of the household implies the household's head or at least one of the household's member had experienced malaria in the past six months. This variable was measured by asking the selected farming household to respond "yes" or "no" to question from the questionnaire.

- **Independent variable**

The explanatory variables which are of importance for this study are those variables which are thought to have influence on malaria attack frequency of the household. These variables include demographic, socio-economic, climatic and institutional variables:

- **Demographic and socio-economic variables**

Age: This variable was measured as the number of years of the respondent. Age of the farmer is one of the important characteristics of a farmer that affects his responsibility as a head of the family. The more the farmer is aged, the more he carries the responsibility to take care of the family.

Education: This variable was measured as the number of years of formal education that the farmer has. Educated household heads may know more about malaria transmission and how to prevent it.

Family size: This variable was measured as the number of persons of the household, including the respondent. Large family size may be more subjected to malaria attack.

Income: This variable was measured as the gross farm income of farmers in the study sites. Because farmers usually under-estimate their net farm income, expenditures /debts of farmers were used to determine farmer's financial situation. Mostly, several different measures have been used to define the financial situation of farms. Measures of gross farm income are the most common measure used by many because it is easy and least offensive to collect (Hilts et al., 1990). Malaria attack is linked to many factors, including food security and prevention. A poor household head may be more exposed to malaria attack because of inadequate feeding.

- **Climatic variables**

These are temperature and precipitation variables; for temperature in degrees Celsius (˚C) and precipitation in millimeter per month (mm/month). The climate of the Northern Ghana is relatively dry, with a single rainy season from May to October. The temperature and rainfall normal were computed based on the seasons mentioned above.

- **Institutional variables**

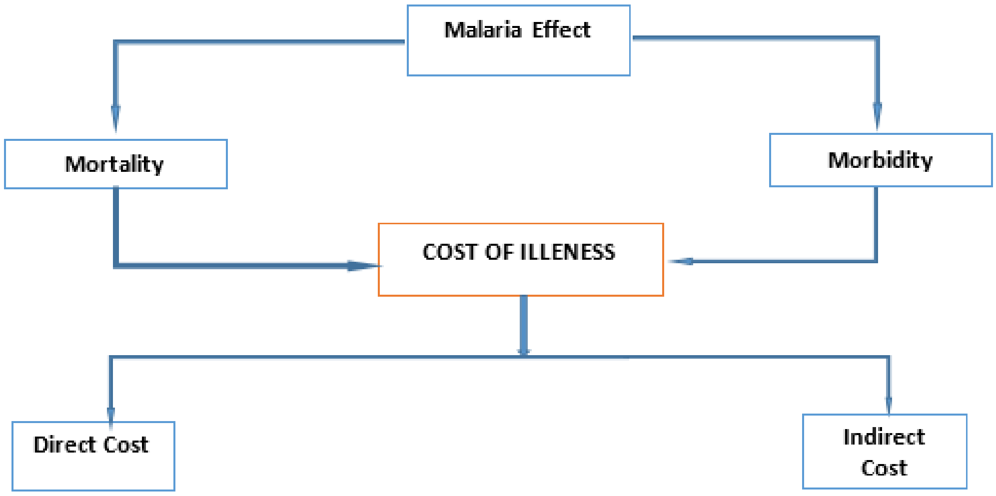
This variable is measured as dummy, where one is the household received some form of assistance from health centres or Non-Governmental Organizations (NGOs). It is believed that households who received some form of assistance other than malaria prevention methods are expected to have high adaptive capacity towards malaria attack.

Variables	Description	Measurement	A priori Expectation
Literacy level	Number of years of formal education of respondent	Number of years	-
Total direct expenditure	Direct cost of malaria treatment	GH₵	+
Family size	Number of persons in the household	Number of persons	-
Support for malaria prevention or treatment	Whether household received support or if household members are assured	Dummy: 1=yes; 0=no	+/-
Prevention of malaria	Use of ITNs, insecticides, or drugs	Dummy: 1=yes; 0=no	-
Information about mosquito breeding and development	Knowledge and understanding of the conditions that are suitable for malaria transmission	Dummy: 1=yes; 0=no	-
Absenteeism at farm	Number of days of disabilities.	Number of days	+
Flooding	When land not normally covered by water becomes covered by water.	Number of days	+
Decrease of rainfall season	Reduction of days of rainfall	Number of days	-
Increase of temperature	Increasing of annual average maximum temperature	Degrees Celsius	+
Flooding		Dummy: 1=yes; 0=no	+

Table 2: List of independent variables

3.2.2-The framework for estimating the economic cost

The most comprehensive framework for estimating the economic cost of malaria was developed by Shepard et al. (1990).



<u>Figure 3:</u> Framework for economic cost estimation

<u>Source</u>: Adapted from Shepard et al. (1990).

3.3- Data collection and analysis

This section presents the types of data used for the study, the sources of the data and various methods used in the data collection. Both qualitative and quantitative data of primary and secondary sources were collected to help answer the research questions and achieve the objectives of this study.

3.3.1-Data collection

Primary data were collected through a field survey and secondary data through reviewing of relevant documents.

Primary data-Field survey

To obtain the relevant data at a micro level, a district-based cross-sectional survey of household were conducted.

Study population

The target population is the farmer's households. Therefore, the household in this case is considered as a social and economic unit; so an attack of malaria on a member is a drain on the resources of the household.

Sampling procedure for primary data collection

In the study, multi-stage sampling methods is used. Bole district comprises six (6) area councils; they are Bole Town, Mankumah, Mandari, Maluwe, Tinga and Bamboi. Out of the six (6) area councils, five (5) were considered except Bamboi because of its geographical location (it is far from the other area councils)

Randomly, one (1) community was selected in each area council. In each area council, fourty (40) respondents were selected by stratified random sampling (men and women). Finally, 20 men and 20 women were selected by simple random sampling

The household data need for the study were gathered from 200 households in the 5 area councils. For each household selected, the head or his wife were interviewed.

Questionnaire

This study employed the interview questionnaire instrument for the data collection based on the strength and desirable characteristics about interview questionnaire instrument developed by Kumekpor (2002) and Twumasi (2001). This method was used to collect data from farming households. The questionnaire was pre-tested to ensure validity and reliability. All the survey questions were pre-coded.

To ensure the quality of the work, completed questionnaires were checked by the researcher and tested on the field for errors and inconsistencies. The information were principally collected from either the head of a household or an adult member, if a household head is absent.

A structured questionnaire was the main research instrument for the collection of primary data from the households; it has gathered the following data:

- Socio-economic and demographic characteristics of households;
- Households' possession and assets (wealth);
- Direct cost of a malaria episode to the households (out-of-pocket expenses);
- Indirect cost in the form of productivity lost by malaria patients, caretaker and substitute labour, and protection strategies of households against malaria attack;
- Household consumption expenditure and debt;
- Information about climate change and its link with the prevalence of malaria.

Focus group discussion

Focus groups elicit a multiplicity of views and emotional processes within a group context. The researcher gains a large amount of information in a relatively short period of time (Morgan and Krueger, 1993). Motivated and convinced by the strength and desirable characteristics of focus groups, the study employed the focus group discussion to acquire useful and additional detailed information which would have been difficult to collect through the questionnaire administration only. In each locality visited, farmers were put into two groups of 10-15 (males and females) for a discussion. The main issues discussed in each group were the sickness they suffer more from, the season when they are affected by malaria, the effects of malaria episode on their activities and income and how they can link occurrence of malaria to climate variability.

Secondary data collection

Studying and reviewing relevant documents for secondary information to supplement other sources of data is necessary in social and scientific research. Therefore, the researcher needs to consult and read extensively on existing relevant literature on the subject. So information about malaria prevalence and its economic analysis were sort out from research reports, journals technical papers, magazines and project documents, libraries, books, government and non-governmental organizations and the internet. In the district, outpatient diagnosis data were collected from the health centres. In addition, official documents from the Ministry of health, the Ghana Health Service and the WHO on malaria and related issues were reviewed; this include malaria control program, malaria death rate, malaria incidence and prevalence rate.

Monthly rainfall and temperature (both minimum and maximum) data were collected at the Meteorological Service Agency in order to determine the climate parameters patterns.

3.3.2- Methods of data analysis

This section discusses the statistical models and measures that were used to analyse the data for this study.

A trend detection analysis was conducted in the annual and seasonal datasets to assess climate change over the study area. The software package used in this study include the Statistical Package for Social Sciences (SPSS). The statistical tests that were used to analyse the data are discussed in the next sections.

3.3.2.1. Trend Analysis of Rainfall and Temperature to Assess Climate Change.

This study examines trend in rainfall and temperature pattern in Bole district, using Mann-Kendall statistic test. Bole town Meteorological station was selected; it had record of 25 years (1987-2012) of data to determine whether there have been any significant changes in those variables, using Mann-Kendall test run at 5% significant level on time series data. Available monthly rainfall and temperature data were firstly grouped into monthly and annual average data. Missing data were filled through linear interpolation of the same months data of the contiguous years on either side of the missing value.

-Mann-Kendall Test

Mann-Kendall test was formulated by Mann (1945) as non-parametric test for trend detection and the test statistic distribution was given by Kendall (1975) for testing non-linear trend and turning point. This test is generally employed in various studies to check the presence of statistically significant trend in hydrologic and climatic variables with reference to climate change (Yu et al., 1993; Douglas et al., 2000; Hess et al., 2001; Burn and Elnur 2002; Yue et al., 2003; Burn et al., 2004; De Toffol et al., 2008; Singh et al., 2008).

There are two advantages of using this test. First, it is a non-parametric test and does not require the data to be normally distributed. Second, the test has low sensitivity to abrupt breaks due to inhomogeneous time series. According to this test, the null hypothesis H0 assumes that there is no trend and under the alternate hypothesis, it is assumed that a significant change has occurred over time, or that an increasing or decreasing trend is evident in the time series.

In this study, trend analysis has been done by using non-parametric Man-Kendall test together with the Sen's Slope Estimator (Qi) for the determination of trend and slope magnitude to find out the annual and monthly variability of rainfall and temperature in Bole district.

The null hypothesis is tested at 95% confidence level for both rainfall and discharge data.If the p value is less than the significance level α (alpha) = 0.05, H0 is rejected. Rejecting H0 indicates that there is a trend in the time series, while accepting H0 indicates that no trend was obtained.

Positive value of Qi indicates an upward or increasing trend and a negative value of Qi gives a downward or decreasing trend in the time series. Statistical Mann-Kendall test and Sen's Slope Estimator Test were performed, using Addinsoft's XLSTAT 2015 software.

3.3.2.2. Analysis of the determinants of households' vulnerability to malaria

The multiple linear regression model was used to analyse the determinants of households' vulnerability to malaria. This model is used to analyse relationships between a non-parametric dependent variable and parametric or dichotomous independent variables. In linear regression, data are modeled using linear predictor functions, and unknown model parameters are estimated from the data. Such models are called linear models.

A linear regression model assumes that the relationship between the dependent variable y_i and the *p*-vector of regressors x_i is linear. This relationship is modeled through a disturbance term or errorvariable $\varepsilon_{i,}$ an unobserved random variable that adds noise to the linear relationship between the dependent variable and regressors. Thus, the model takes the form

$$y_i = \beta_1 x_{i1} + \cdots + \beta_p x_{ip} + \varepsilon_i = \mathbf{x}_i^{\mathrm{T}} \boldsymbol{\beta} + \varepsilon_i, \qquad i = 1, \ldots, n,$$

where $^{\mathrm{T}}$ denotes the transpose, so that $\boldsymbol{x}_i^{\mathrm{T}}\boldsymbol{\beta}$ is the inner product between vectors $\boldsymbol{x}_i$ and $\boldsymbol{\beta}$.

