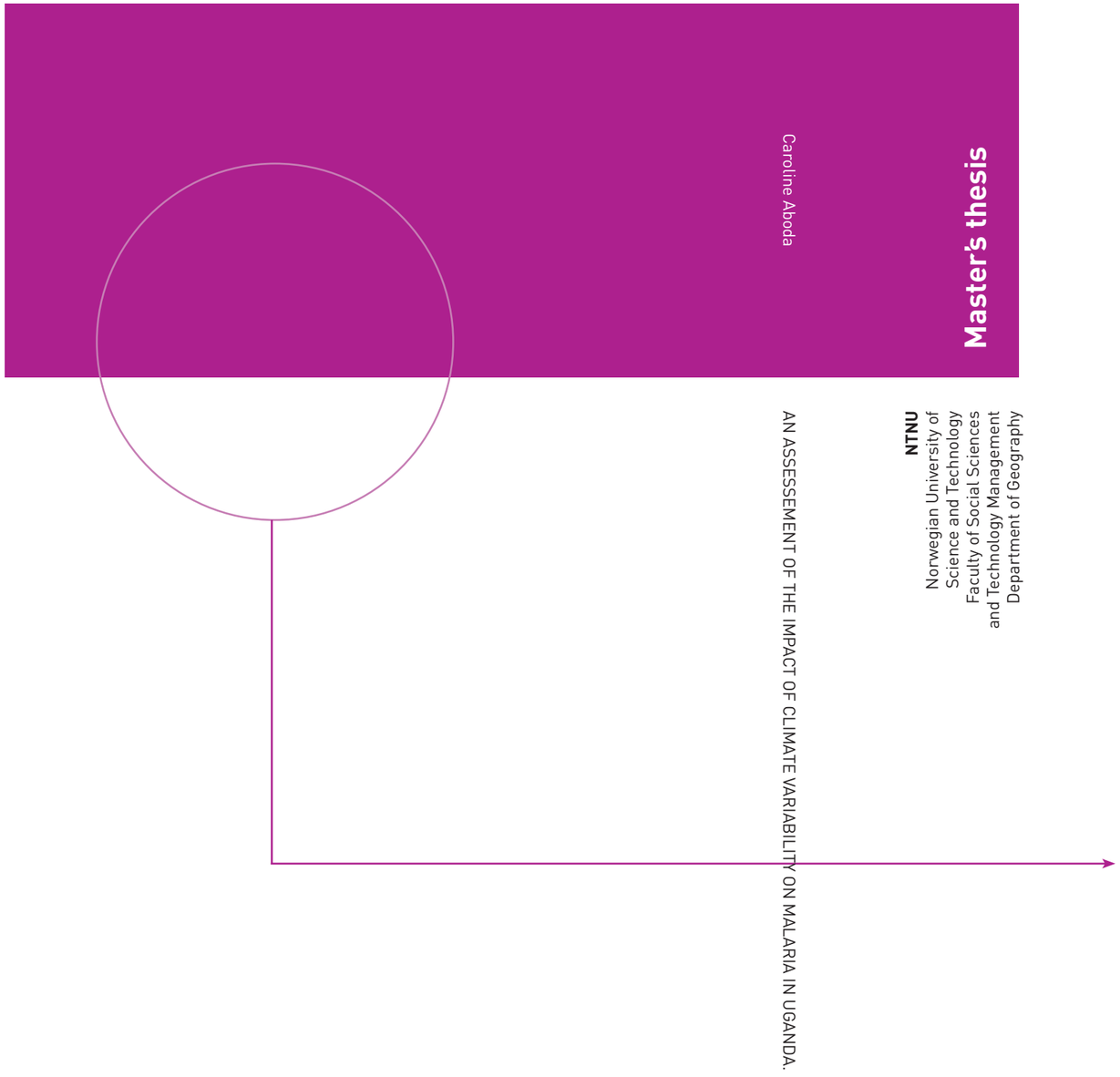

Caroline Aboda

AN ASSESSEMENT OF THE IMPACT OF CLIMATE VARIABILITY ON MALARIA IN UGANDA.

A STUDY FROM MOUNT ELGON REGION OF BUDUDA DISTRICT

Degree of Master of Philosophy in Development Studies

Trondheim, Spring 2012

NTNU – Trondheim
Norwegian University of
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AN ASSESSEMENT OF THE IMPACT OF CLIMATE VARIABILITY ON MALARIA IN UGANDA.

A CASE STUDY OF MOUNT ELGON REGION OF BUDUDA DISTRICT

By Caroline Aboda

A thesis submitted to the Department of Geography in partial fulfilment of the requirements for the award of the Degree of Master of Philosophy in Development Studies of Norwegian University of Science and Technology.

May, 2012

Trondheim, Norway.

ABSTRACT.

The thesis involved an assessment of the impact of climate variability on malaria epidemic around Mount Elgon of Bududa district, Uganda. The specific objectives were to investigate certain impacts of climate variability influencing malaria epidemic and to explore people's awareness of the possible association between climate variability and malaria, and corresponding copying strategies in their communities.

Climate variability refers to variations in the mean state of climate on all temporal and spatial scales far than that of individual weather events. Climate variation is attributed directly or indirectly to human activity that alters the composition of the global atmosphere. The variation is also due to natural climate variability observed over comparable time periods. In Uganda including Bududa district malaria has become high and rampant in high altitude areas like 1800 meters above sea level in recent years.

The Human ecological model was used as an analytical tool for the study to explain the impacts of climate variability influencing malaria. The human ecology model is a theoretical and analytical framework that fairly explains the objectives under study and can be used for local level studies. However, the model doesn't explain some external linkages like political issues or factors either at local, national and international levels. Concepts explaining causes of climate variability, risk factors, climate variability and health concept, controlling and preventing malaria out break all contributed in the flow of arguments of the findings.

A qualitative method of data collection was used. For this study, information was collected using formal interviews, informal interviews, observation, focused group discussion and secondary data. An interview guide was used. Quantitative approaches were also used to a smaller extent to look at relationships between age, education level, gender and place of residence. It was also used in presenting some secondary information like rainfall and temperature data, and malaria cases for Bududa district. Informants were selected through purposive sampling. 10 key informant interviews, 18 individual interviews with local community members and 12 female members of the community from the lower (Buwanabisi with 1400m asl), middle (Bumakuma with 2000m asl) and higher (Bufukhula with 2500m asl) villages for focused group discussion to collect primary data.

Findings revealed that Bududa district is experiencing increasing outbreak of diseases such as malaria. Malaria has even become common in areas of the high altitude which didn't have malaria cases in the past. Injuries and loss of lives all have been attributed to the variation in climate besides other risk factors. More frequent occurrence of heavy rainfall and extreme weather conditions (temperature) has direct effects in the spread of malaria to the upper village (Bufukhula) and more frequent to the lower area (Buwanabisi) by creating suitable breeding grounds for the mosquito vector. Extreme weather has caused landslides, damage to houses and infrastructure to the people in the higher altitude village of Bufukhula contributing to migration (permanent or temporary) to the lower area which are more malaria infected, hence creating an indirect effect of climate. Those from the higher altitude village are prone to malaria attack due to reduced immune system and low experience in protection against mosquitoes and malaria. Awareness of climate variability and existence of strategy at the individual and community, district, and national level is still low and limited. Copying strategies to the impacts of climate variability are of three types: *Adaptation and active adjustments*, *acceptance* and *migration* at different levels ranging from individual and community, district and national level. Possible recommendations for risk reduction for vector control and malaria were made by the informants and the researcher.

DEDICATION.

I dedicate this thesis to my parents Mr John Aboda and Mrs Irene Aboda for the endless support in all ways. My dedication goes to Sr Mary Angel Acayo and Mr Kamukama Saul for the constant parental words of encouragement that helped me to finish successfully.

My dedication also goes to my sister Sarah who helped me a lot during the field study. Besides encouraging me, she always woke me up in the morning and uplifted me whenever I wasn't feeling fine.

ACKNOWLEDGEMENTS.

Special thanks go to my supervisor Assoc Prof Stig.H.Jørgensen for the constant support in terms of advice, guidance, constructive comments and time sacrificed to read through my work from the time I started till the end. May the almighty be your strength always and forever.

Am also highly indebted to the lecturers in the Department of Geography at the Norwegian University of Science and Technology Prof Ragnhild Lund, Prof Haakon Lein, Assoc prof Brun Cathrine, Assoc Prof Aasetre Jørund, Assoc Prof Lujala Päivi, among others for having contributed to the completion of my studies.

Many thanks go to the administrators and stuff in the Department of geography Miss Wold Bodil, Miss Knutsen Annette Sofie among others for the constant cooperation and advice that helped me complete my studies and have a good study environment in Norway. You were more like parents. I also acknowledge the Norwegian state loan fund and Quota programme co-odinator Miss Anette Moen for providing the financial support for the whole study period in Norway. I cannot forget Miss Turid Bræk and Gro Synnøve Johnsen for their motherly words and guidance whenever one felt stressed with any issue. Besides guidance, thank you for all the timely information as regards academics, life and stay in Norway.

The contribution of the stuff like Dr Bob Nakileza, Dr Tumwine.D.Ruguma, Assoc Prof Basalirwa, Prof Nyakaana, Miss Clare Nantumbwe, Mr Ndyabahika Matete Micheal among others in the Department of Geography of Makerere University is also paramount in enabling me pursue my master degree. They were so encouraging and even still kept offering advice that enabled me to complete my thesis in time. You are all special in my life.

Finally, I would like to thank my sister Sarah, Sr Mary.A. Acayo, Mr Kamukama Saul, Dan Semugenyi, Florence Najjemba and other friends for all the beautiful words of encouragement that enabled me complete my Master degree and live well in Norway.

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LIST OF ABBREVIATIONS AND ACRONYMS.

USAID.....United State Agency for International Development.

IPCC.....Intergovernmental panel on climate change.

NEMA.....……National Environment Management Authority.

NAPA.....National Adaptation of Action.

FIFOC.....Forest initiative for the community.

NGO.....Non Governmental Organisation.

NFA.....National Forestry Authority.

WHO.....World Health Organisation.

A.S.L.....Above sea level.

CO2.....Carbon dioxide**.**

LC.....Local council.

Mt..... Mount.

CHAPTER ONE.

1.1 BACKGROUND

Malaria affects millions of people from all over the world every year. The death and the suffering that the disease causes in the human population are big. Several people suffer repeatedly from the disease due to constant bites from the mosquito vector. Though malaria affects millions of people all over the world, the prevention and treatment is simple, unless the person suffers from the most severe type of malaria.

Malaria is a common disease in all countries, including the developed. There are cases reported from almost all countries in the world. Malaria disease is transmitted from one person to another due to the bite of a mosquito. When the mosquito bites a person who is infected with malaria and then bites another person who is not infected, the infection is transmitted from the affected person to the healthy person.

Malaria in human beings is due to infections with *plasmodium falciparum, plasmodium. malariae, plasmodium.Vivax or Plasmodium.ovale.* Out of all the different types, *Plasmodium falciparum* is the most dangerous and most virulent species as it multiplies so fast and is able to sequester in small blood vessels causing damage to the brain and other organs. Malaria is influenced by the bite of an infected female Anopheles mosquito. In Africa like Uganda where the research was conducted, Anopheles mosquito is the most common type. Each parasite has a distinctive morphology and characteristic antigens at each stage of its life cycle. This takes place in both the mosquito and the liver and blood vessels and red blood corpuses of man. The parasite releases toxin which is responsible for fever. The epidemiology features of malaria mainly determined by the climate and the ecology of the mosquito vectors, influence immunity in the population (Lankinen et al., 1994).

1.2 CLIMATE VARIABILITY AND MALARIA.

Climate variability refers to variations in the mean state of climate on all time and spatial scales more than that of individual weather events. Examples of climate variability include extended droughts, floods, heavy rainfall among others. Climate variability may be as a result of either natural internal factors or external factors (United State Agency for International Development, 2007).

Climate may play a major role in determining the spread and number of insects like the mosquito vector. This can be either directly or indirectly through its effects on habitats and

animals. Climate change may have an effect on the geographical range of many malaria vector species (Rogers, 1996; Sutherst, 1998).

1.2.1 Global Trends.

Malaria is one of the world's most serious disease and difficult public health problems. About 400–500 million cases of the disease occur every year and more than one million deaths, though children are more affected. Malaria is undergoing a global resurgence because of a number of factors (World Health Organisation, 2001). Malaria cases has been increasing in many countries since the 1970's all over the world, even after successful control and prevention, hence taken to be a new disease that can keep on occurring (Gubler, 1998a; Nchinda, 1998).

Children and pregnant women are the most affected by malaria disease. Today, a child dies of malaria every 40 seconds and between one and three million people die each year around the world, especially in sub-Saharan Africa where it is more prevalent. Although these figures and estimates show spatially coarse patterns, they do not reveal the fact that spatially fine patterns have been changing. Such patterns are quite evident in the geographical malaria regions like the sub Saharan highlands including Mount Elgon of Bududa district in Eastern Uganda. These highlands are sparse land extensions in several African countries, with altitudes of at least 1200 m asl (Chaves & Koenraadt, 2010).

World Health Organisation estimates that, by 2000, the global burden of diseases including malaria attributed to climate change had exceeded 150,000 excess deaths annually. Continuous increase in the transmission and distribution of infectious diseases worldwide malaria, typhoid fever is speculated by models estimating the effects of climate change while others for example will see a decrease in transmissibility due to excessive warming of some water as well as some regional drying (Gatrell & Elliott, 2009).

1.2.2 In the African and East African Highlands.

There are several factors contributing to malaria spread ranging from social and built environments, human behaviour, and population but climate can be considered the major determinant. Temperature and rainfall limit malaria to the warm, humid regions of Africa especially the highlands, where the mosquitoes and parasites can breed and develop and transmission can occur. Of recent, there have been much debate and wonders on the issue of highland malaria in Africa. Highlands which have always been regarded as areas of little or no malaria transmission mainly because of low temperatures appears to be changing. This is

due to the variations in climate. Increase in the number of epidemics in highland areas, as well as a spread of endemics in highland fringes is indicated by several incidences. Among the various and prominent reasons explaining the apparent change in epidemiology have been attributed to climatic and ecological change. Unfortunately the analysis of this highland malaria has been difficult due to lack of reliable malaria data (MARA, 1998).

The debate in the African highlands especially East Africa has primarily focused on malaria where there is high prevalence rate of malaria cases. This is due to the health outcomes that are attributed to the recent observed climate variability. About 17% of the population of East Africa lives in the highlands (1,500 –2,500 m above sea level) which is characterised by high malaria prevalence due to a climate-related emerging hazard. The climate related hazard therefore calls for urgent solutions and appropriate strategies to reduce its negative health impacts (Githeko, 2007). In Tanzania, Uganda and Kenya, malaria incidences increased by 146%, 256% and 300% respectively during the 1997/98 epidemic; both periods coincided with El Nino events in the region. In Uganda 12% of the population live in areas of low and unstable malaria transmission yet they are now areas susceptible to diseases like malaria, cholera, diarrheal and typhoid fever. The districts include Kabale, Rukungiri, Kanungu,, Kisoro, Kasese, Kabarole, Bundibugyo, Ibanda, Isingiro, Mbarara and the Mount Elgon area Kapchorwa, Sironko, Bududa, Manafa (Githeko, 2007).

1.2.3 In Uganda, including Mount Elgon region

Malaria transmission is high in 90 percent of Uganda, with 5 percent of the country mainly in the highland areas. Malaria transmission is typically severe as a result of extreme rainfalls associated with malaria epidemics (National Environment Management Authority, 2006/2007). The remaining 5% of the country are in the highlands of the southwest like Rwenzori, Midwest, and along the eastern border of Kenya for example Mount Elgon and north-eastern border of Sudan. Malaria transmission is unstable and epidemic prone in these highlands. It is the most reported disease that is causing high morbidity and mortality (President's Malaria initiative Uganda, 2009). Today, 39 percent of outpatient visits and 35 per cent of inpatient admissions are due to malaria in Uganda. This is because it contributes to the biggest share of the disease problem within the country (National Environment Management Authority, 2006/2007). The poor countries including Uganda with limited adaptive capacity are expected to suffer most from the consequences of adverse effects of climate variability (Uganda: National adaptation programmes of action, 2007).

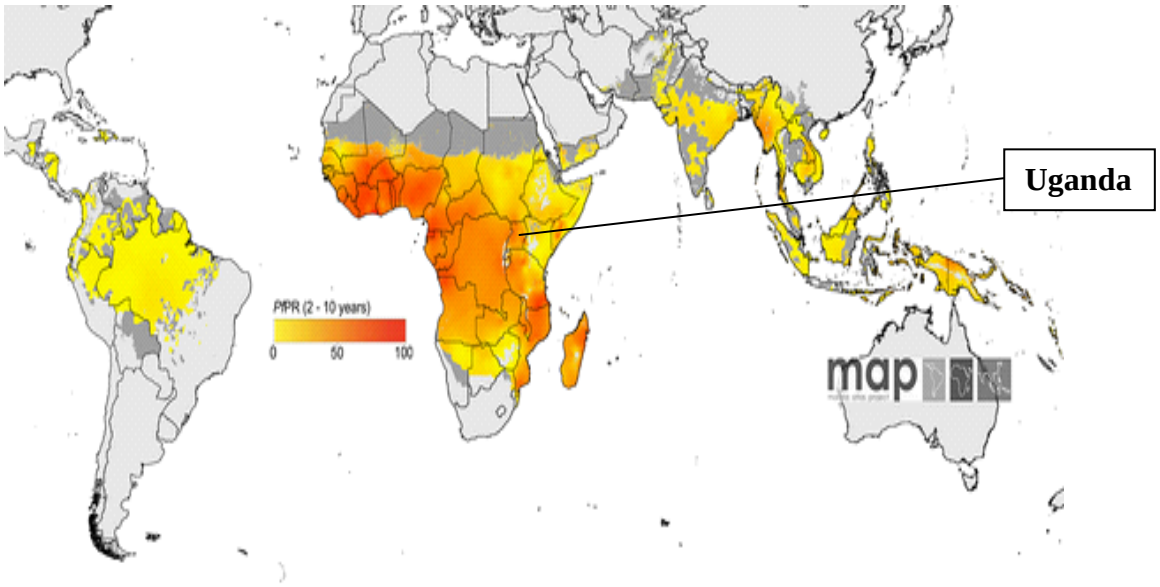

Figure 1.1: GIS map showing the spatial distribution of malaria endemic areas in the World.

Source; (Hay et al., 2009).

From the above map, it can be noted that malaria prevalence is high in Africa compared to other parts of the world. Uganda lies within the countries that experience highest number of deaths from malaria. While many factors play a role in the distribution of malaria and occurrence of malaria epidemics, climate is considered a major determinant. Temperature, rainfall and humidity affect breeding and survival of vector mosquitoes and development of malaria parasites within the mosquitoes.

Because the disease is so strongly influenced by the interaction between people and their natural environment, geographical perspectives and ideas are very relevant to research and strategies aiming to control the disease and the conditions created by climatic variations.