The multiple linear model employed by this study is empirically specified as follows:

Yi= $\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e_{ij}$

3.3.2.3. Data checking and statistical test for the regression model

Before running the regression model, the explanatory variables were checked for the existence of multi-colinearity. A contingency coefficient test was used to omit independent variables that are highly and strongly correlated to each other (Table). Absolute value of correlation coefficient of pairwise correlation that is greater than or equal to 0.7 threshold colinearity is considered as high and can severely distort model estimation and subsequent prediction (Anderson, et al., 1990). After testing, multi-colinearity was not observed between any variables.

<u>Table 3:</u> Correlations matrix for the two stage logistic regression model

	In the past six months, have you or any member of your household had malaria?	How old are you?	Marital status of the respondent	Educational level of the respondent	Number of people in the household of the respondent	How much would the member have earned in a day if he had not been ill?
In the past six months, have you or any member of your household had malaria?	1					
How old are you?	-.037	1				
Marital status of the respondent	.124	.167*	1			
Educational level of the respondent	-.152*	-.158*	-.061	1		
Number of people in the household of the respondent	-.214**	-.057	-.060	.041	1	
How much would the member have earned in a day if he had not been ill?	-.083	-.183	-.137	-.088	.026	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

3.3.2.4. Estimating the economic costs

This section describes the approach used in estimating the direct and indirect costs of malaria.

Direct cost estimation

In this study, the direct cost of malaria includes all cash expenditures on seeking malaria care by malaria patients and their caretakers. The components of the direct cost includes cash expenditure on special food, transportation, drugs, services and all other out-of-pocket expenditures made on malaria care by malaria patients and their caretakers.

The direct cost was recorded on the questionnaire as reported by the respondent; in the case where respondents could not recall the specific amounts, lump sums were recorded. Where receipts of purchase were available, they were cross-checked with the verbally reported figures. All direct costs were then estimated to obtain the average and total values of cash expenditure on malaria episode to household.

Indirect cost estimation

Malaria patients are asked how much they would have earned a day if they were not disabled by the malaria episode. Similarly, caretakers are asked how much they would have earned per day if they did not have to take care of the malaria patients (mostly children). The mean earnings per day are reported by considering the prevailing agricultural wage. In estimating the total indirect cost that an economically active malaria patient and caretaker incurred when absent from their normal productive activities due to a malaria attack, the daily average agricultural wage will be multiplied by the corresponding number of days.

3.3.2.4. Variables used for proportion of farmers' household income spent on health security

The farmers' household expenses were described using descriptive statistics. After computing the total annual expenses of the household, they were plot in percentage according to the type of expenses.

For malaria cost as percentage of a total expenditure, the annual cost of malaria was computed by considering the percentage of household income spent on health security as 100%.

To highlight the impact of malaria cost on income, households' income were computed by quintiles. Quintile 1 represents the most poor and quintile 2 the richest. Considering the mean malaria cost and the income according to the quintile, the burden of malaria is heavy as much as malaria cost is representing an important proportion of the households' income according to the quintile.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter presents results of the research based on the primary and secondary data collected.

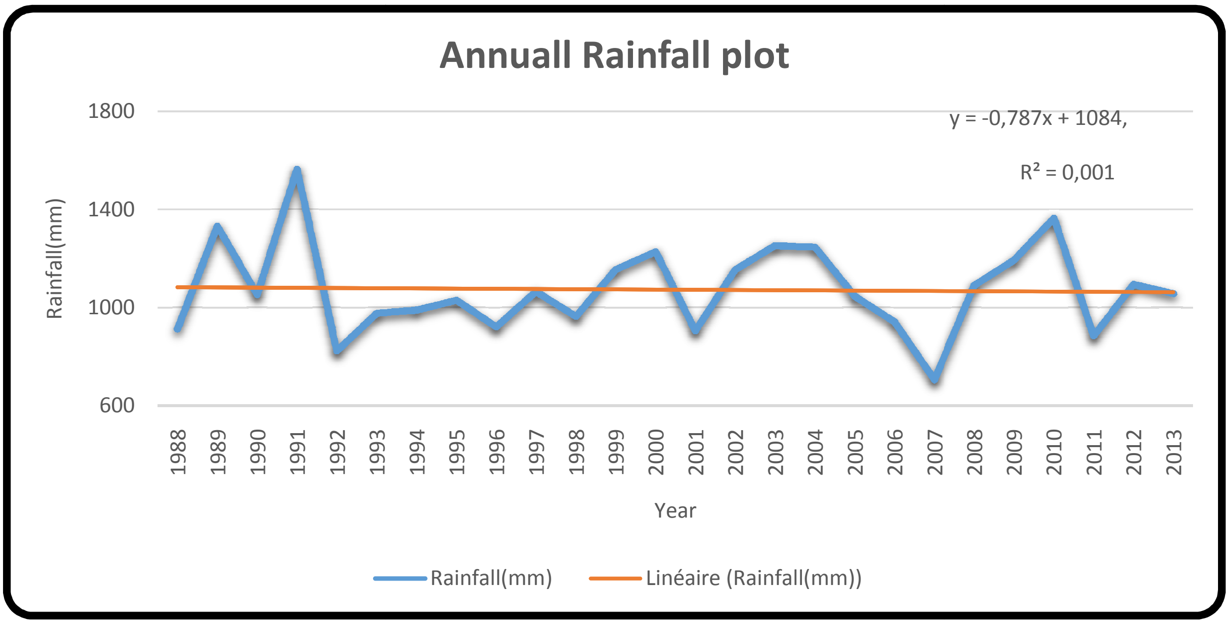
4.1-Empirical Finding on Trend and Variability Analysis

4.1.1-Precipitation Time Series Analysis

Statistical properties of the annual and monthly rainfall series were tested and presented in "Annex 1". The result shows that April, June, July and September represent the smallest Coefficient of Variation (CV): 0.456; 0.429; 0.489 and 0.285 which means that they were the homogenous months in term of rainfall variations during the period of record. On the other hand, December, February and November show the largest CV with 2.389; 1.857 and 1.232, respectively. The rest of the months present similar rainfall patterns representing similar variations during the study period. The annual maximum rainfall occurred in the year 1991 with the total precipitation of 1562 mm; the minimum rainfall occurred in the year 2007 with the total 704.8mm.

On running the Mann-Kendall test on precipitation data, the Sen's slope shows an evidence of a positive trend in annual series. The rate of annual rainfall change is about 1.689 mm/year. The result indicates that the null hypothesis was accepted for the annual rainfall trend (p-value= 0.836). Thus, a statistically significant positive trend is not found for the annual rainfall over the time period.

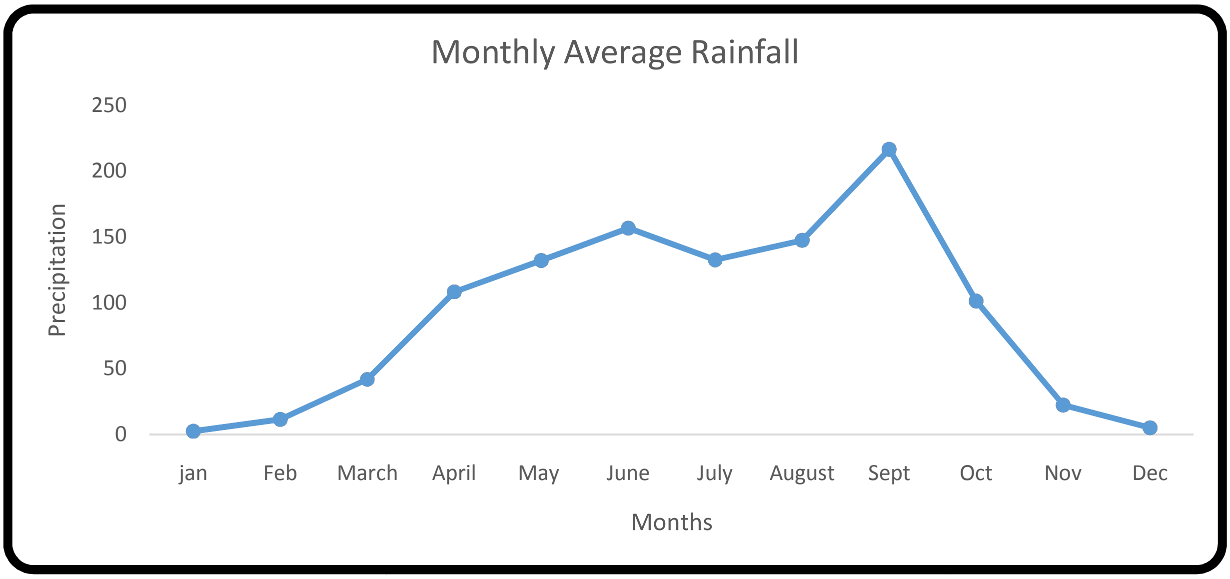
The linear trend line for the 26 years rainfall data is shown in figure 4 below. The trend line indicates a slight decrease in total annual rainfall amount between 1988 and 2013 for the Bole district.



<u>Figure 4</u>:Linear trend line corresponding to rainfall data (1988-2013: Bole station)

<u>Data Source</u>: Tamale Meteorological service, 2015

The figure 5 represents the graph for the twelve (12) months average rainfall for the period (1988-2013). It shows one yearly peak in September (101.2423 mm) which reveals the monomial pattern of rainfall in the study area.



<u>Figure 5</u>: Monthly Average Rainfall (1988-2013)

<u>Data source</u>: Tamale Meteorological service, 2015

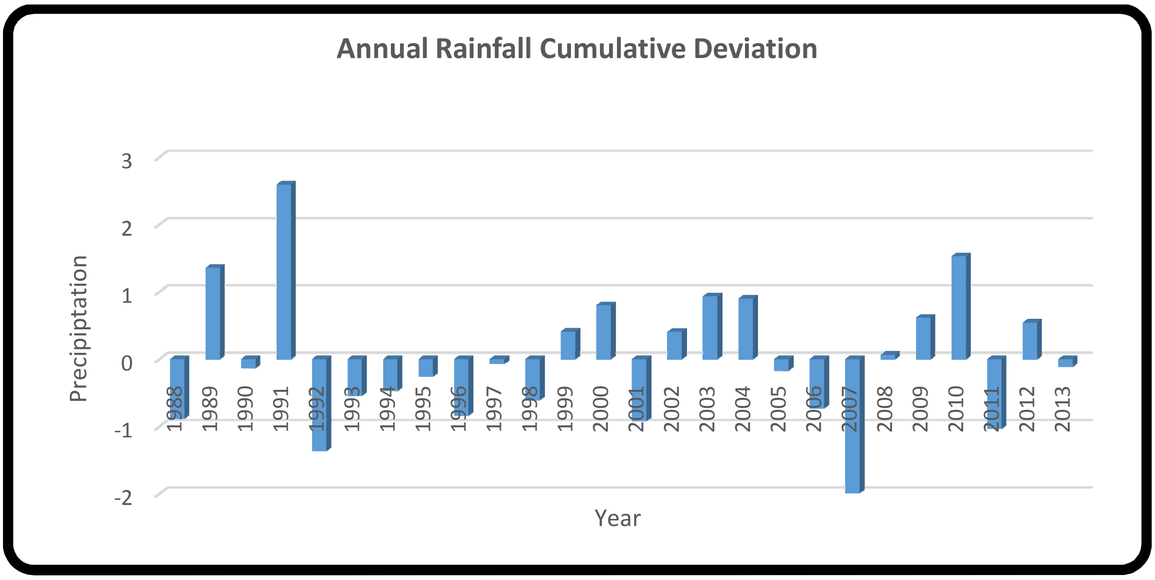
In the Mann-Kendall test, the Sen's slope estimator reveals the trend of the series for 26 years for individual twelve (12) months from January to December (Table 4).