1.3 STATEMENT OF THE PROBLEM.

At the moment, the variation in climate due to global warming is one of the most serious environmental and health problems worldwide since it is affecting and hindering development efforts like health improvement, poverty eradication and environmental sustainability as it is seen in the highland regions including Mount Elgon. The impact of climate variability is no longer a new or surprising concept but a reality on the ground (Uganda: National adaptation programmes of action, 2007). Climate variation is leading to

the increase in frequency and severity of extreme weather events such as droughts, floods, and landslides. Besides that it is also leading to the intensities and frequencies of heavy rains in the Mount Elgon areas as well as out breaks of associated water and vector borne diseases like malaria, cholera, diarrheal and typhoid fever. In Uganda, malaria is endemic in approximately 95% of all areas and today in the highlands of eastern and south western regions of Uganda (Elgon and Rwenzori highlands respectively), malaria continues to be a major health problem and concern since it is spreading in areas of high altitude like 1800 meters above sea level (Presidents Malaria Initiative Uganda,2009). Malaria incidence in the highland (1500-1800m asl) areas of Uganda has increased more than 30 times (Mouchet et al., 1998). High altitude areas (like Bumakuma and Bufukhula villages of Bududa district) are taken to be areas where conditions are critical for the vector parasite to survive. Due to this, they have had less intense transmission and lower protective immunity to malaria among the population in this high altitude than other parts of the country where malaria is more endemic. Malaria is transmitted by *Anopheles gambie* in the highland areas which are the main malaria vector mosquitoes in Uganda.

Temperature rise due to climate variability has significant impacts on health as well as agriculture in the highlands. These highlands are mainly in south-western part of Uganda in the surrounding Rwenzori Mountain range districts like Kisoro, Kabale, Kabarole, Kasese and eastern districts like Bududa, Mbale, Sironko surrounding Mount Elgon that were previously malaria-free, are now invaded by malaria. People living in the Elgon Mountain region for generations have not developed immunity for malaria and are therefore susceptible to it. Equally, rise in temperature and rainfall or shorter periods with increased rainfall can lead to outbreaks of pests and emergence of new diseases other than malaria like cholera, diarrheal and typhoid fever.

The impact of climate variability has been felt in causing malaria spread though population, built and social environment and behavioural factors also play a great role in malaria prevalence. The recent severe malaria epidemics in these highland regions due to the variations in climate have raised concern about the attitudinal expansion of malaria hence the need for research. This research therefore helped in assessing the impacts of climate variability on malaria in Mountain Elgon region, so that appropriate copying strategies could be designed and integrated within the health sector.

1.4 OBJECTIVES.

The specific objectives included:

1. Assess certain impacts of climate variability in influencing malaria epidemic in Bududa district.

    - How does the variation in temperature and rainfall influence malaria epidemic?
    - What are the built and social environments, population and human behavioural risk factors influencing malaria spread?

2. To explore people's awareness of the possible association between climate variability and malaria, and corresponding copying strategies in their communities.

    - What are the informant's awareness levels and perceptions on the impacts of climate variability in relation to malaria?
    - What are the copying strategies and efforts to the impacts of climate variability in relation to malaria epidemic?

1.5 SIGNIFICANCE OF THE STUDY.

The study could contribute to other similar research on the impacts of climate variability on health: case of malaria in the Mountainous or highland regions. This information will act as a source of information to other related research for those who intend to carry out research in climate variability and health field. Hence acting as a reference material (Secondary data), especially to institutions like universities, research organizations and Non-governmental organizations carrying out activities as well as study in the area of climate change or variability, and health or related field.

The study will also be useful to geographers taking courses, carrying out research and working in the field of health geography. It will help them to understand and analyze social and environmental aspects of human diseases and enlighten the geographers with knowledge that can make them able to shed light on the causes of diseases, interaction of risk factors, impacts and suggest appropriate solutions that can help in copying with the prevailing conditions.

In order to fight other diseases like cholera, diarrheal, typhoid fever resulting from the impacts of climate variability, the country and Bududa district public health officials can use this information as part of decision making tools in the allocation of funding for diseases

research, prevention and control. Changing factors in relation to increased transmission such as above average temperature and precipitation can be closely monitored and appropriate copying strategies and measures to prevent the impacts can be implemented where needed.

1.6 ORGANIZATION OF THE THESIS.

Chapter one deals with the introduction, statement of the problem, objectives and the significance of the study. The chapter gives a highlight on malaria disease and global (world) trends. It gives information on climate variation and malaria situation at global level, continent, region and the study area. Chapter two explains the theoretical and analytical framework used in interpreting and analyzing findings. Chapter three deals with research methodology. Chapter four explains information about the study area. Chapter five and six present the main findings of the study. Chapter five focuses on the impacts of climate variability on malaria spread and other risk factors to malaria. Chapter six present people's levels of awareness and perceptions of the possible association between climate variability and malaria, and corresponding copying strategies in their communities. Chapter seven gives the summary of findings, conclusion and recommendations.

CHAPTER TWO: THEORETICAL AND ANALYTICAL FRAMEWORK.

2.1 INTRODUCTION.

This chapter presents the theories, ideas and concepts related to geography that are important in understanding the association between climate variability and malaria.

There are several definitions of theory by different authors and scholars. *Theory has been defined as an "analytical and interpretive framework that helps the researcher make sense of "what is going on in the social settings being studied" (*Mills 1993:103). *These theories, "provide the researcher with a framework for the problem and questions to be addressed in the study"*(Mills, 1993:114).

In defining theoretical framework, "*we are cognizant that any fieldwork or theory allows the researcher to "see" and understand certain aspects of the phenomena being studied while concealing other aspects. No theoretical framework provides a perfect explanation of what is being studied* (Anfara & Mertz, 2006).

In this study, besides the human ecology of disease model being the main analytical theory, ideas about the causes of climate variability, risk factor of disease concept, climate variability and malaria, ideas on control and prevention of malaria outbreak, all contributed in supplementing the flow of arguments in the empirical chapters five and six.

2.2 CLIMATE VARIABILITY.

World climate change shows a change in either the mean state of the climate or in its variability, persisting for several decades or longer. It can be on spatial or temporal scale. This includes changes in average weather conditions on earth, such as a change in average global temperature, as well as changes in how frequently regions experience droughts, heavy rain falls, and floods. It is important to note that changes in individual weather events will potentially contribute substantially to changes in climate.

2.3 CAUSES OF CLIMATE VARIABILITY.

Climate variability varies naturally as a result of several factors: the way the ocean and the atmosphere interact with each other, changes in the earth's orbit and changes in energy received from the sun. However, there is evidence that the recent global warming is not only

attributed to natural factors but human causes which seem to be the major cause. The changes seen over recent years and those predicted for the next century, are taken to be mainly the result of human behaviour through interaction with the environment. Human activity is the main cause of the variations seen in climate during recent decades. (http://www.direct.gov.uk/en/Environmentandgreenerliving/Thewiderenvironment/Climatechange/DG_072920, 07/04/2012).

The earth has warmed by 0.75 degrees Celsius in the last 100 years globally that sea levels have gone up; glaciers and sea ice have melted. Extreme weather events, like floods and droughts, are likely to happen more often hence having direct and indirect effects like outbreak of diseases like malaria. World atmospheric concentrations and emissions of carbon dioxide, methane and nitrous oxide have increased substantially as a result of human activities since 1750 and now far exceed that of past thousand years. The increases in carbon dioxide concentration worldwide are majorly due to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture that usually results from the production process of animals (Intergovernmental panel on climate change, 2007). Human activity is also continuing to change and increase the amount of greenhouse gases in the atmosphere in three important ways as seen below (http://www.direct.gov.uk/en/Environmentandgreenerliving/Thewiderenvironment/Climatechange/DG_072920.Fossil, 07/02/2012). During the interaction with the environment, holes and ditches are left behind. These holes collect water during rainy seasons that become suitable breeding grounds for mosquitoes.

2.3.1 Burning fossil fuels

Burning fossil fuels like coal, oil and gas leads to release of green house gases like carbon dioxide, methane and nitrous oxide. For example, in 2005, burning fossil fuels produced about 27 billion tonnes of carbon dioxide into the atmosphere. Human beings burn fossil fuels to create energy, which is used for many things like heating homes and buildings, growing, transporting and cooking food, travelling (can be by car, plane, bus and train), treating water to make it drinkable, heating and piping it into homes, manufacturing, using and transporting products, from clothes to fridges, from plastic bags to batteries. http://www.direct.gov.uk/en/Environmentandgreenerliving/Thewiderenvironment/Climatechange/DG_072920.Fossil, 07/04/2012).

Coal, oil and natural gas are all fossil fuels that society has come to depend on. Transportation and energy infrastructures have been built on fossil fuels consumption, and people rely on them to power the devices that provide shelter and food. Much as many enjoy the contributions of using and consuming fossil fuels, there are effects as well. Fossil fuel energy has negative as well as beneficial effects on air, the environment and industrial areas. These effects can be long or short term. For example, some diseases like malaria have also found new avenues of infection due to shifts in regional temperatures. This can be seen in the African highlands. In 2010, "The Quarterly Review of Biology" cited East Africa, Indonesia and Afghanistan highlands that were not affected by malaria previously to be suffering now due to the rise in average temperature which is contributing in the expansion of the anopheles mosquito's habitat (http://www.ehow.com/list_6120939_fossil-fuel-cons.html., 27/03.2012).

2.3.2 Deforestation

Deforestation contributes to alteration of the world's climate as well as the environment. Cutting down forests faster than they are replaced (deforestation) is a major contributor to climate variation. It accounts for about 20 percent of human carbon emissions more than the entire global transport sector produces. Deforestation makes such a huge contribution to carbon emissions because trees absorb CO2 as they grow. The more trees are cut down, the fewer there will be left to absorb CO2, leading to it concentrating in the atmosphere. In addition to the above, the agriculture and industry that replace the forests often cause an extra problem by producing carbon emissions of their own. In order to develop an area that is vegetated with trees and bushes, there is need to carryout clearance. Activities to develop an area, such as deforestation and irrigation, can increase the number of vector breeding sites. This is due to the fact that many new breeding grounds in terms of holes and ditches will be left behind, hence contributing to an increase in malaria. Colonization may be accompanied by major building projects, such as dams, canals, highways, or mining activities referred to as the tropical aggregation of labour which can further enhance malaria transmission (Martens & Hall, 2000).

2.3.3 A growing world population

Human population growth has led to increasing demands for energy and land resources. Through the burning of fossil fuels to produce energy for industrial use, transportation, and domestic power, and through land-use change for agriculture and forest products, the earth's energy balance has been altered by humans. Scientists believe that these changes may have

already begun to alter the global climate. The increasing demand will lead to increasing emissions which is causing variation in climate (http://www.direct.gov.uk/en/Environmentandgreenerliving/Thewiderenvironment/Climatechange/DG_072920, 07/04/2012). As population increases, large pieces of land are cleared for agriculture, settlement and several other developments. In the process of creating land through all the above activities, suitable breeding grounds are opened.

Therefore human activities like burning fossil fuel, deforestation and increase in population has effects on the climate by increasing temperature due to the warming brought about. This in turn affects rainfall amount and distribution. The amount of rainfall and the rise in temperature all contribute to conditions which favour the survival of mosquito vectors.

2.4 CLIMATE VARIABILITY AND HEALTH.

Climate constrains the range of many infectious diseases and weather affects the timing and intensity of outbreaks. The most worrying effect of this world warming is on the wide and increasing spread of malaria especially in the highland areas. This warming is due to the rise in temperature and humidity. Increased flooding at the lowland resulting from heavy rainfall also becomes breeding site for mosquitoes. This therefore explains why links between climate and diseases are not new. Due to health outcomes attributable to observed climate variability, the debate has primarily focused on malaria in the highlands of Africa, especially East Africa around Usambara Mountains, Mount Rwenzori, Mount Elgon, Mount Kenya, and Mount Kilimanjaro where there is high prevalence rate of malaria cases (Haines & Patz, 2004).

The problems of malaria and it's prevalence in Africa and Asia continues to be scaring due to climatic factors like temperature and rainfall which has great influence on the geographical spread and seasonal incidence (Epstein, 1999).

The relationship between climate change and health is that vectors like pathogens and hosts reproduce within certain optimal climate conditions as a combination of rainfall and temperature and changes in these conditions can alter greatly these properties of disease transmission. The most important and influencing climatic factor for vector borne diseases like malaria includes; temperature and precipitation. Extreme low temperatures are often

critical to the survival of disease causing pathogens but incremental changes in temperature may exert varying effects because the human body immune system and the blood system will be weak to withstand such changes. Variability in precipitation may have direct consequences in infectious disease outbreaks. Increases in precipitation may increase the presence of disease vectors by expanding the size of existent larval habitat and creating new breeding grounds. In addition, increased precipitation may support growth in food supplies, which in turn support a greater population of vertebrate reservoirs. Alternatively, flooding may force insect or rodent vectors into houses and increase the likelihood of vector-human contact (National Environment Management Authority, 2006/2007).

2.5 RISK FACTORS OF DISEASE

Risk has been defined as "an abstraction that represents the likelihood of specific outcomes. Risk is the real chance of something occurring, taking into consideration real behaviour or exposure. It is often presented as a chance arguing that; everything we do exposes us to dangers. It is the way we do things, and how often, that determines the risk. As such, risks appear largely external to us, particular events happen whether we want them to or not. It is assumed that people become ill when they are exposed to risk factors (Bill, 2005).

Risk factors may affect disease and injury outcomes through other intermediate factors. It may also affect disease and injury outcomes in combination with one another. Some risks have common social and behavioural determinants. Because of these epidemiological and social characteristics of risk factor exposure and hazard, policy frameworks should include an assessment of health benefits of continuous reductions in multiple risks (Lopez, 2006).

The major influences on the risk include: individual or environmental factors which may be physical, social and built, population factors like age and gender and behavioural factors like belief, technology and social network. These risk factors will be discussed in detail under the human ecology model. Malaria disease is usually a result of both direct and indirect factors as mentioned above. The physical risk factors considered in this study include, climatic conditions like temperature and rainfall. Temperature and rainfall are risk factors that make one prone to malaria epidemic, hence the need to take appropriate precautions.

Malaria epidemic risk is related to both warm temperatures and the months of the rainy season that follows. This is exemplified with the fact that temperature controls the rate of larval and parasite development. Higher temperatures shorten the development time of the larvae and parasites in the mosquitoes. Climatic events that create this condition can quicken epidemics. Rainfall increases the presence of mosquito breeding habitats, and thus the size of the mosquito population (Wandiga et al., 2010).

Communities living at altitudes above 1,500 metres asl have added risks of malaria disease due to climate variability, lack of immunity, and poverty due to more marginal living conditions. The observed climate trends indicate that the highland communities of East Africa have a higher exposure to malaria epidemics. Additionally, the poor are at greater risk due to their inability to access medical treatment and the lack of health care facilities during such epidemics (Wandiga et al., 2010).

2.6 THE HUMAN ECOLOGY OF DISEASES AS AN ANALYTICAL FRAMEWORK.

Human ecology of disease approaches the geography of disease from an ecological point of view. Ecology has been defined as the scientific study of the relationship of organisms to each other and their environment. Disease ecology can thus be interpreted as the study of how disease interacts with humans, animals, plants and the environment (Draak, 2005).

The human ecology of disease model is defined as a holistic approach that focuses on how habitat or environment, population and behaviour relationships among interacting population affect the human state of health. Health has also been defined in terms of adaptability which suggests that health is the result of interactions between the three dimensions of habitat (environment), population and behaviour (culture). These three dimensions form a triangle model of human ecology and underlie disease aetiology, consequences and prevention (Meade & Earickson, 2000; Meade & Emch, 2010). The human ecology of disease is concerned with the ways human behaviour, in its cultural and socio-economic contexts, interacts with environmental conditions to produce or prevent disease among susceptible people (Meade & Emch, 2010). More specific approaches to associations between human behaviour and health, physical environment and health, population (genetics) and health could be derived, but this study is based on the human ecology of disease approach, which provides basic concepts for understanding the factors that affect the health of people. The

model describes how environment, biology or population and behavioural factors affect the health of individuals or people. These factors are vital in explaining the epidemiological features of malaria. The human ecology model contributes in explaining the question on the impacts of climate variability influencing malaria epidemic in the three villages: lower (Buwanabisi), middle (Bumakuma) and the higher (Bufukhula). This explores the influence of temperature and rainfall and other physical and social risk factors influencing malaria. Through the triangle of human ecology of disease model the perceptions (beliefs or culture) and level of awareness is also explained. Since the triangle of human ecology helps in identifying risk factors to malaria, human behaviour as one of the dimensions may give more insight into the perceptions and level of awareness on the impacts of climate variability on malaria disease. With this model, after identifying the risk factors to malaria and impacts of climate variability on malaria, appropriate measures and copying strategies can be designed by individuals and communities, district and national authorities.

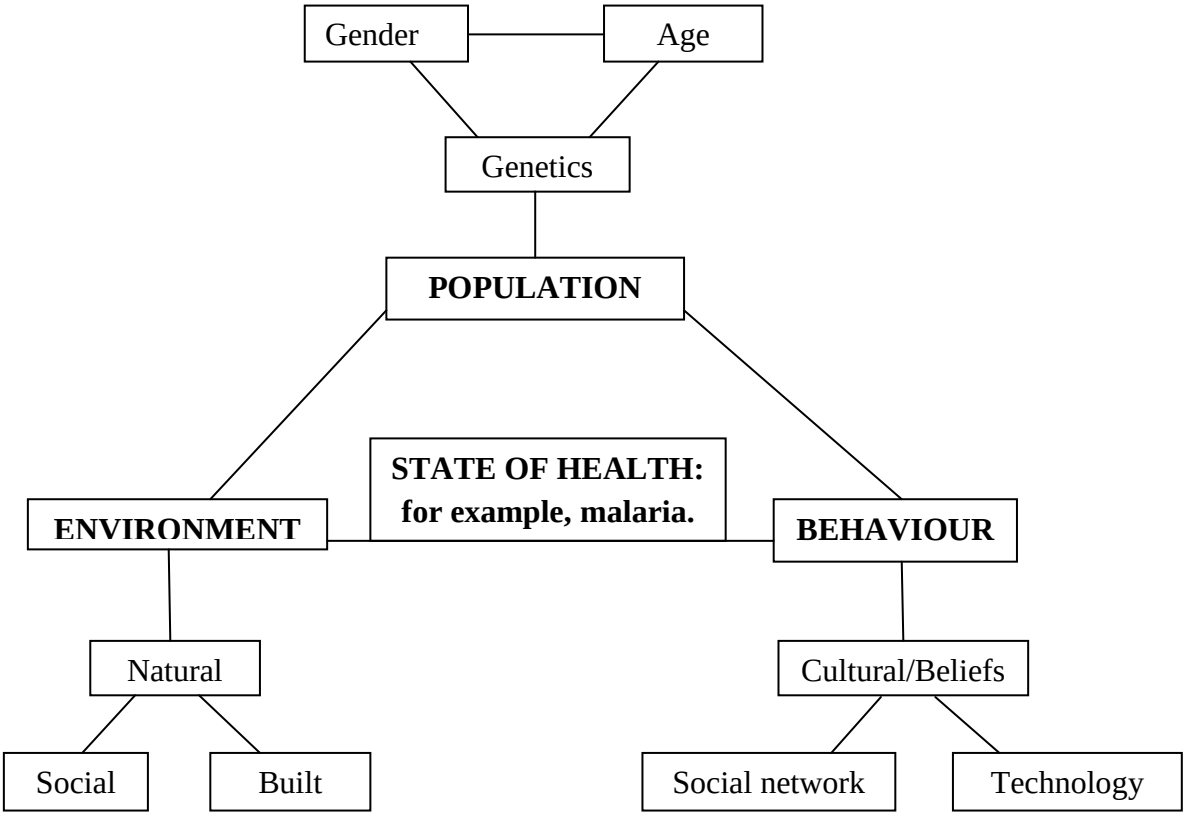

Figure 2.1: The triangle of Human ecology model.

Source: Adopted by (Meade & Earickson, 2000; Meade & Emch, 2010).