<u>Table 4:</u> Monthly Sen's slope estimator from 1988 to 2013

MONTHS	Sen's Slope
January	0
February	0
March	0.153
April	-0.931
May	1.648
June	-1.683
July	-34.7
August	-47.25
September	-25.2
October	0
November	0
December	1.689

April, June and December, have a rising trend, while May, July, August, September and October display a negative trend. Thus, Sen's slope estimator shows a positive trend for three (3) months and display a negative one for other five (5) months representing almost a non-significant condition. The null hypothesis was accepted for all the twelve (12) months (Annex 2). Therefore, statistically significant trends are not found for precipitation on monthly basis, at 95% confidence level, even though there are negative and positive trends for the record of period (1988-2013) considered.

To be able to determine normal, wet and dry years, cumulative deviations from mean of rainfall pattern were computed for the periods of record. "The figure 6" reveals that a cyclic pattern of variations with alternating drier and wetter years is suggested. This result explains rainfall variability over the study area during the period under examination.



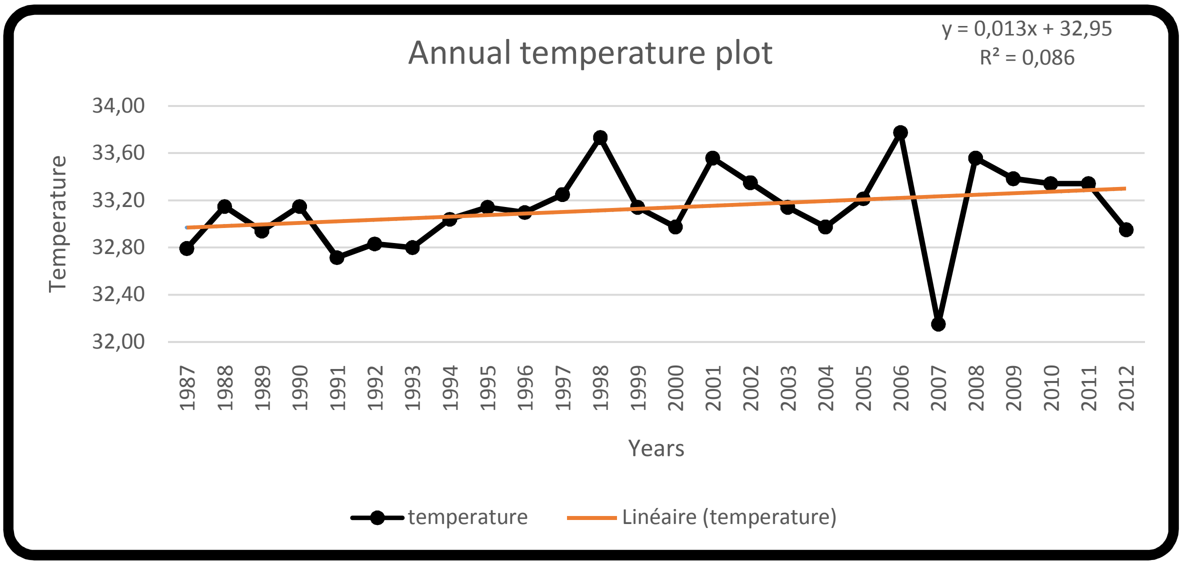
<u>Figure 6</u>: Annual rainfall cumulative deviation (1988-2013, Bole station)

<u>Data source</u>: Tamale Meteorological service 2015

4.1.2-Temperature Time Series Analysis

On running the Mann-Kendall test on annual average maximum temperature data, the Sen's slope shows a positive trend in annual series. The rate of annual average maximum temperature change is about 0.016˚C/year. The result indicates that the null hypothesis was accepted for the annual average maximum temperature trend (p-value= 0.080). Thus, statistically significant positive trend is found for the annual average maximum temperature over the time period.

This result corroborates the finding of IPCC WGII (2013). They found an increase in near surface temperature over West Africa.



<u>Figure 7</u>: Linear trend line corresponding to temperature data (1987-2012; Bole station)

<u>Data source</u>: Tamale Meteorological service, 2015.

4.1.3- Seasonal trend of malaria cases

Figure 8 represents the graph for the twelve (12) months malaria cases from 2008-2014. It shows an increase of malaria cases during the rainy season which starts in April-May and ends in October; and a decrease of malaria cases in dry season. During the rainy season pools of stagnant water are always found and these serve as conducive breeding grounds for the mosquito which transmit the malaria parasite. Temperature and relative humidity are also relatively high during the rainy season and these help further in facilitating the rapid increase in the numbers of mosquitoes hence the increase in reported malaria cases during this period in the district. This result fits with the finding of study done by Odongo-Aginya et al., (2005)in Uganda showing that there is a statistically significant relationship between mean parasite density (PD) and the annual pattern of rainfall. In fact, all mosquitoes lay eggs in water, which can include large bodies of water, standing water (like swimming pools) or areas of collected standing water (like tree holes or gutters). The mosquito eggs hatch into larvae or "wigglers", which live at the surface of the water and breathe through an air tube or siphon. After the fourth molt, mosquito larvae change into pupae, or "tumblers", which live in the water anywhere from one to four days depending on the water temperature and species. At the end of the pupal stage, the pupae encase themselves and transform into adult mosquitoes.

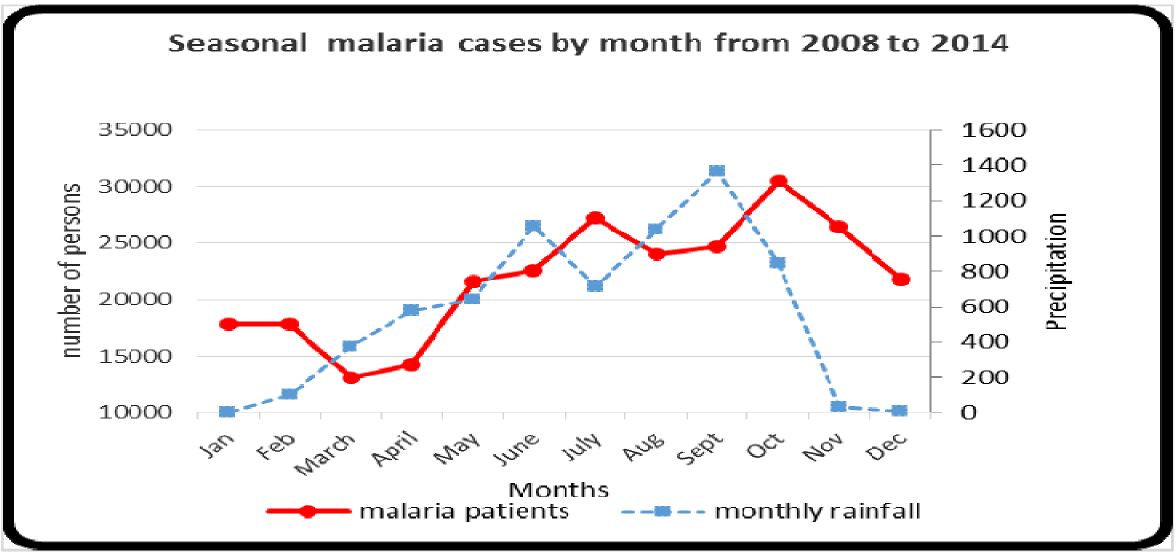


Figure 8: Graph showing seasonal malaria cases.

Data source: Bole district hospital, 2015

4.2. Socio-Demographic and Economic Characteristics of respondents

The socio-economic status of this community may constitute another source of their vulnerability to malaria (Table 5). The social economic status of households is an important factor in assessing their vulnerabilities to disasters (Wisner, et al., 2004, p.12).

Marital Status

The study has established that about 81% of the respondents are married. While few 3.5% of them are divorced, 12.5% are widowed. The results equally indicate that the majority (70.5%) of the respondents were household heads. The higher percentages of married respondents imply that they are more likely to continue giving birth and spending more on malaria treatment.

<u>Table 5</u>: Socio-demographic characteristics of the respondents

Variables	**Frequency**	**Percent**
Marital status		
Married	161	80.5
Single	5	2.5
Widowed	9	12.5
Divorced/Separated	25	4.5
Respondent status		
Household Head	141	70.5
Adult household member	59	29.5
Age (Mean age=46 years)		
18-30	24	12
31-45	88	44
46-64	69	34.5
65+	19	09.5
Education level		
Literate	53	26.5
Illiterate	147	73.5
Total	**200**	**100**

Age

The study established that majority (44%) of the respondents are between the ages of 31-45; about (35%) are between the age of 46-64, while few (9.5%) of them had the age of 65 and above (Table 5). The mean age of the respondents is about 46 years, with a minimum of 20 years and a maximum of 94 years. The role of age in explaining vulnerability of households is crucial in the sense that age is most of the time related to responsibility of taking care of households. On the other hand, because of their attachment to culture, elder persons are not so much excited to know much about the climate change nor its impacts. They are normally pre-disposed to attributing the impacts of climate change to traditional belief.

Education level

The study has shown that majority (73.5%) of the respondents have never been to school or never had any formal education (Table 5). This is likely to affect the farming household vulnerability in the study area. .” This is so because education of household heads is crucial in health care and other decision making process of the households. Muttarak and Lutz (2014) stated that “education can directly influence risk perception, skills and knowledge and indirectly reduce poverty, improve health and promote access to information and resources. Highly educated individuals and societies are reported to have better preparedness and response to the disasters, suffered lower negative impacts, and are able to recover faster.

Household size

Majority of the respondents have their household size to be within the range of 1-9, representing 70.5%, followed by those who have their household size within the range of 10-19, representing 26% while few of the respondents have their household size comprise between 20-29 and 30-40 representing 2.5% and 1% respectively (Table 6). The mean household size is 8 with a minimum of 1 and a maximum of 40. This means that, most of the respondents have quite a large family size. The implication of this is that the large family size can either affect the cost of malaria treatment negatively or positively depending on the output provided by each person.

<u>Table 6</u>: Household size of respondents

	Frequency	**Percentage**
Household size(Mean household size=8)		
1- 9	141	70.5
10-19	52	26
20-29	5	02.5
30-40	2	01
Total	**200**	**100**

Income

The study has also collected data on the income of the respondents. Income was divided into quintiles (Table 7). The average income for the patients if they were not sick is GH₵ 35.53 with a range of GH₵ 0.00 to GH₵ 500.00. The average income for the caretaker if he/she were not taking care of the sick would have been GH₵ 75.48 with a range of GH₵ 0.00 to GH₵ 1700.00. The results indicate that majority (50.5% and 73%) of the respondents (both malaria patients and caregiver respectively) fell within the first quintile and very few (4.5% and 3.5%) of the respondents (both malaria patients and caregiver respectively) fell within the fifth quintile.

Table 7: Income of patients and caregiver by quintile

	Frequency	**Percentage**
Daily income of the patient (Average income=GH₵35.53: Range: 0-500)		
1st quintile 0-8	128	50.5
2nd quintile 9-15	29	28
3rd quintile 16-35	19	9.5
4th quintile 36-60	15	7.5
5th quintile 61-500	10	4.5
Daily income of the caregiver(Average income=GH₵75.48; Range: 0-1700.00)		
1st quintile0-12	144	73
2nd quintile13-30	23	11.5
3rd quintile31-50	16	8
4th quintile51-120	8	4
5th quintile 121-400	8	3.5
Total	**200**	**100**

Source: Field survey, 2015

The fact that majority of the respondents fall within the first quintile in both cases implies that most of the respondents are poor in the study area. This is in line with the findings of Ghana Statistical Service (2014) which shows that the three northern regions comprising Northern, Upper East and Upper West Regions have the highest poverty incidence. This indicates that there is poverty in the three Northern regions of Ghana. Poverty incidence in the three northern regions of Ghana are Upper East (44.4%), Northern region (50.4%) and Upper West (70.7%). In terms of extreme poverty, the outlook is as follow: Upper West region has the highest extreme poverty incidence of 45.1%, followed by Northern (22.8%) and Upper East (21.3%). The national poverty incidence is 24.2%.

In addition to the geographic pattern of poverty incidence, the poverty rate is related to the economic activities in which households are engaged. The poverty incidence is highest among households where the head is engaged as self-employed in the agricultural sector (GLSS6, 2014).