The triangle of human ecology model focuses on the three main categories of factors that affect the state of health: Population, behaviour, and habitat or environment and underlying disease aetiology. Adaptation and prevention strategies will be presented later in chapter six. The three dimensions which form the human ecology of disease model, habitat, population and behaviour form the vertices of a triangle that encloses the state of human health. The elements and processes that contribute to the ecology of an epidemic environment can be identified by the relationships and patterns among the interacting populations (Meade & Earickson, 2000).

Habitat is that part of the environment within which people live, that which directly affects them. Houses and work places, settlement patterns, naturally occurring biotic and physical phenomena, health care services, transportation systems, schools and government are parts of the habitat thus broadly conceived (Meade & Emch, 2010). The focus for the study is on the natural environment factors such as climate where temperature, rainfall and humidity are the major indicators. However, there could be physical environmental outcomes of changes in these factors like flooding, landslides and soil erosion. From the social element of habitat, income level and house conditions are presented.

Population is concerned with humans as biological organisms, as the potential hosts of disease. The ability of a population to cope with insults of all kinds depends on its genetic susceptibility or resistance, its nutritional status, its immunological status and its immediate physiological status with regards to time of day and year. In the study, with the human ecology model, age and gender are the main variables focused at. Gender is comprised of male and female exploring their health seeking behaviour inside the family environment. The age structure of a population influences the spread of infectious agents and the severity it causes. Children, pregnant women and the elderly suffer more from malaria due to lack of immunity.

Behaviour is the observable aspect of culture. It springs from cultural precepts, economic constraints, social norms and individual psychology. It includes mobility, roles, cultural practices and technological interventions. Through their behaviour, people create habitat conditions hence changing malaria patterns; people move not only themselves from place to place, but also other elements of disease system. Moving from place to place also leads to moving the malaria and the vectors as well. Behaviour also exposes individuals and populations to some diseases like malaria and protects from others. The habitat presents

opportunities and hazards to the population genetics, nutrition and immunology. All these aspects have in one way or another influenced the pattern of malaria disease and the cultural creation of disease is true for malaria

Under the behaviour element, education factor can be explained rather than population status. Education involves behavioural exposures to an opportunity in the habitats; this experience can influence behaviour in a way that improves health status by reducing harmful exposures, increasing protective zones, and inducing alterations of the habitat itself through technology. Behaviour roles are also determined by age, sex and class or ethnicity. This is mostly in Africa where who is exposed to malaria is determined and also can be reflected in population status.

The behaviour of community groups can be explored under the social organisation structure of the model. Mobility, habits and cultural perceptions, and social beliefs are related to a belief or cultural element. Vector control activities, protective measures against mosquitoes, medical care and the hospital system are explained within the technological element of the model.

For this study, the human ecological triangle model was applied to the mosquito as a vector resulting from the conditions created by the impacts of climate variability especially rainfall and temperature that is leading to the wide spread of malaria around Mount Elgon region and humans as separate entities through certain behaviours, interaction with the environment and population factors.

The human ecology triangle can help us to better understand the ensemble of factors and their interplay that contribute to non infectious diseases propagation like malaria. It also explains why certain groups over others are more affected by malaria diseases. Besides the mentioned, the human ecology model can be a framework by which we can understand how health can be maintained and improved. After understanding how health can be maintained and improved, one becomes aware of these sorts of interventions, and ultimately it helps us remain conscious of the larger web of factors continually shaping our lives. The model is expanded in that it has significant advantages over the older models that looked primarily at the human-landscape interactions responsible for the spread of diseases

However, much as the human ecology model helps one to understand the different risk factors to malaria epidemic, the model does not help if one wanted to understand political issues for example hidden agendas and decisions (political and economic decisions at national level) of individuals and groups like political leaders in a political context, as well as political issues at all levels as risk factor to diseases like malaria. This is because it does not include political perspectives of diseases. This would require one to use the political ecology of disease theory which suggests that illness and disease among populations in a local place could be identified as a result of political powers or decisions over environments and people's interaction with environment. It would also require use of other relevant theories in explaining and arguing out political issues as external linkages which is not the case in this presentation.

It would have been possible to use some other theories like the political ecology of disease, holistic approach but due to time and comprehensiveness of the thesis, the researcher felt the need to focus on the human ecological triangle model that helps not only in explaining the impact of climatic factors influencing malaria but also other risk factors within the built and social environment, population and human behaviour element.

2.7 CONTROLLING AND PREVENTING MALARIA OUTBREAK.

Geographical approaches and ideas are useful in the fight against malaria because the disease is quite well understood from a medical and epidemiological point of view, giving a clear idea of the physical and natural environment factors such as temperature, rainfall, vegetation and altitude which are known to be important. At the same time, most commentators, emphasis the need to take into account social and behavioural factors. The interaction between individual people, societies and their environment are vital for the geography of the malaria disease and spread. Controlling and preventing malaria outbreak needs understanding these essentially geographical aspects of malaria that are known as risk factors because it can contribute to efforts to combat the disease. WHO (1998a) promoted some malaria control strategies which involves four basic elements: the need for early treatment and diagnosis of the disease, the need for proper planning and implementation of selective and long lasting control measures including prevention of the mosquito vector (this will help controlling and guarding against the risk factors), identifying the major outbreaks of the disease early enough to prevent more outbreak and spread, local research capacities need to be strengthened to

promote frequent investigation and assessment of the malaria condition especially in the affected countries (Curtis, 2004).

To combat the impacts of climate variability influencing malaria epidemic in the highland areas of Africa, a range of measures need to be put in place. Malaria control and eradication programmes will require more resources not only during the eradication stage, but also to sustain strong health systems to prevent the re-introduction and emergence of malaria. The existing tools cannot be expected to eradicate malaria globally. More effective and efficient tools than the ones present today are needed in the interference of transmission in conditions with high vectorial prevalence (Mendis et al., 2009).

CHAPTER THREE: RESEARCH METHODOLOGY.

3.1 INTRODUCTION.

In every research there has to be a systematic way in which data is collected. This is referred to as research methodology where different methods are employed to collect data. It can be a combination or a single method with different ways of collecting and gathering information as will be explained in this chapter. Methodology has been explained to be about the choices we make about cases to study, methods of data collection among others in planning and executing a research study. *('a general approach to studying research strategy' your choice of method should reflect an overall research strategy'*) (Silverman, 2005:109). In this study qualitative methodological approach was used because of the topic under study which tries to explain reality from the point of view of the people or communities. It involved interviews, discussions, and narratives to get more details about events, tendencies and situations regarding malaria outbreak in relation to the impacts of climate variability, other risk factors, communities awareness level's and perceptions associated to impacts of climate in relation to malaria, the strategies to cope with the prevailing situations created by the variations in climate. In this chapter therefore, the necessary methods used during data collection will be explained. Some limitations encountered during the field study will be pointed out and how they affected the research process. However, quantitative research has been used to a smaller extent to look at relationships between age, education level, gender and place of residence. It was also used in presenting some secondary information like monthly average rainfall, temperature data and malaria annual report for Bududa district.

3.2 QUALITATIVE METHOD.

Qualitative research is one that locates the observer in the world in his or her real setting. This therefore means qualitative researchers interpret the world in their original make up trying to interpret occurrences according to the meanings people bring or attach to them. Qualitative techniques try to explain the social world through people's beliefs, values and decisions (Denzin & Lincoln, 2005). Qualitative research uses a naturalistic approach that seeks to understand any happening and situation in context specific settings, like real world setting in which the researcher does not try to control the happening that he or she likes and just attempts to unveil the ultimate truth (Golafshani, 2003).

Qualitative research is conducted in cases where he or she wants to find in-depth information about happenings or phenomena since it is concerned with the way people make sense of their social worlds and how they express their understanding through language, sound and imagery.

In most cases quantifications and tests are not used as in quantitative research. Qualitative method provides an understanding of social world or phenomena and also tries to address questions that need in-depth understanding. It tries to produce results that are not based on the statistical principles and formulae. (Quantification is not involved in qualitative research). It takes place in natural setting. The qualitative researcher usually gets to the place of the participant, thus coming up with more information about the individual or place to be most included in real experiences and understanding of the participant. (Eisner, 1991).

Qualitative methodology does not employ only one method, instead it employs various alternative methods in data collection like: observations, interviews and group discussions (Kvale, 1996).

3.3 WHY QUALITATIVE RESEARCH.

Qualitative research is useful in several research approaches. In this study, the researcher was able to get clear and detailed information on issues through interactions and discussions with the informants of the three selected villages of Bumakuma, Buwanabisi and Bufukhula of Bududa district. Those practicing qualitative research have placed emphasis on human interpretative aspects of knowing the social world. Qualitative methodology is aimed at delivering a detailed and interpreted understanding of the social world through holding conversations, interviews that can help one know more about people's social and material situations, their experiences, views and histories (Ritchie & Lewis, 2003). Qualitative methodology also in this research helped me to be flexible in that I had the freedom to change and formulate questions as they came in mind about the issues under the prevailing situation. The method therefore helped me get rich and valuable information rather than being stuck on one question. Qualitative research design through interaction allows different issues, happenings either past or present to be explored and investigated from the informant's point of view hence allowing them to shape the conversation (Mikkelsen, 2005). Qualitative methods employed also gave me the freedom to interact with the people at will without following the written interviews every time and was also able to use informal methods like

discussions to acquire certain information that I wasn't able to get during the interviews. In research, qualitative method helps to explore different complexities of daily life so as to acquire deeper insight into the processes shaping the worlds of the people under study and the way things are done (Dwyer & Limb, 2001). The method also helped me during the research as I was able to make questions clear to the informants and even make them simpler for them to grasp and answer. The way one understands the social reality and one's research questions too influences the use of qualitative research (Dwyer & Limb, 2001).