Based on GLSS6, almost all of the respondents engaged in this study are poor, since the target populations is farming household. This implies that most of the farming households' head were poor in the study area and this will contribute to their vulnerability, in the sense that the treatment of malaria depends significantly on the availability of financial resources (Annexe 5 and 6).

Decrease in respondents' income by percentage

The study revealed that majority (96%) of the respondents is experiencing decrease in income due to the variability of the climate. Among them, 65%, 24% and 7.5% have a decrease of 25%, 50% and more than 50% respectively. This implies that the climate variability is seriously affecting farming household income, thus worsening their poverty.

Table 8: Decrease in respondents' income

	Frequency	Percentage
Decrease in income		
Yes	192	96
No	8	4
Percentage of decrease		
0	0	0
25	130	65
50	48	24
>50	15	7.5
Total	**200**	**100**

4.3-Determinants of household vulnerability to malaria.

To determine the factors that impact the vulnerability of farming household to malaria, the multiple linear regression model was used. The results of the analysis indicate an R square value of 83%, at 5% significant level (Table 9). From the results in table 9, farming households' vulnerability to malaria is significantly influenced by support for malaria prevention or treatment, information about mosquitoes breeding and development, household size and total direct cost of treatment. Among these variables, household size and information about mosquito breeding and development are negatively related to vulnerability to malaria, while total direct cost of treatment and; support for malaria prevention or treatment are positively related to household vulnerability to malaria.

Total direct cost expenditure

The results in Table 9, indicate that total direct cost of treating malaria is positively related to household vulnerability to malaria, and is statistically significant at 10%. The coefficient of 0.019 indicates that as the cost of treating malaria increases, the level of vulnerability of the household also increases. This is to be expected because the household will need more money to be able to cater for the health needs of malaria patients. This is in line with *a prior* expectation that total direct cost of malaria treatment affects household vulnerability to malaria positively. This means, when the direct cost of malaria care increases, the farming household vulnerability increase. With the poverty incidence of 55.7% and 50.8% for 2005/06 and 2012/13 respectively for Northern region (GLSS6, 2014), it is not surprising that an increase in the cost of treating malaria will lead to an increase in the household's vulnerability to malaria.

Number of people in respondents' households.

The results in Table 9 indicate a negative relationship between number of people in the respondents' households and farming households' vulnerability to malaria and are statistically significant at 10%. This confirms the *a priori* expectation of negative association between number of people in the respondents' household and farming household vulnerability to malaria. This means that when number of people in respondents' household increases, the probability of farming household vulnerability to malaria decreases. Indeed, the farming households' income depends on the individual incomes; large family size tends to have large family labour which in turn leads to cultivation of large farmland. Cultivation of large farm land results in better crop yield which when sold brings income to the household. Higher income for the household means the household's ability to take care of the health needs of household members which ultimately leads to a reduction in the household's vulnerability to malaria.

Support for malaria prevention or treatment

The results in Table 9 show that support is positively related to household vulnerability to malaria at 5% significant level. This is contrary to the presumed expectation that support level will be negatively related to household vulnerability to malaria. This implies that when there is an increase in household support, the household's vulnerability to malaria decreases. In the study area, the support comes in the form of health insurance. Treatment of malaria patients is covered by the National Health Insurance Scheme (NHIS). This means that the NHIS pays for the treatment of malaria and therefore patients do not have to pay on their own. This probably may be causing some complacency towards malaria because people may think that even if one is sick, he will not pay any fees for the treatment. This is likely to lead people in the area taking the treatment of malaria for granted hence the positive relationship between support for malaria prevention and treatment and vulnerability.

Having information about mosquito breeding and development

From the results in Table 9, information about mosquito breeding and development is negatively related to farming household vulnerability to malaria and is significantly at 5%. This is in line with *a priori* expectation that having information about mosquito breeding and development affects farming household vulnerability negatively. This means that when the respondent access to information about mosquito breeding and development increases, the household's vulnerability to malaria decreases. Having access to more information about mosquito breeding and development increases the person's awareness which helps the person to develop a positive attitude towards the maintenance of good hygienic environment and subsequent prevention of malaria.

Effect of temperature increasing on households'vulnerability to malaria

The result in Table 9 indicates a positive relationship between increase in temperature and household vulnerability to malaria and is statistically significant at 10%. The result is in line with the expectation that increase of temperature will be positively related to farming household vulnerability to malaria. This means, when the temperature increases, the farming household vulnerability to malaria increases also. . Increase in temperature and humidity create conducive environment for the breeding of mosquitoes. This means that the mosquito population increases in such environment. Since mosquitoes are the vectors for the Plasmodium parasite, an increase in their population means an increase in the transmission of the parasite hence an increase in vulnerability to malaria. The result confirms the work done by Aklesso et al., (2011) which revealed that the effect of temperature on malaria cases at any given climate variability follows an increasing but not linear trend. The effect increases for temperature levels between 20 ºC and 25 ºC but becomes positive only from 22 ºC. At temperature levels above 25 ºC, the effect slows down but remains positive with an increasing trend. This may be the reason of the low statistical significance of this variable in the sense that in the study area, the annual mean temperature is above 25˚C.

According to Walsh *et al*. (1993), higher temperatures can increase the pace at which mosquitoes develop into adults, the frequency of their blood feeding, the rate at which parasites are acquired, and incubation of parasites within mosquitoes. Niringiye and Douglason (2010), however, observed in Uganda that temperature was not associated with malaria prevalence

Days of absence at farm of the malaria patient or caregiver

The result(Table 9) indicates that absenteeism at farm of the respondent is positively related to farming household vulnerability to malaria, and is statistically significant at 10%. This is in line with the expectation that absenteeism at farm affect vulnerability to malaria positively. The positive relationship between absenteeism at farm and vulnerability to malaria means that when the days of absenteeism increases, the farming household vulnerability to malaria increases. The result is consistent with the finding of Shepard et al., (1991) saying that the days of disabilities caused by malaria episode reduce the time spent on productive pursuits. With a lot of days of absence at farm particularly in the farming period (rainy season) may cause less production leading to income reducing

Literacy level of the malaria patient or caregiver

From the result in Table 9 literacy level of the respondents is negatively related to vulnerability to malaria although it is not statistically significant. This is in line with the *prior* expectation that high literacy level of the respondent reduces farming household vulnerability to malaria. This is so because a household head who has high literacy level will have fair knowledge of factors or conditions that decrease malaria transmission. The more one is educated, the more one will have knowledge about the development of mosquitoes' and malaria prevention. On the other hand, the statistical insignificance of the variable indicates that having knowledge about the development of mosquitoes and malaria prevention is not sufficient to reduce the malaria vulnerability. What matters most is how the knowledge is used orput to use so as to reduce the farming household's vulnerability to malaria. Furthermore, the level of literacy in the study area is quiet low.

Use of malaria prevention method by the household.

The results in Table9 again indicate that household prevention of malaria is negatively related to household vulnerability to malaria although it is not statistically significant. This is in line with *a prior* expectation that prevention of malaria affects household vulnerability to malaria negatively. This means that when the prevention of malaria decreases, the probability of farming household vulnerability to malaria increases. In the same vein when malaria prevention increases household vulnerability to malaria decreases. Preventive measures like the use of Insecticide Treated Nets (ITNs), Indoor Residual Spraying (IRS), outdoor insecticide spraying of the surroundings of family or household compound and the use of mosquito repellants reduce the mosquito population and subsequently reduce vulnerability to malaria. The statistical insignificance of this variable may be explained by the fact that farming household members may not have efficient malaria prevention. . They may be using the ordinary mosquito spray which controls them for only a short period of time. In other words, the absence of health extension officers may be the other cause; indeed, they are the ones supposed to inform the population about the prevention of diseases particularly during epidemics.

Effect of flooding on household vulnerability to malaria.

The results indicate that there is a positive relationship between flooding and household vulnerability to malaria, even though it is not statistically significant (Table 9). This finding has met the *a priori* expectation that flooding has positive effect on household vulnerability to malaria. This means when frequency of flooding increases, the probability of farming household vulnerability to malaria also increases.

Flooding can never occur without water. Since the availability of the breeding habitat is related to stagnant water that remains after rainfall, flooding is favorable for the breeding and development of mosquitoes. It may play an important role in malaria transmission; and increases household vulnerability to malaria. Najera (1999) has noted that the extent to which flooding is associated with increases in malaria cases is dependent on the timing of the floods in relation to other factors such as local rainfall and humidity.

The statistical insignificance of this variable can be explained by the fact that flooding events are very rare in the study area; and according to the field work, the target population has never experienced it in the last ten years.

Effect of decrease in rainfall on households’ vulnerability to malaria

Decrease in rainfall during the rainy season is negatively related to household vulnerability to malaria, but is not significant (Table 9). The finding is in line with the expectation that decrease in rainfall negatively affects farming household vulnerability to malaria. This means, when the frequency and amount of rainfall decrease, the farming household's vulnerability to malaria increases.

Linking the decrease in rainfall to farming activities, it is found that the decrease in rainfall may lead to less productivity as it is noted now in the West Africa sub-region that rainfall plays a key role in crop production in particular and agriculture in general. Crops need certain required rainfall amounts to do well. In addition to the amount the distribution of the rain during the farming season is even more critical for crop production than the total amount. Crops have critical periods during the growth periods when they need water. For example cereals and legumes need water during the seed and grain formation stages and any deprivation of water during this stage affects the productivity and yield of these crops.

<u>Table 9</u>: Determinants of related factors to malaria vulnerability

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.850	.891		3.198	.011
Total treatment expenditure	.000	.004	.019	.109	.015**
Educational level of the respondent	-.111	.131	-.142	-.843	.421
Number of people in the household of the respondent	-.039	.020	-.351	-1.979	.079*
Do you have support for malaria prevention or treatment?	1.112	.389	1.246	2.858	.019**
Do you prevent malaria?	-.446	.464	-.272	-.961	.361
Do you have some information about mosquito breeding and development?	-1.379	.470	-1.158	-2.935	.017**
Absenteeism at farm	.029	.064	.083	.456	.059*
Does flooding have any effect on malaria transmission?	.019	.251	.016	.075	.942
If the trend is decrease of rainfall, how long does the dry season last?	-.129	.143	-.172	-.903	.390
Effect of increasing temperature?	-.259	.126	.405	2.066	.069*

R Square =0.835

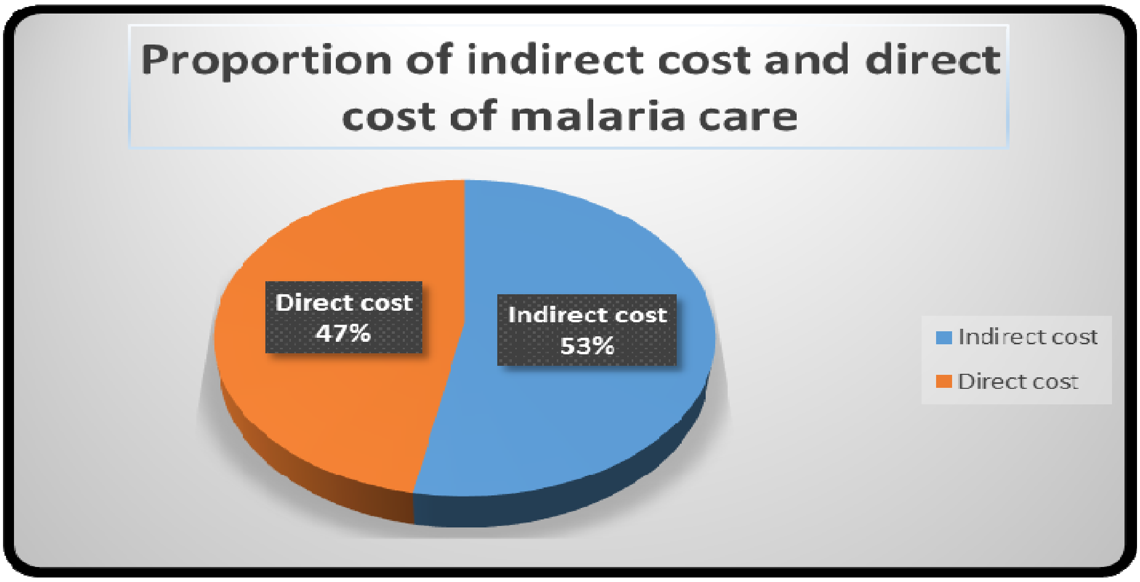
Note: ***, **, * means 1%, 5% and 10% significant level respectively

4.4- Economic cost of malaria care

This section presents the estimated results of direct and indirect costs of malaria care.

Total direct and indirect cost of malaria care

The overall total cost was estimated at GH₵ 8,713. The indirect cost was estimated at GH₵ 4,654 and the direct at GH₵ 4,059.



<u>Figure 9</u>: Proportion of indirect and direct cost of malaria care

Source: Field Survey

The results indicate an average daily income of GH₵ 35.53 and GH₵ 75.48 for the malaria patient and the caregiver respectively. Furthermore, the average days lost due to malaria episode in six months is estimated at 8.91 days for the malaria patient and 10.54 for the caregiver. This is an enormous loss of productivity for the farming household. The results are in line with a study conducted by Sauerborn et al (1991) in Burkina Faso which revealed that adult lost 9 working days due to malaria.

Direct cost

The annual direct cost was estimated by summing the diagnosis-consult cost, the cost of drugs, the cost of transportation (in and out) and the cost of special food. The estimation was based on the following model:

$$Y=X_1 + X_2+ X_3+X_4+X_5$$

where

Y= Direct cost; X_1= Diagnosis-consultation cost; X_2= Cost of drugs; X_3= Cost of transportation; X_4=Cost of special food; $X_{5=}$other related expenditure. Then:

Diagnosis-consultation cost=GH₵ 0.00

Cost of drugs=GH₵ 4,654.00

Cost of transportation=GH₵1,954.68

Cost of special food=GH₵ 2,327.00

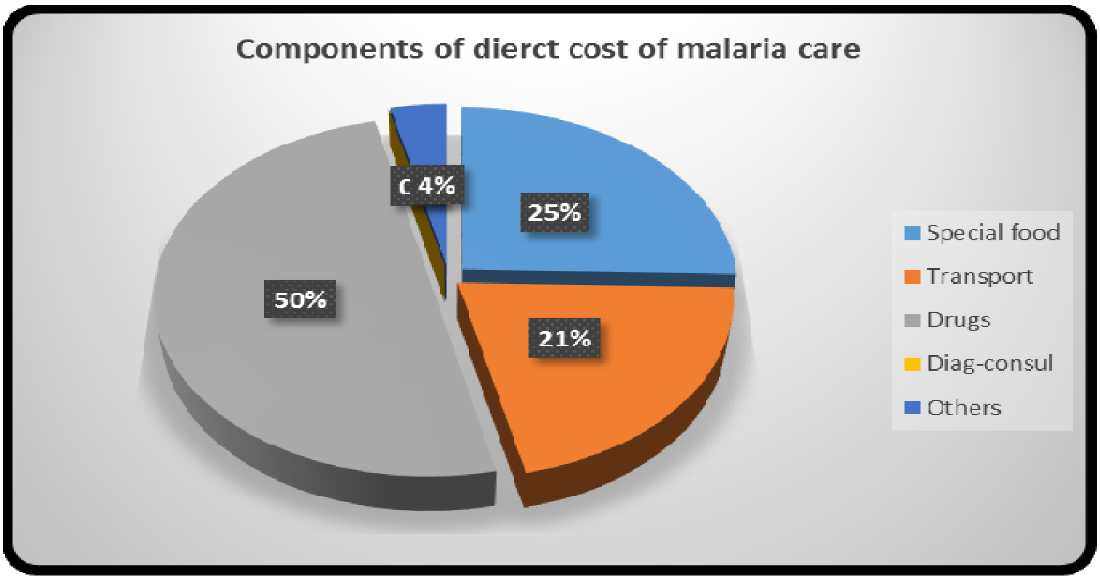
Other related expenditure (sending people) =GH₵ 372.32

For the 200 farming households selected, the annual total direct cost of seeking malaria care was estimated at GH₵9,308. It was found that the components of direct cost of malaria care were: expenditure on drugs (50%), special food (25%), transport (21%), other related expenditure (4%) and diagnosis-consultation expenditure accounted for 0% (see Figure 12).

Expenditure on drugs and special food were the major components of direct cost and together, they make up 75% of total direct cost of malaria care in Bole district. Contrary to the expectation, expenditure on drugs is leading the components of direct cost of malaria care. This is not supposed to be so in the sense that National Health Insurance Scheme (NHIS) of Ghana is supposed to cover the cost of drugs for malaria treatment. This study is probably showing the inefficiency and the limit of this health insurance. This inefficiency could be due to the unavailability of drugs in the health centres thus causing the malaria patient to buy drugs from peddlers or pharmacies. The danger in buying the drugs from peddlers is that their quality cannot be trusted since people normally do not know the sources of supply of these peddlers. This has implications for malaria treatment, especially in the rural communities. Where patients unknowingly procure the drugs from sources that cannot be trusted there is the likelihood that the drugs may be fake and this can aggravate the malaria cases in the communities since the fake drugs tend not to have any effect on the parasite.

The 0% proportion of consultation-diagnosis cost is due to Health Insurance which covers these services entirely thus making them free. The proportion of special food (25%) is confirming the study of Owusu et al., (1997) done in the Kassena-Nankana district which showed that 30% of the population had the perception that poor quality food worsens the plight of malaria patients than special or good quality food different from the ordinary diet could care malaria. While poor quality food reduces the immunity of the patient, good quality food helps to rebuild the depleted red blood cell and hence improve the immune system of the patient. This helps in facilitating treatment. Transport cost constitutes 21% of the total direct cost of treating malaria in the Bole District because the common means of transport is motorbike. Though fuelling the motorbike a relatively cheaper means of transport when compared with vehicles, the cost of petroleum products is making it relatively expensive.

This result confirms the study done by Akazili (2000) who found in the Kassena-Nankana district that expenditure on special food (46.2%) and drugs (45.7%) were the major components of direct cost of malaria treatment.



<u>Figure 10</u>: Components of direct cost of malaria care

The annual average direct cost being GH₵ 40.59 per household, it is not an enormous burden on households considering the annual average income of malaria patient (GH₵ 12,969) and caregiver (GH₵ 27,550).

Indirect cost

The days that the malaria patient or the caregiver lost due to malaria episode was considered for the opportunity cost of time lost. A total of 1,822 days were lost from productive activities by the malaria patients and caretakers in six months. Out of these days, 1065 days were lost by the malaria patients, and 757 by the caregivers.

The value of days lost from productivity was estimated by multiplying the prevailing daily average agricultural wage by total number of days lost. Then, the total value for all days lost in six months for malaria patients was GH₵ 37,839.45 and GH₵ 57,138.36 for caregivers. This implies that annually, the total value for all days lost for malaria patients was GH₵ 75,678.89 and GH₵ 114,276.72 for caregivers.

The Total Cost of malaria treatment is obtained by summing the Direct Cost and the Indirect Cost; then TC=DC+IC. For household with malaria patient who has caregiver, the total cost was GH₵ 189,996.20 and GH₵ 75,719.48 for malaria patient without caregiver.

4.5- Malaria cost as a percentage of total expenditure.

Table 10 depicts the household occasional and basic expenditure. In general, occasional expenditure (clothing and wares, utilities, capital goods and funeral celebrations) represent 32.7% of farming household expenditure. Farming household expenditure on healthcare was 10.6% of annual expenditure. 32.6% of annual household expenditure was on food, 18.5% was for education and 0.8% for rent.

The survey revealed an average of 2.68 malaria cases per household for one year period and this cost (direct and direct) a household on average GH₵ 67.8, which represented 3.5% of total average annual expenditure per household. This may be relevant if we consider the fact that total annual expenditure on health was just 10.6%. Given the share of health expenditure of 10.6%, the annual cost of malaria was 33% of the annual household healthcare expenditure. This may be a substantial burden to farming households if we consider the fact that malaria is one of the diseases causing health problem in the district.

Table 10: Household basic and occasional expenditure.

Item (basic and occasional)	Annual expenditure GH₵	% of total expenditure
Food	63,048	32.6%
Clothing and wares	36,240	18.7%
Education	35,800	18.5%
Health care	20,494	10.6%
Utilities	20,297	10.5%
Capital goods	3,172	2.2%
Funerals, wedding, etc.	5,392	1.3%
Rent	3,172	0.8%
TOTAL	187,615	100%

4.6- Malaria cost to household as percentage of annual income by quintiles

The mean annual income of the bottom poor (quintile 1) was estimated at GH₵453.10. Compared to the top rich quintile with mean annual income of GH₵83,138.89. Given that the mean malaria cost was GH₵501.35, the cost of malaria was as much as 110.6% of the total annual income of patients of quintile 1, 12.1% of quintile 2; 5,8% of quintile 3; 2.8% of quintile 4 and only 0.6% of the total annual income of the quintile 5. This clearly shows that the very poor are the ones who are more challenged when it comes to malaria treatment. Their income levels are very low for those in the first quintile and this implies that the greater percentage of their income is spent on taking care of the sick. The fact that they spent up to 110.6% of their income means that they can only take care of their health with support from other sources. This result is supporting the finding of Sharma et al., (1990), Guiguemde et al., (1994) and Koradsen et al., (1997) that the brunt of malaria cost fall more on the poorest of the poor of the people who have very limited income.

CHAPTER V

CONCLUSION AND POLICY RECOMMENDATION

This chapter concludes and makes policy recommendations based on the findings of the study. It also makes suggestions about areas for further study or further.

5.1- Conclusions

The results indicate an increasing trend in temperature change which may be at major contributing factor of vulnerability to malaria disease. Malaria incidence in the target area is not only due to the increase of temperature, but also to some socio-economic conditions. The analysis of factors influencing vulnerability to malaria among smallholder farmers in Bole District revealed that total treatment expenditure, number of people in the respondents' household, having information about mosquitoes breeding and development, absenteeism from farm and increasing temperature were the main predictors of vulnerability to malaria.

Among the components of direct cost (diagnosis-consultation cost, the cost of drugs, the cost of transportation, and the cost of special food), drugs and special food accounted for 75%. Drugs accounted for quite a high percentage of direct cost (50%), which is contrary to our expectation because the Ghana National Health Insurance Scheme is supposed to cover the diagnosis-consultation and drugs cost fully. While diagnosis-consultation was free the cost of drugs was the highest contributor to direct cost of treating malaria. This may be caused by the unavailability of the drugs at the health facilities and may be due to systemic inefficiencies of the scheme. It is common knowledge in Ghana that health insurance payments to health facilities by the National Health Insurance Authority (NHIA) is unduly delayed thus leading to a depletion of drug stock of the facilities. Special food accounted for quite a high percentage (25%) which may be as a result of the perception that low quality food worsens the plight of malaria patients.

The study revealed that both direct and indirect cost associated with malaria episode are very crucial burden to farming households. The indirect cost of malaria which results from losts of time due to disabilities linked to malaria episode was found to outweigh direct cost of malaria. The proportion of indirect cost to the total cost of malaria was 53% which is quite substantial.

Both direct and indirect malaria care cost a farming household a significantly amount of household income, which is quite enormous, taking into consideration the low incomes of farming households in the study area. The indirect losses composed of opportunity cost of days lost from productivity are substantial cost to the farming households and could seriously affect household's budgets, particularly farming households. The study revealed that low-income households carried a disproportionate share of the economic burden of malaria. As the proportion of malaria cost to annual income was 110.6% of the very poor malaria patients, it was only 0.6% of the rich malaria patients.