As mentioned earlier the subject of the research also influences the choice of methodology. However, the use of qualitative research partly evolved from social science after critiquing the use of quantifications and statistics. In this research not only did I use qualitative methodology but quantitative methods were also employed to a certain degree. Hence I was able to capture certain issues and information like age, gender, and education level. Secondary data in statistical form on climatic data, malaria cases was also obtained. The people would not tell me about their age, education levels if I only used qualitative methods. Since quantitative method deals with statistics, it was modestly employed in order to sort and characterize attributes or variables like education level, age, and gender that were to be interviewed.

3.4 STUDY POPULATION AND SAMPLING METHOD.

It is very important to clearly define the target population in any research. Defining the target population is a critical step, and begins with a clear definition of the unit of the study. In social geography this might be an individual, a household or an organisation.

The study area Bududa district currently is estimated to have a total population of 159,794 (79,773 males and 80,021 females). In this study, a total of 40 informants were purposively chosen based on stratification by three villages by altitude as discussed later. Purposive sampling (sometimes called judgemental sampling) is based on the assumption that a researcher has past information of a particular group in relation to its relevance to the study (Alston & Bowles, 2003). Purposive type of sampling helps in identifying particular cases for detailed investigation. It was helpful in this research because I wanted to reach a targeted group with best experience, opinions and deeper insights on issues to be explored. This explains why the key informants included the political leaders where the Chairman Local Council Five (LC V) was chosen, two sub county chiefs from the upper and lower altitude

villages of Buwanabisi and Bufukhula respectively, the district health officer, the local health care providers from two villages that is the lower and upper altitude, traditional healers and a nurse from the main local government hospital in Bududa district. Primary informants comprised of six informants from each of the three villages and twelve women for the focused group discussions taking six from the two villages of the lower and upper altitude. Though purposive sampling was helpful in selecting some group of people for this research, it has also got some limitations. It generalises the population under the study area by taking a small sample. Despite some serious limitations like; the lack of wide generalizability, purposive samples are occasionally used by researchers. In total I interviewed 40 informants, which included: 18 primary individuals from the three villages of Buwanabisi (1400 m asl), Bumakuma (2000 m asl), and Bufukhula (2500 m asl), 10 key informants (the Chairman Local Council Five, the district health officer, three local health care providers, two traditional healers, two sub-county chiefs, and a nurse from the regional referral hospital. Focused group discussion comprised of 12 female primary informants not picked among the interviewed individual females in two of the villages of Buwanabisi (lower altitude) and Bufukhula (higher altitude). Splitting gender into male and female was important as it helped getting opinions on perception, attitudes and behaviour from both sides.

3.5 METHODS APPLIED IN THIS STUDY.

This section describes the tools used in data collection and how each tool selected was used pointing out the strength and weaknesses and also explains how the data collected was transformed into useful information that informs this research as its findings. Both primary and secondary data collection techniques were employed as discussed below. Due to several risk factors to malaria disease besides climate (temperature and rainfall), a number of methods was used so as to understand and get clear information of the whole situation.

3.5.1 Interviews.

Interview involves exchange of views between two persons chatting about a theme of mutual interest. In an interview conversation, the researcher listens to what people themselves tell and explain about their lived world, hears them express their views, feelings and opinions in their own words and understanding, and learns about their views and opinions in their own words, life, their dreams and hopes. An interview is a structured conversation that is

purposeful. In qualitative interview research the subjects explain as briefly as possible what they experience and feel and how they respond or act (Kvale, 1996).

Interviews are aimed at obtaining uninterpreted descriptions, either formally or informally (Ritchie & Lewis, 2003). For this study both the informal and formal method used helped in collecting the necessary information as it is the most widely used method in qualitative research. The interview method provided undiluted focus on the individual and offered an opportunity for detailed investigations of people's perspectives for deeper understanding of the personal context within which the research was going to take place. Interview helps in providing richer and more detailed information of the participant's perspective on the research topic. An interview guide designed was used to collect the necessary information where different selected categories of people were interviewed. This was through a face to face discussion so as to acquire the necessary and detailed information as regards to the impacts of climate variability on malaria. Information from different perspectives (communities, other local stakeholders, external experts) on events and conditions influencing the outbreak of malaria, vulnerability, copying strategies to cope with the impacts of climate variability was obtained.

Interviews also helps to establish a rapport with the informant and develop an understanding of the situation, removes fear and negative feeling that the interviewer might have had before starting the interviews (Kvale, 1996). Interviewing helps one to know the participants behaviour and thereby provides a way for researchers to understand the meaning of that behaviour and their action. The major problem is that the time to establish access and make contacts with the participants, interview them and collect all the necessary and different information may not be enough, leading to less or inadequate information. *Interviewing research takes a great deal of time and, sometimes, money* (Seidman, 1998:6).

Use of interviews encouraged the informants to narrate their experience, perception, awareness, feelings and different conditions as regards to the impacts of climate variability on malaria epidemic. They revealed the different conditions and risk factors created by climate variability, perceptions, and level of awareness of possible association between climate variability and malaria epidemic. In addition they gave opinions and suggestions of the possible strategies to cope with the prevailing situations resulting from the impacts of climate variability on malaria outbreak. During the study, I used the interview guide where issues and questions to be covered were clearly specified in an outline form. Since some of the questions

and issues in the interview guide led to answers that necessitated further understanding, more questions arose during the interview. This made me not to limit myself just to the interview guide questions, hence giving me an opportunity to explore more issues, stories, information and close the anticipated gaps within the data. *Interview is deeply satisfying to researchers who are interested in others stories* (Seidman, 1998:8).

In my interview guide, I used open ended questions which specified issues on the impacts of climate variability and malaria that were related to the research objectives and questions.

Besides the formal interviews I conducted, informal interviews during interactions about other risk factors to malaria carried out also helped in providing useful information. *Individual interview vary according to content, such as seeking factual information, or opinions and attitudes or narratives and life histories (*Kvale, 1996:101).

3.5.2 The use of research assistants.

Before the fieldwork started, I contacted my sister who also participated as a research assistant. She linked me to somebody (born of the area) who knew the area very well to help me as another research assistant. I immediately communicated with him. In this communication, I introduced myself, aims and interests as regards to the research topic and objectives, persons I was interested in meeting and the specific areas I wanted to base my study. I also explained to the research assistants their tasks, like organising informants, taking notes and also interpreting to the informants the questions and issues that weren't clear in their local language (Lugishu). The research assistant quickly made contacts with the relevant people (key informants and local communities) as he carried out the survey and made them aware about my going there as a researcher, aims and interests in relation to the topic under study. When I went to carry out my fieldwork, before starting off with the research process of interacting and interviewing the informants, I spent four days moving and surveying the area under study as well as establishing a friendly relationship with the local communities to be accepted, put them at ease and interact freely to ease the research process. This helped also so much to get an overview of how certain things are done in this area ranging from social organisation of the area, culture, common foods, activities and malaria relevant behaviour. It also helped me access the informants quickly and with ease.

The research assistant helped so much in informing the informants to get ready on days when I was to meet them for an interview and discussion. This further eased my work and also saved time that would have been spent. The research assistant also played a great role when it

came to interpretation of certain unclear things and issues in the local language (Lugisu). However, much as the research assistant was helpful, he was also of some bias especially when interpreting issues. This is because if the informant failed to answer a question, he would want to answer on their behalf which I had to criticise immediately to let the informants answer with their own knowledge and at will. Some of these questions especially on other risk factors to malaria had to be answered through probing during informal interviews after the whole interview process and during some free time when interacting with the community members.

In all I used two research assistant's one male (born of the area) and female who helped in voice and video recording during the focused group discussion and also taking notes during individual interviews. The notes she was taking could be compared with the notes that I was taking at the end of the day during debriefing meetings, where we could go through all the discussions and interviews conducted for the day. The two played a paramount role during the focused group discussion and the whole research process.

3.5.3 Primary informants.

Data from the primary informants for this study comprised of 18 members of the community who have settled and lived in the area for a long period of time (over 10 years). Six informants from each of the three villages ranging from lower (Buwanabisi 1,400m asl), middle (Bumakuma 2000m asl) and higher (Bufukhula 2500m asl) altitudes were chosen focusing on the age between 30 to 45 and 46 to 60 years and above. The researcher focused on these ages reasoning that they would provide rich and true information with the experience and observations made over a long period of time in the variations in climate and it's relation to malaria epidemic having lived for long and permanently in the specific villages. There were two males and seven females between the age of 30 to 45 years and seven male and two females between the age of 46 to 60 years and above as seen from the table below. These primary informants were purposively chosen as it aimed at getting information from both men and women who were elderly looking at the experience and knowledge they had about the study area. The researcher considered both male and female in order to get different views and opinions. According to the interviews conducted, in general the level of education is low among the local individuals and communities living in all the three villages. The upper altitude village Bufukhula tend to have more uneducated and few educated compared to the lower altitude village. This is because the higher altitude village tend to have more elderly people than the lower. More youth and children live in the lower altitude village since it is

next to Bududa town centre where they can easily access schools, entertainments, vocational institutions and people of diverse backgrounds. However, it is difficult for one to draw conclusion on the level of education; this is because the sample interviewed was small, hence difficult to say if these tendencies reflect the whole population in the area.

Table 3.1: Overview of primary informants by gender, age groups and place of residence.

	Lower Village	**Middle Village**	**Upper Village**	**Total**
Males				
30-45 years	0	0	2	2
46-60+ years	3	2	2	7
Females				
30-45 years	3	4	0	7
46-60+ years	0	0	2	2
Total	**6**	**6**	**6**	**18**

3.5.4 Key Informant Interviews.

Key informants are persons with special knowledge on a particular topic; they are not necessarily leaders; their information is rich and complements other information from the local informants though there maybe risk of being misled through giving biased information (Mikkelsen, 2005). The key informants may have the necessary information but fear to release out because they want the local people and other higher authorities to know that they are doing so many good things to develop the district. They try as much as possible to uphold their image.