5.2- Policies recommendations

Based on the findings of the study, the following policies recommendations are made both to government and households so as to minimize the costs of the disease in the district.

5.2.1- Government

- Recruiting and training malaria awareness creation volunteers

Volunteers should be trained to assist farming households by educating them on proper sanitation and waste disposal, mosquitoes breeding and development, malaria symptoms in order to seek early treatment. This recommendation is based on the fact that one of the factors that contributed to reducing vulnerability to malaria was knowledge of mosquitoes breeding and development. The volunteers will help in creating more awareness among the people and this will lead to a reduction in vulnerability. Those who are being trained to be health assistants by the Ministry of Health can take up this responsibility.

- Reinforcement of the National Health Insurance Scheme

Since the cost of drugs is a high component of direct cost, the government should revise the availability of malaria care drugs. Efficiency should be injected into the operations of the NHIS to ensure prompt release of funds to health facilities to enable them stock their dispensaries with the basic drugs, including those for treating malaria. This should help the very poor household to cut down on cost of treating malaria.

- Economic empowerment

In order to make money available to the very poor households for them to access health care, farmers should diversify their sources of income in order to cope with climate change which is affecting their productivity and income; government, together with the communities can build some small scale irrigation facilities such as dams for supplying water because of the reduction in the duration of rainfall season. But irrigation dams, if poorly constructed may, however be prime breeding nest for mosquitoes breeding leading to malaria.

5.2.2- Farming households

- Use of preventive methods

Temperature increase seems to be one of the factors affecting farmers' household vulnerability to malaria; during warm period, people tend to sleep outside without protection against malaria; therefore, people should use ITN's even in warm period when they sleep outside so as to protect them from mosquito bite.

- Changing of behavior

Households should keep their immediate environments clean by avoiding stagnant water in cans and, from bath rooms. It also seems that because of the use of malaria preventive methods such as ITNs, insecticides (spray, repellent) mosquitoes have changed their habit of biting; they bit more in the evening than at night. This implies that people should also change their habits by being be in the room as earlier as possible, use of net for doors and windows, and smearing mosquito repellant on the body in the evening and night.

5.2.3- Further research

For further research in the area, the study recommends the following:

- Firstly, a similar study should be conducted to look at the effects of temperature increase on the direct and indirect cost of malaria treatment over a certain number of years. . This can help ascertain the real effect of temperature increase on the cost of malaria treatment.
- Secondly, a study should be conducted by considering the other components of indirect cost such as value of productive time lost due to mortality and morbidity, and value of life earnings lost due to premature mortality.

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ANNEXES

Annex 1: Statistical summary of annual and monthly precipitation for Bole

Bole station	Minimum	Maximum	Mean	Stdev	Variance	CV
Annual	704.8	1562	1077.112	187.0583	34990.8	0.174
Jan	0	50.8	2.361538	9.952088	99.04406	4.214
Feb	0	84.9	11.36923	21.11141	445.6918	1.857
Mar	0	138.7	41.76154	39.86972	1589.594	0.955
Apr	0	189.1	108.2038	49.355	2435.916	0.456
May	38.7	390.4	132.05	66.91494	4477.61	0.507
Jun	48	304.7	156.5923	67.23178	4520.113	0.429
Jul	0	259.9	132.4038	64.75456	4193.153	0.489
Aug	0	268.6	147.3962	75.33842	5675.878	0.511
Sept	118.6	348	216.4423	61.61156	3795.984	0.285
Oct	0	347.5	101.2423	77.07812	5941.036	0.761
Nov	0	95	22.20769	27.35734	748.4239	1.232
Dec	0	55	5.080769	12.13557	147.272	2.389

Annex 2: Man-Kendall test results of annual, monthly and seasonal precipitation

Months	Man Kendall Statistic (S)	p-value (two tailed test)	alpha	Sen's slope Estimate	Test Interpretation
Jan	-10	0.762	0.05	0	Accept H0
Feb	26	0.535	0.05	0	Accept H0
Mar	-4	0.944	0.05	0	Accept H0
Apr	4	0.945	0.05	0.153	Accept H0
May	-18	0.695	0.05	-0.931	Accept H0
Jun	44	0.320	0.05	1.648	Accept H0
Jul	-40	0.367	0.05	-1.683	Accept H0
Aug	-2	0.773	0.05	-34.7	Accept H0
Sept	-6	0.149	0.05	-47.25	Accept H0
Oct	-4	0.386	0.05	-25.2	Accept H0
Nov	2	0.981	0.05	0	Accept H0
Dec	-4	0.932	0.05	0	Accept H0
Annual	10	0.836	0.05	1.689	Accept H0

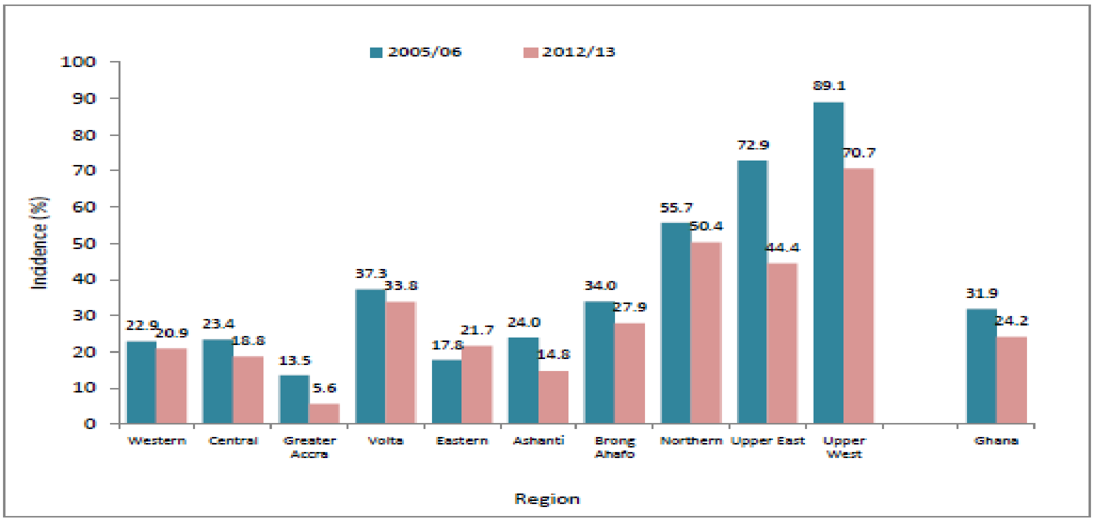
Annex 3: Statistical summary of annual and monthly temperature for Bole

Bole station	Minimum	Maximum	Mean	Std	Variance	CV
Jan	33.3	37.4	35.37	0.95773	0.917246	0.027075
Feb	20.2	37.7	36.19	0.95773	3.331537	0.092051
March	34.7	38.5	36.84	0.95773	1.032138	0.027575
April	32.4	36.6	34.96	1.103149	1.216938	0.031557
May	30.5	34.6	33.27	0.95489	0.911815	0.028702
June	29.9	32.4	31.09	0.627584	0.393862	0.020187
July	28.6	31.6	29.68	0.61969	0.384015	0.020878
Aug	28.4	29.7	29.14	0.366795	0.134538	0.012586
Sept	29.4	30.9	30.24	0.415859	0.172938	0.013751
Oct	30.6	33.5	32.03	0.172938	0.576615	0.023707
Nov	25.3	37.5	33.98	1.992648	3.970646	0.058647
Dec	33.1	36.5	34.82	0.838717	0.703446	0.024085

Annex 4: Man-Kendall test results of annual and monthly maximum temperature

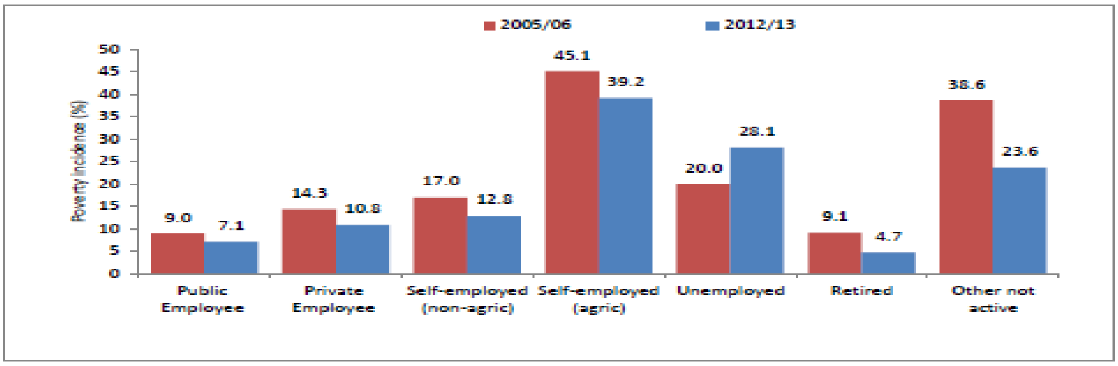
Months	Man Kendall Statistic (S)	p-value (two tailed test)	alpha	Sen's slope Estimate	Test Interpretation
Jan	0.155	0.292	0.05	0.035	Accept H0
Feb	0.047	0.761	0.05	0.006	Accept H0
March	-0.192	0.197	0.05	-0.051	Accept H0
April	0.047	0.761	0.05	0.01	Accept H0
May	-0.020	0.907	0.05	0	Accept H0
June	0.250	0.091	0.05	0.027	Accept H0
July	0.501	0.001	0.05	0.05	Rejected H0
Aug	0.324	0.029	0.05	0.025	Rejected H0
Sept	0.250	0.091	0.05	0.021	Accept H0
Oct	0.020	0.907	0.05	0	Accept H0
Nov	0.085	0.574	0.05	0.011	Accept H0
Dec	0.487	0.001	0.05	0.077	Rejected H0
Annual	0.255	0.080	0.1	0.016	Accept H0

Annex 5: Poverty incidence by region (poverty line= GH¢ 1,314)



Source: GLSS6, 2014

Annex 6: Poverty incidence by employment status of household, 2005/06-2012/13 (poverty line=GH¢1,314)



Source: GLSS6, 2014

<u>Annex 7</u>: FOCUS GROUP DISCUSSION

I-IDENTIFICATION

Region	
District	
Sub-District	
Number of participants	
Name of the leader	
Name of note taker	
Date of discussion realisation	
Starting hour	______ H ______ mn
Ending hour	______ ___H_ mn
Laguage used in discussion	

II-INTRODUCTION

Hello, be the welcome (s) in this focus group. My name is ___________________________

My colleague here with me is called ________________________________. I'm a student who want to know more about malaria in your area. Thank you for agreeing to participate in this meeting despite your many duties.

We will discuss about the malaria and its impacts. You are invited to discuss freely, but one after another. There is no right or wrong answers, all answers are welcome. The information you provide is important. That's why we ask you to answer honestly and truthfully to questions. During the discussion, my colleague will try to take notes. You will be designated by the numbers in front of you in the allocation of speech.

Because he cannot log everything and as we do not want to lose any of your ideas, we would like to record our discussion with permission. I want you to know that anything said will remain confidential and will be treated anonymously.

THEMES	QUESTIONS	RESPONSES
1.Historical aspect of diseases in the locality	1.1. What are the diseases you suffer from in your locality?	
	1.2.Rank them from the most frequent to the least	
	1.3. Do you think malaria is a major one? Why?	
	1.4. How many times do you get sick from malaria in the year?	
2.Causes and consequences of malaria episodes	2.1. According to you, what are the causes of malaria?	
	2.2. Is the malaria episode caused by heat?	
	2.3. According to you, what are the consequences of malaria on your health?	
	2.4. Do the malaria prevent you to do your farming activities?	
	2.5. Do you go to farm if one of your family member is suffering from malaria (children)?	
	2.6. How much can you spend in average to treat malaria?	
	2.7. Do the annual treatment of malaria has effect on your income?	
3. Climate and malaria	3.1. According to you, is there any link between malaria episode and seasons?	
	3.2. In which season do you experienced malaria outbreak?	
	3.3. In which months do you suffer more from malaria episode?	

4.Perception on climate change	4.1. Have you ever heard of “climate change”?	
	4.2. What is your perception about climate change?	
	4.3. How is it manifested in your locality?	
	4.4. Do you notice any change in the seasons in your area?	
	4.5. Is there an extension of dry season?	
	4.6. Do you notice increase in temperature?	
	4.7. Are the days and nights become more and more hotter?	
5.Climate change and farming activities	5.1. Do the climate change affect your farming activities? How?	
	5.2. Do the climate change affect your income? How?	

Annex 8

Form No

HOUSEHOLD SURVEY INSTRUMENT

Financial Burden of Malaria on Farming Communities: Case study of Bole District

IDENTIFICATION

Name of the community: ………………………………….. Interviewer's Name: ………….…………………………….

In the past six months, have you or any member of your household had malaria?	**01**.Yes.[ ]	**00**.No…..[ ]	EXPMAL
NOTE: if No=2, end interview			
Last name: Surname:			RESNAM
Respondent (HH head=1; Adult HH member=2)	**1**.[ ]	**2**.[ ]	RESPOND
House number			HHDNUM
Sex	F [ ]	M [ ]	SEX
Date of interview			DINT

<u>SECTION 1</u>: Socio-economic and demographic characteristics of interviewee

1	How old are you? (in completed years)		AGE
2	What is your marital status	1. Married …………………………………………. [ ] 2. Never married………………………………. [ ] 3. Divorced……………………………………… [ ] 4. Widowed………………………………………. [ ] 5. Separated……………………………………. [ ] 6. Other (specified)…………………………. [ ]	MASTCUR
3	What is your educational level	1. None………………………………………………. [ ] 2. Primary…………………………………………. [ ] 3. Secondary……………………………………. [ ] 4. Tertiary…………………………………………. [ ] 5. High school…………………………………. [ ]	EDUC
4	What is your occupation	1. Subsistence farmer…………………………. [ ] 2. Large scale farmer…………………………. [ ] 3. Trader………………………………………………. [ ] 4. Salaried worker………………………………. [ ] 5. Artisan (specify)………………………………. [ ]	OCCUP
5	How many people live in this household (eat in the same pot)	Number of people…………………..	HHSIZE

SECTION 2: Household baseline survey

6-State of housing (observe)

6.1-	Does the household have a modern design (i.e. zinc roofing excluding animal pound?)	01. Yes…………… [ ] 00. No……………. [ ]	MODESIGN

7-Household goods and assets

Does any member of your household own the following items (functioning?) (Code 00 if No)

Item	**Yes / No**	**If yes, how many?**	
7.1-Motor vehicle (cars, tractor, motor bike)			MOTVEH
7.2-bicycles			BICYCLE
7.3-TV			TV
7.4-Radio			RADIO
7.5-What is the common toilet facility used by the household?		1. Free range……………………….. [ ] 2. Pit latrine………………………… [ ] 3. KVIP………………………………… [ ] 4. W.C………………………………… [ ] 5. Other (specify)………………… [ ]	TOILET
7.6-What is the common source of drinking water for the household?		1. Pipe borne water……………. [ ] 2. Bore-hole……………………….. [ ] 3. Well water……………………… [ ] 4. Dam/dugout…………………… [ ] 5. Stream…………………………… [ ] 6. Other (specify)………………. [ ]	WATER

<u>SECTION 3a</u>: Indirect and direct cost of malaria treatment

8	Is malaria a common illness in the area	01. Yes………… [ ] 00. No………… [ ]	COMILL
9	How many of your household members (including respondent) have had a malaria episode within the past:	1. one month…………………..members 2. three months………………..members 3. six months……………………members	NUMEM

INSTRUCTION: IF MORE THAN FOUR MEMBERS IN 9, LIST THE MOST RECENT CASE IN 10……..

Q	No	Name (in capital)	R' ship to resp.(refer to **)	Sex (M/F)	Age	Occupation (refer to ***)
10a	**Person 1**					
10b	**Person 2**					
10c	**Person 3**					
10d	**Person 4**					

****** Self=1**;** Relative= 2; husband=3; wife=4; friend=5; other (specify) =6

*** Subsistence farmer=1; Large scale farmer=2; Farmer too old to work=3; retired salary worker=4; Trader=5; Artisan=6; Retired worker=7

NOTE: FW MUST READ CAREFULLY THE INSTRUCTION:

IN THIS SECTION FW SHOULD ASK ALL QUESTIONS OF RELEVANCE TO EACH MEMBER BEFORE PROCEEDING ONTO THE NEXT MEMBER (ie VERTICALLY, NOT HORIZONTALLY).

I WOULD LIKE TO ASK YOU ABOUT THE MEMBERS OF YOUR HOUSEHOLD WHO HAD MALARIA IN THE PAST MONTH (FOUR WEEKS AGO)

	Person 1	Person 2	Person 3	Person 4
	Name: ………………… ………………………….	Name: …………………. ……………………….….	Name: ………………… ……………………….….	Name: ……………. ……………………….
How long did member experience the malaria? **(enter DK if respondent does not know and NA for not applicable)**	**11a……………..days**	**11b……………..days**	**11c……………..days**	**11d……………..days**
What was the state of member's malaria episode	**12a** 1. Severe……….. [ ] 2. Mild…………… [ ] 3. Other (specify)…. ……………………...[ ] 9.DK…………………. [ ]	**12b** 1. Severe……….. [ ] 2. Mild…………… [ ] 3. Other (specify)…. ……………………...[ ] 9.DK…………………. [ ]	**12c** 1. Severe……….. [ ] 2. Mild…………… [ ] 3. Other (specify)…. ……………………...[ ] 9.DK…………………. [ ]	**12d** 1. Severe……….. [ ] 2. Mild…………… [ ] 3. Other (specify)…. ……………………...[ ] 9.DK…………………. [ ]
Did member do anything to treat the malaria? **(if no(2) skip to Q.21)**	**13a** 1. Yes……………… [ ] 2. No………………. [ ]	**13b** 1. Yes……………… [ ] 2. No………………. [ ]	**13c** 1. Yes……………… [ ] 2. No………………. [ ]	**13d** 1. Yes……………… [ ] 2. No………………. [ ]

If yes in 13, what did member do to treat the malaria?	**14a** 1. Sought modern health care only…… [ ] 2. Trad/herbal health care only……………… [ ] 3. Trad/herbal/modern health care…………. [ ] 4. Other (specify)... …………………………………	**14b** 1. Sought modern health care only…… [ ] 2. Trad/herbal health care only……………… [ ] 3. Trad/herbal/modern health care…………. [ ] 4. Other (specify)……………………	**14c** 1. Sought modern health care only…… [ ] 2. Trad/herbal health care only……………… [ ] 3. Trad/herbal/modern health care…………. [ ] 4. Other (specify)……………………	**14d** 1. Sought modern health care only…… [ ] 2. Trad/herbal health care only……………… [ ] 3. Trad/herbal/modern health care…………. [ ] 4. Other (specify)…………………

If 1 or 3 in 14, what type of modern health care was sought?	**15a** 1. Hospital……….. [ ] 2. HC/clinic………[ ] 3. CHPS compound[ ] 4. Vil Hosp worker. [ ] 5. Chemist………… [ ] 6. Trad/Treat… [ ] 7. Self-treatment [ ] 8. Other (specify)……………………	**15b** 1. Hospital…………. [ ] 2. HC/clinic………… [ ] 3. CHPS compound.[ ] 4. Vil Hosp worker. [ ] 5. Chemist…………. [ ] 6. Trad/Treat….. [ ] 7. Self-treatment… [ ] 8. Other (specify)…………………	**15c** 1. Hospital…………. [ ] 2. HC/clinic………… [ ] 3. CHPS compound.[ ] 4. Vil Hosp worker. [ ] 5. Chemist…………. [ ] 6. Trad/Treat….. [ ] 7. Self-treatment… [ ] 8. Other (specify)…………………	**15d** 1. Hospital…………… [ ] 2. HC/clinic………… [ ] 3. CHPS compound.[ ] 4. Vil Hosp worke... [ ] 5. Chemist………[ ] 6. Trad/Treat……. [ ] 7. Self-treatment…. [

				] 8. Other (specify)................
If 1to 6 in 15, where did member seek the malaria treatment?	**16a** 1. Town clinic………. [ ] 2. Vil. HC/clinic…….. [ ] 3. Another vil. Clin (specify)………………. 4. Vil. Market……….. [ ] 5. Other vil. Mark (specify)……….………	**16b** 1. Town clinic………. [ ] 2. Vil. HC/clinic…….. [ ] 3. Another vil. Clin (specify)………………. 4. Vil. Market……….. [ ] 5. Other vil. Mark (specify)……….………	**16c** 1. Town clinic………. [ ] 2. Vil. HC/clinic…….. [ ] 3. Another vil. Clin (specify)……………. 4. Vil. Market………. [ ] 5. Other vil. Mark (specify)……….……	**16d** 1. Town clinic………. [ ] 2. Vil. HC/clinic…….. [ ] 3. Another vil. Clin (specify)………………. 4. Vil. Market………. [ ] 5. Other vil. Mark (specify)……….………
If member went to the hospital/health centre/clinic/chemist/ Trad-herb., by what means of transport did he/she go to the health facility	**17a** 1. On foot……………. [ ] 2. Bicycle…………….. [ ] 3. Motorbike……….. [ ] 4. Vehicle……………. [ ] 5. Other (specify)………..	**17b** 1. On foot……………. [ ] 2. Bicycle…………….. [ ] 3. Motorbike……….. [ ] 4. Vehicle……………. [ ] 5. Other (specify)…	**17c** 1. On foot……………. [ ] 2. Bicycle…………….. [ ] 3. Motorbike……….. [ ] 4. Vehicle……………. [ ] 5. Other (specify)…	**17d** 1. On foot……………. [ ] 2. Bicycle…………….. [ ] 3. Motorbike……….. [ ] 4. Vehicle……………. [ ] 5. Other (specify)…
If No in 13, why was nothing done to treat the malaria?	**18a** 1. No money………… [ ] 2. Expensive………… [ ] 3. Not severe……….. [ ] 4. Trad. beliefs…… [ ] 5.Lim. Acc. HCS……[ ] 6. Other (specify)…….. ……………………………	**18b** 1. No money………… [ ] 2. Expensive………… [ ] 3. Not severe………. [ ] 4. Trad. beliefs…… [ ] 5.Lim. Acc. HCS……[ ] 6. Other (specify)…….. ……………………………	**18c** 1. No money………… [ ] 2. Expensive………… [ ] 3. Not severe………. [ ] 4. Trad. beliefs…… [ ] 5.Lim. Acc. HCS……[ ] 6. Other (specify)…….. …………………………….	**18d** 1. No money………… [ ] 2. Expensive………… [ ] 3. Not severe………. [ ] 4. Trad. beliefs…… [ ] 5.Lim. Acc. HCS……[ ] 6. Other (specify)…….. ……………………………

If 1to 3 in 15, how long did member have to wait before seeing the health worker? **(probe and estimate the time in hours and minutes)**	**19a** …….HR ……….Min	**19b** …….HR ……….Min	**19c** …….HR ……….Min	**19d** …….HR ……….Min
Was member able to go about his/her normal activities during malaria episode? (if yes fully, skip to 23)	**20a** 1. Yes fully…………….[ ] 2. Yes partially…….. [ ] 3. Not at all…………. [ ]	**20b** 1. Yes fully……………. [ ] 2. Yes partially…….. [ ] 3. Not at all…………. [ ]	**20c** 1. Yes fully……………. [ ] 2. Yes partially…….. [ ] 3. Not at all…………. [ ]	**20d** 1. Yes fully……………. [ ] 2. Yes partially…….. [ ] 3. Not at all…………. [ ]
If yes partially (2) or Not at all (3), how long was member unable to do his/her normal activities?	**21a** ……………..days	**21b** ……………..days	**21c** ……………..days	**21d** ……………..days
How much would the member have earned in a day if he/she had not been ill with a malaria episode?	**22a** Cedis……….	**22b** Cedis……….	**22c** Cedis……….	**22d** Cedis……….