For my research, key informant interviews was of great importance in generating information on the indicators of climate variability, historical climatic events, climate variability impacts, the local perceptions on climate and malaria, and measures to cope with the impacts of climate variability in the spread of malaria. The information was obtained from the political leaders, health officials and traditional healers and sub-county chiefs mainly using an open

ended interview guide. A total of 10 key informant interviews were conducted covering the Chairman of Local Council Five, the district health officer, and two sub-county chiefs, three local health care providers picking one from each village, two traditional healers and a nurse from the regional referral hospital of Bududa. The Chairman Local Council Five gave information regarding the impacts of climate variability in general, on malaria outbreak, strategies to cope with the adverse impacts of climate variability on malaria outbreak. Based on the objectives of the study and research questions, an interview guide (see Appendix) with open ended questions besides other questions that came up during the discussion was mainly used to allow varied and elaborate answers. The questions were focused on obtaining information that relates to how climate variability has affected the local people in causing malaria outbreak, awareness levels and perceptions, measures to cope with the prevailing situations created by the impacts of climate variability on malaria outbreak.

All the key informants were selected because they seemed to be having an informed knowledge and understanding of the problem since they relate with the community, often attend workshops and come across similar issues.

The interview and discussion with the key informants lasted for about 15 to 20 minutes as they had enough information and understanding about the topic under study with the designed research objectives and questions. Most of the key informants interviewed were very cooperative and willing to give the information they had as regards the impacts of climate variability on malaria outbreak.

3.5.4 Informal Interviews.

Informal interviews many times are conducted where open ended questions are used. It involves conversation between the researcher and the interviewee. Usually comes up outside the formal interviews and discussions. It helps to explore issues that were not discussed deeper and understood during the formal interviews. Informal interviews increase the salience and relevance of the questions since interviews and discussions emerge from observations where the interviews are matched with the circumstances and individuals. This method helped in getting information about other risk factors to malaria especially from the local informants. Informal interviews helps in making the participants relaxed and puts them at ease hence feel free to express their opinions, perceptions and emotions (Mikkelsen, 2005). Through the informal interviews, the researcher was able to acquire certain hidden information on certain issues from the traditional healers like how to make the local herbs

cure critical sicknesses and respond to difficult life situations. Other risk factors to malaria epidemic which wasn't captured during the formal discussions too were obtained. The traditional healers don't want to release their secrets anyhow.

3.5.5 Focused Group Discussion.

Focus group is a one meeting where samples of between four to eight are gathered to discuss a particular topic chosen by the researcher, can be through the objectives. Researchers are the ones who normally moderate and structure the discussion (Dwyer & Limb, 2001).

Focus group meetings usually take 90- 120 minutes. The meetings are beneficial in several ways since they help the researcher to know the ways in which people construct environmental and social issues: through sharing their knowledge, experiences and prides while arguing their different points of view. Focus group places the individual in a group context, where conversations can develop and flow in a more common place social situations than being interviewed for a questionnaire survey. Focus groups are especially useful when one wants to compare the world views, beliefs among others of different sectors or groups of people in an efficient way and also effective at establishing a group identity quickly. In this study, focused group discussion permitted the observation of interactions especially with the middle age groups who were very free and interactive making the discussion to flow smoothly hence producing results without wasting time. The focused group discussion conducted also helped in placing the participants on a more equal footing with each other and the researcher. However during the focused group discussion, some members were more active than the others. Usually in focused group discussions, some people tend to dominate the discussion hence leaving out opinions from those who tend to be quiet. Conflicts can also result in during the discussion because sometimes a totally different understanding of a problem, occurrence emerges from the group discussion (Dwyer & Limb, 2001).

In this study, focused group discussion was used to get information from 12 women, six from the lower and six from the upper villages (higher and lower altitudes), the two villages were chosen simply to make comparisons on malaria prevalence between the lower and higher altitudes. This is because it is known that malaria cases at the lower altitude tend to be more prevalent than the higher altitudes due to the influence of temperature and rainfall. In order to generate more in-depth information on perceptions and attitudes, strategies and life histories, focused groups in two separate villages under study was conducted. During the focused group discussions, open ended discussions were held with the women that were selected. This

provided useful information on strategies to cope and or adapt to the impacts of climate variability, community perceptions of climate variability in association to malaria and histories of climate related events. Focused group information is among the key types of generated data in qualitative research.

The women chosen were between the age of 25 to 45 (middle age group and 46 to 60 and above (elderly women), married and unmarried who have lived in these areas their whole life. In each of the villages, six (6) women were chosen and the focused group discussion held in the afternoon at one of the participant's place as was suggested by all the participants. I and the research assistants agreed that the focused group discussion should not exceed one hour and indeed it was conducted within one hour as the participants (especially the middle age groups) were very active and vibrant that the discussion had to go on smoothly without any interference. However, the elderly became more open and active in the middle of the discussion unlike when it had just started, the only unfortunate bit is that during the discussion towards the end, one of the participants received a phone call that his brother had died, this halted the discussion for about 10 minutes as the affected screamed with tears that attracted every bodies attention. After the ten minutes, since we had almost finished the discussion, we had to summarise a bit fast but captured all what we intended too.

Only women were chosen for the focused group discussion because they are among the vulnerable groups to the impacts of climate variability. The women were also chosen because of the comprehensiveness of the master thesis which makes it hard to include everything. The age categories of women varied with intentions to create privacy, openness and free interaction and also to compare the opinions of the middle age with that of the elderly. This made the middle age group very vibrant and free to express their opinions and feelings as regards to the topic under study in relation to the objectives and research questions. Both discussions were tape recorded and notes also taken, this helped a lot during data transcription.

3.5.6 Field observation.

Observation provides an opportunity to record and see different happenings and situations as they occur. In this method one's behaviour, events, objects, physical environment and situations could be understood through non verbal communications. "*Observation functions as a major form of data collection for field research. Whereas obtaining members accounts about activities within a setting through interviews and interactions is fundamental to field*

research, so too is seeing with one's own eyes" (Bailey, 1950:79). *Social Scientists are observers of both human activities and of the physical settings in which such activities take place* (Denzin & Lincoln, 2003:107). During the field study, the researcher had open and covert observations at the very start of the fieldwork in the process of knowing and getting used to the study area for about four days. The observation method helped me to observe the critical living places, environment both social and built, behaviour and situations that the people did not reveal in interviews. Eroded soils too were observed in the higher altitude village of Bufukhula and the middle altitude village of Bumakuma. The soil colours had changed to brown indicating low soil fertility, as observed by the quality of the crops too. Through the observations, I was also able to judge the features and events that influence risk to malaria epidemic created by the variations in temperature and rainfall. This was in a situation when one wanted to understand the environmental risk factors, social and risk taking behaviours that contribute to the spread of mosquitoes and malaria. The method also established a degree of openness in social relationships with members of the studied group. During observation different photographs were taken to portray and visually represent the current situation, the households or communities settled around Mount Elgon region and different phenomena that I felt could support and better explain my findings. Information from individual households, focus group discussions, and key informants were complimented by field observations that were made along to depict features that could signify changing climate in the respective villages.

Some of the strength and weaknesses of using field observation include; it helps in studying behaviour in its natural and original form and puts informants more at ease. The above strength then leads to greater and in-depth understanding of the prevailing situation and environment under study. The observation method also since it puts people at ease and more time spent with a small group of people, the researcher can get to know the participants in much greater depth than if one encounters them as a stranger and hurriedly administers a questionnaire. However, much as it's a good method it has also got some weaknesses in that it does not obtain in-depth information leading to unclear and incomplete description of a prevailing situation observed. It also leads to misinterpretation of an event and situation if the researcher doesn't make clarifications later for example people may say they carry out an activity to support their livelihood. This may not be true and can be difficult to validate because there may be nothing that shows what the people say they do (Dwyer & Limb, 2001).

3.5.7 Secondary data and Document review.

This method involved studying the different and relevant written and published information on issues of climate variability and impacts on malaria, vulnerability and adaptation of communities. It consists of data and any information obtained from other sources to act as a backup on what has been found in the field. Secondary data helps in supporting an argument since it offers justifications for the choice of topic and location (Clifford et al., 2010).

In this study, this method helped me acquire past information on the rainfall and temperature data of Bududa district for the year 1961 to 1990 and 1995 to 2000 obtained from the Department of Meteorology. This is to compare how rainfall and temperature has been varying and be able to make judgements on its contribution to malaria prevalence in this area under study. Bududa district annual malaria report for the year 2006 to 2010 was also obtained.

Published and unpublished information from articles, journals, books, reports as well as internet information on climate variability in relation to malaria was obtained. The map of the country (Uganda) and district under study was also obtained, including GIS world and country maps showing spatial distribution of malaria epidemic.

3.6 DATA ANALYSIS.

Data analysis involves gathering all the collected data by giving it order, structure and meaning.

Analysis is a taxing and interesting stage in the qualitative research process. It requires integration of creativity and orderly searching, blend of inspiration and critical detection. Analysis is an ongoing process and continuous part of qualitative research (Ritchie & Lewis, 2003). It provides a sense and meaning for the whole research process and the data collected during fieldwork. A good and outstanding analysis is where the researcher is able to draw his or her own meanings, interpretations and understanding from the interviews that are conducted (Kvale, 1996). For this study therefore, I edited and analysed the data I collected by constantly reflecting on the objectives and research questions by matching it with the questions in the interview guide and removed irrelevant and unnecessary information. Perceptions, experiences and opinions resulting from different methods of collecting data were interpreted and described from the categories, and themes of responses that each

question generated. The description was based on the concepts as found in the theoretical analytical tools. In this attempt, primary data supported with secondary data found useful was used. The analysis included translating, transcribing and interpretation of data from the methods like interviews, focused group discussion, observation and key informants that were used in the field. Text from secondary data was analysed to compare sources of information which was obtained from the field such as other risk factors to malaria besides the impacts of climate variation to malaria spread and coping strategies to the impacts of climate variability among others.