INSTRUCTION: QUESTIONS 23a to 23d ARE ARRANGED VERTICALLY BELOW. PLEASE CAREFULLY ESTABLISH COST OF EACH SERVICE TO INDIVIDUAL MEMBER WHO HAVE SOUGHT CARE FOR THEIR MALARIA EPISODE

23. In seeking health care (i.e. from Hosp/HC/clinic; CHPS compound; Vill. Hosp. worker; chemist; Trad/herb and self-treatment) of member during the malaria episode, how much do you think was spent on the following to treat malaria**? (Obtain individual cost and add up to get the total cost)**

Person	**Special food**	**Transporta-tion**	**Cost of drugs**	**Diagnostic consulta-**	**Other Expenditure**	**Total expenditure**

			(in and out)		tion fee	(specify and Value)		
23a	1	Cedis…………	Cedis…………	Cedis………..	Cedis………..	Cedis…………	Cedis………..	TOEXP26 A
23b	2	Cedis…………	Cedis…………	Cedis………..	Cedis………..	Cedis…………	Cedis…………	TOEXP26 B
23c	3	Cedis…………	Cedis…………	Cedis………..	Cedis………..	Cedis…………	Cedis…………	TOEXP26 C
23d	4	Cedis…………	Cedis…………	Cedis………..	Cedis………..	Cedis…………	Cedis…………	TOEXP26 D
Total expen-diture		Cedis…………	Cedis…………	Cedis………..	Cedis………..	Cedis…………	Cedis…………	GRTOEXP
		TEXPFOOD	TEXPTRAN	TEXPDRUG	TEXPDCON	TEXPOTH	GRTOEXP	

SECTION 3b: Caretaker/Caregiver

NB: In the case the member has more than one caretaker, be interested in the main caretaker

	Person 1	Person 2	Person 3	Person 4
Did member have a caretaker (especially relevant to children) during his/her malaria episode?	**24a** 01. Yes…………….. [ ] 00. No……………… [ ] **(if 2 go to 24b)**	**24b** 01. Yes…………… [ ] 00. No…………….. [ ] **(if 2 go to 24c)**	**24c** 01. Yes…………….. [ ] 00. No……………… [ ] **(if 2 go to 24d)**	**24d** 01. Yes…………….. [ ] 00. No……………… [ ] **(if 2 go to section 4)**
What is caretaker relationship to the member who had the malaria episode?	**25a** 1. Husband/wife. [ ] 2. Mother/father [ ] 3. Son/daughter [ ] 4. Grd parents… [ ] 5. Guardian……. [ ] 6.Others…………………	**25b** 1. Husband/wife. [ ] 2. Mother/father [ ] 3. Son/daughter [ ] 4. Grd parents… [ ] 5. Guardian………. [ ] 6.Others…………………	**25c** 1. Husband/wife. [ ] 2. Mother/father [ ] 3. Son/daughter [ ] 4. Grd parents… [ ] 5. Guardian……… [ ] 6.Others	**25d** 1. Husband/wife. [ ] 2. Mother/father [ ] 3. Son/daughter [ ] 4. Grd parents… [ ] 5. Guardian……. [ ] 6.Others…………………

Sex of caregiver	**26a** 1. Male……………… [ ] 2. Female………… [ ]	**26b** 1. Male……………… [ ] 2. Female………… [ ]	**26c** 1. Male…………… [ ] 2. Female………… [ ]	**26d** 1. Male……………… [ ] 2. Female………… [ ]
Age of caretaker (in completed years)	**27a** ………………….years	**27b** ………………….years	**27c** ………………….years	**27d** ………………….years
Occupation of caregiver	**28a** 1. Subsistence farmer................. [ ] 2. Large scale farmer……………… [ ] 3.Other (specify)……………….	**28b** 1. Subsistence farmer................. [ ] 2. Large scale farmer……………… [ ] 3.Other (specify)……………….	**28c** 1. Subsistence farmer................. [ ] 2. Large scale farmer……………… [ ] 3.Other (specify)……………….	**28d** 1. Subsistence farmer................. [ ] 2. Large scale farmer……………… [ ] 3.Other (specify)……………….
Was caretaker able to do his/her normal duties at the time of taking care of member who had malaria? **(if yes fully, skip to section 4)**	**29a** 1. Yes fully………… [ ] 2. Yes partially… [ ] 3. Not at all………. [ ]	**29b** 1. Yes fully………… [ ] 2. Yes partially… [ ] 3. Not at all………. [ ]	**29c** 1. Yes fully……… [ ] 2. Yes partially… [ ] 3. Not at all………. [ ]	**29d** 1. Yes fully………… [ ] 2. Yes partially… [ ] 3. Not at all………. [ ]
If yes partially (2) or Not at all (3), how long was caretaker unable to go about his/her normal duties?	**30a** …………….days	**30b** …………….days	**30c** …………….days	**30d** …………….days
How much would the caretaker (if working) have earned for a day if he/she were not taking care of the member	**31a** **……………….Cedis**	**31b** **……………….Cedis**	**31c** **……………….Cedis**	**31d** **……………….Cedis**

Yes or No	**If yes how?**

32	Do you prevent malaria? **(if No, skip to next question)**		1. Use of ITNs………………………………….. [ ] 2. Use of mosquito repellent……….…….. [ ] 3. Use of insecticide………………………….. [ ] 4. Use of malaria preventive drugs……… [ ] 5. Use of traditional methods……………… [ ] 6. Closing of the doors……………….……… [ ] 7. Other (specify)………………………………. [ ]
33	Do you have support for malaria prevention or treatment? **(if No, skip to question 34)**		If yes, from who? 1. Government………………………………. [ ] 2. NGOs…………………………………………. [ ]
34	If yes, What is the nature of the support?		1. ITNs………………………………………………. [ ] 2. Mosquito repellent………………………. [ ] 3. Insecticide……………………………………. [ ] 4. Malaria preventive drugs………………. [ ] 5. IPT (pregnant women) …………………. [ ] 6. ACTs ………………………………………….. [ ] 7. Other (specify)……………………………… [ ]
35	Do you have some information about mosquito breeding and development?		01. Yes……………………. [ ] 00. No……………………. [ ]
36	If Yes(1) in 35, how does the information help you to prevent malaria?		
37	How often do you clear debris from drains and ditches		1.Always………………. [ ] 2.Very often…………… [ ] 3.Not at all……………. [ ]

<u>SECTION 3c</u>: Prevention of malaria

Household expenditure

38. In the last six months, did the household spend money on the following items? (If No, enter 00)

Items	Y/N	Amount if Yes (Y)	Code
38.1 Clothing and shoes: for both adults and children			CLSHOE
38.2 Health care: clinics/HC/hospitals fees, buying drugs from private/market, dispensaries, traditional/herbal treatment fees (**other health care expenditure)**			HEALTH CARE
38.3 Education: children school fees, books, etc...			EDUCATION
38.4 Foods: including millet, corn, beans, salt, food staff			FOODCST
38.5 Utility service: water, electricity			UTILITIES
38.6 Capital goods: radio, bicycle, motor, vehicle, building…			CAPGOOD
38.7 Rent			RENT
38.8 Direct taxes			TAX
38.9 Funeral celebration, marriages…			DRCOTOF
38.10 Other (specify)			OTHER
38.11 Total expenditure			TOTEXPD

SECTION 4: Environment and malaria

39	How many rainy seasons and dry season do you experience in your area?	1.2 rainy seasons and 2 dry seasons………… [ ] 2.1 rainy seasons and 1 dry seasons………… [ ] 3. Other (specify)……………………………………… [ ]
40	Have there been any changes in the rainfall distribution in the last 10 to 15 years? (if No (2), end the interview)	01. Yes……………………………………………………… [ ] 00. No……………………………………………………….. [ ]
41	If yes (1), what is the nature of the change?	1. Decrease in rainfall……………………………. [ ] 2. Increase in rainfall……………………………. [ ] 3. Fluctuation in rainfall distribution………. [ ] 4. Other (specify)…………………………………… [ ]
42	If the trend is increase of rainfall, how long does the rainy season last?	1.7 months……………………………………………. [ ] 2. More than 7 months…………………………. [ ] 3. Other (specify)…………………………………… [ ]
43	Do this increase of rainfall causes flooding?	01.Yes……………………… [ ] 00.No……………………… [ ]
44	If Yes (1), what has been the trend of floods in your community over the past 10-15 years?	1. Increasing…………………………… [ ] 2. Decreasing…………………………… [ ] 3. No change…………………………… [ ]
45	What is the effect of climate change on floods?	1. Increases floods…………………………… [ ] 2. Decreases floods…………………………… [ ] 3. Has no effect…………………………… [ ]
46	Does flooding have any effect on malaria transmission?	01.Yes……………………… [ ] 00.No……………………… [ ]
47	If Yes (1), what are the effects?	1. Increase in mosquito population…………………… [ ] 2. Decrease in mosquito population…………………… [ ]
48	How often do the members of your household contract malaria during floods when compared to years without floods?	1. Very often………………………………… [ ] 2. Often……………………………………… [ ] 3. Quite often……………………………… [ ] 4. Less often………………………………… [ ]
49	If the trend is decrease of rainfall, how long does the dry season last?	1.5 months……………………………………………. [ ] 2. More than 5 months…………………………. [ ] 3. Other (specify)…………………………………… [ ]
50	Have there been any changes in the temperature in the last 10 to 15 years?	01.Yes……………………… [ ] 00.No……………………… [ ]

51	Does temperature have any effect on mosquitos' population and malaria transmission?	01.Yes……………………… [ ] 00.No……………………… [ ]	
52	If Yes (1), what are the effects?	1. Increase in mosquito population…………………. [ ] 2. Decrease in mosquito population………………. [ ] 3.Sleeping out of ITNs	
53	Is there any water body close to your house?	01.Yes……… [ ] 00.No………. [ ]	If Yes (1), which type? 1.River……………………… [ ] 2.Dam……………………… [ ]
54	Do the members of your household contract malaria more often now because of temperature increases as compared to when temperatures had not increased?	01.Yes……………………… [ ] 00.No……………………… [ ]	
55	Is there any temporary pools of water around your compound?	01.Yes.... [ ] 00.No……[ ]	If Yes (1) why? 1.Poor drainage system………………… [ ] 2.Presence of ditches…………………… [ ]
56	In what season do you experience more malaria episode?	1. Rainy season……………………………………… [ ] 2. Dry season…………………………………………. [ ] 9. Don't Know…………………………………………. [ ]	
57	Do you notice any change in your crop yield?	01. Yes…………. [ ] 00. No………….. [ ] 2. No change... [ ]	if Yes: 1. Increase……………. [ ] 2. Decrease………….. [ ]
58	Do you experience any change in your income?	01. Yes……………. [ ] 00. No……………. [ ] 2. No change... [ ]	if Yes: 1. Increase……………… [ ] 2. Decrease……………. [ ]
59	If decrease in income, about how percentage?	1.25%………… [ ] 2.50%………… [ ] 3.>50%………… [ ]	
60	Which of these factors make your household vulnerable to malaria?	1. Deforestation………………………………………. [ ] 2. Presence of wetlands areas coverage………. [ ] 3. Blocked swamp drainage…………………………. [ ] 4. Presence of water bodies…………………………. [ ]	

DK= Do not know

00= No

01= Yes

AFTER THE INTERVIEW:

1-Check your form to ensure you have not left blanks or inconsistences

2-Thank the respondent for his/her cooperation and time