3.7 POSITIONALITY IN THE RESEARCH.

During research, I tried as much as possible to position myself in a way that could not affect the data I needed to get from both the local communities and the key informants. The way one positions him or herself during field research matters a lot. This is because if one doesn't position him or herself well with both the local people and the key informants, some fear and mistrust may be there especially for the local people hence affecting the whole research. This is important right from the very start of the field research process. In my study especially with the local people, my positionality helped me to obtain all the data and information I wanted. My positionality and relationship put them at ease in that they were very free to interact and discuss issues freely and give desirable answers. I ensured that my interaction with the district authorities was minimal and if I did, I couldn't sit in the open this is because they would think am a spy so would report them based on the information they would give.

3.8 ETHICAL CONSIDERATIONS.

Ethics is the way we conduct ourselves morally as researchers. It is of great importance to maintain ethics during research. Any research study raises ethical considerations. In qualitative research studies it has a specific resonance (Ritchie & Lewis., 2003). Geographers who are thoughtful, informed and reflexive usually take ethics into consideration by acting responsibly in a respectful way. This is because observing and upholding ethics is right for a researcher, not just doing for one's sake (Clifford et al., 2010).

To uphold ethics during the fieldwork study, the researcher had to obtain sample members consent first to be part of the research project. During the process, I made them aware of what

the research was about and the objectives though I had informed them earlier before starting fieldwork through the research assistant. This helped to erase doubts, know benefits that maybe possible through involving them like information, dissemination of master thesis to the district authorities who may use the information while planning related activities or malaria control strategies and risks of unpleasant episodes during meeting for local people. All this informed consent made the informants to be knowledgeable about the whole research process, hence making them be at ease during interviews and the entire research process.

The researcher further upheld ethics of anonymity and confidentiality by not exposing the identity of all those involved in the research process to the outside people and public and avoided the attribution of comments to identified participants and in the presentations. This was done by being very conscious with every information either in words, video and photograph that was given by the informants. This helped to ensure that nobody other than the researcher could access all the information. In general, the principle that the study should not harm informants in anyway was strongly lived up to.

3.9 QUALITY OF THE DATA.

Every study aims at being valid and reliable. Reliability and validity are considered as trustworthiness, rigor and quality in qualitative research (Quinn, 2002).

3.9.1 Validity and Reliability.

Validity concerns the extent to which a study or research reaches a correct conclusion and measures what is aimed at measuring (Lain, 2010). In other words, the researcher should ask him or herself whether the research instrument allows him or her to hit "the bull's eye" of his or her research object. Reliability is defined as the extent to which repetition of the study will produce the same results (Pole & Lampard, 2002). While establishing good quality studies through reliability and validity in qualitative research, *"trustworthiness of a research report lies at the centre of issues conventionally discussed as validity and reliability"* (Seale,1999:266). During the study, the researcher used several methods in order to be able to gather information that would be reliable to answer the specific questions and objectives to be studied. *Engaging multiple methods, such as, observation, interviews and recordings will lead to more valid, reliable and diverse construction of realities* (Johnson, 1997: 284). Using these methods to collect different information was of paramount importance since it acted as

a guide to be able to generate perfect and balanced information from the informants. Besides the multiple methods used, informal interviews performed after formal interviews gave an opportunity to collect additional information and clarify certain issues that were unclear and not mentioned during the formal interviews. The informal interviews and discussions were conducted using a language (Luganda) that the researcher and research assistants were familiar with. This therefore promoted and increased the level of understanding which gave the informants the opportunity to tell and share the feelings, experience and knowledge they had on climate variability in relation to malaria and a situation that seemed unclear. *A good qualitative study can help us "understand a situation that would otherwise be enigmatic or confusing* (Eisner, 1991:58).

To also be sure that my results were valid and reliable, I constantly compared and confirmed the collected data with the research questions and objectives under study every evening after fieldwork.

The cases selected for this research mainly comprised of the elderly (those a bit aged) except in only focused group discussion where the middle aged from the lower altitude location were interviewed. The elderly were the major focus as they would give rich and true information about climate variability having lived in the area for long. The age category considered for the interviews allowed more accuracy of the information and data having dealt with people who have experience.

The observation method used also enhanced the reliability and validity of this study. This is by directly observing the prevailing conditions that could lead to malaria like the flooded swamps, infertile soils due to soil erosion, poor sanitation, unhygienic homesteads with many areas harbouring stagnant water that acts as mosquito breeding grounds, bushy surroundings, and local people's behaviours that are risk to malaria like poor dressing. Eucalyptus trees as one of the copying strategies to drain the flooded areas were also observed.

Continuous reflection of the theory in relation to the prevailing situation in the field helped guide and give direction in conducting the research to avoid losing focus. My positionality and relationship with the local informants was enough to put the people at ease without any fear hence getting genuine information. In general therefore, it would be reasonable enough to say that the data collected through the different methods are reasonably sound. That is to say with relative high validity and reliability as far as possible. Any qualitative researcher should be concerned about validity and reliability while designing a study, analysing results

and making judgements about the quality of the study (Eisner, 1991). However, much as I tried my best to ensure that the data collected is valid and reliable, it is difficult to conclude that the data was fully credible without any bias and limitations.

There were some limitations that I couldn't help as explained below:

3.10 LIMITATIONS ENCOUNTERED DURING THE STUDY.

There is no perfect research design and fieldwork; there are always some limitations (Quinn, 1990). The limitations encountered were both during primary and secondary data collection.

3.10.1 Primary data.

There was restricted physical accessibility to informants due to bad weather and transport. It was always rainy in the afternoon hours and a little sunny in the morning. The heavy rain made it hard to walk on muddy, slippery roads and climbing the Mountain too was difficult. This limited the time to conduct the research because whenever it rained, the research work would be delayed as getting the informants was difficult and also they never wanted to be disturbed at that particular moment. However, such a problem was overcome by moving to the field when well equipped with certain things like rain coats, Gumboots and an umbrella. This was of help other than failing to go to the field in fear of the weather. The field study with the local informants couldn't be conducted in the morning hours because it is the time when most of the local people have gone to their gardens besides those who carry out some small petty businesses of selling breakfast eats (like *mandazi*, *chapatti*, maize, ripe bananas among others).

Language was a problem because the researcher did not know the local language. There was one common language used but whenever the local language would be used while explaining and understanding some issues and questions which were unclear, it required interpretation by one of the research assistant who is a born of Bududa district from Buwanabisi village. Otherwise the researcher and the assistants used the common language (Luganda for the local informants and English for those who could speak well like most key informants and some few local informants).

Limited funds to conduct the research was yet one of the problems that the researcher encountered. Funding to facilitate movement, food and necessary materials to aid research was not enough hence partly compromising the quality of the research. This problem was

overcome by being economical through avoiding unnecessary spending on luxuries and things that was not important during the fieldwork.

During the study also, the informants had high expectations of being rewarded in terms of money after giving out the necessary information. I had to overcome this problem by making it clear that I was a student carrying out research (if I were to give them something it would be from the little that I had, just to appreciate their efforts, time and patience) and explained to them that after compiling all the necessary and relevant information given. A copy of the report would be submitted to the relevant authorities like the Chairman Local Council Five and the district health officer. The District authorities would use this information to develop these areas and try to come up with solutions that could help improve the conditions that are increasing the outbreak of malaria. Later on after interviews, I appreciated them with a symbolic compensation to 1000 Ugandan shillings (0.4 USD equivalents).

3.10.2 Secondary data.

I was not fully contented with the secondary data especially those that involved figures like rainfall figures from the year 2005 to 2010. This is because I was doubting the person who gave the information. At first he stated that there was no record of rainfall data for the year 2005 and 2007 but later managed to produce such data, some days having missing data. He though seemed to have forged some figures besides some days having missing data. I was critical to the figures because according to the eastern regional coordinator in charge of meteorology, rainfall figures have not constantly been recorded. The reason for this was that the people in charge of taking records were not facilitated financially, hence got demoralised and relaxed in taking records daily. This made it difficult to draw conclusions on the variations in rainfall based on what the informants explained and some secondary online information for Bududa in the year 2010. The informants and online secondary information stated that in the year 2010 from March to December there was heavy rainfall causing floods in the low land and landslides in the higher slopes of Mount Elgon, house and infrastructure destructions like roads. When the rainfall graph is seen (refer to chapter four below), one can say rainfall was low in the year 2010, hence not matching with what the informants said.

CHAPTER FOUR: COUNTRY PROFILE AND STUDY AREA.

4.1 INTRODUCTION.

This chapter presents information on the country profile for Uganda and the study area. This include: the human and physical environment including climate and its influence on malaria and health care.

4.1.1 Location

Uganda is located in South east Africa between 1°N and 4°N latitude, and 30°E and 35°E longitude. The country is approximately two/third of Norway as the land surface is 241,139 square kilometres. Uganda is boarded by Tanzania and Rwanda to the South, Zaire to the west, and Sudan to the North and Kenya to the East (NEMA 2000/2001).

4.1.2 Climate and Malaria.

Uganda has an equatorial type of climate meaning that it receives a lot of sunshine. The annual temperature is 16°C in the South west highlands, 25°C in the North West and often exceeds 30°C in the North east. The rainfall occurs regularly in north eastern Uganda, while the South has two rainy seasons. In the North however, it rains regularly between April and October, but is dry from December to February

(http://www.ag.ohio-state.edu/~ockint/studentpapers/Uganda_profile.htm, 08/03/2011).

During the rainy season, there are several diseases among is malaria which increases and is more prevalent due to the spread of mosquitoes. In some areas, especially highland areas like around Mount Elgon and Mount Ruwenzori malaria occurs throughout and from year to year, but often there are peaks around rainy seasons, when the mosquitoes increase. In other areas with less overall malaria, transmission is less stable. Epidemics due to place of living, when malaria cases peaks suddenly, occur in populations with little or less immunity, such that people of all age groups from children to the elderly are at risk of death or severe disease, and they can be devastating (Malaria Consortium, 2010).

The warm tropical climate in Uganda is favourable not only for human beings but also a variety of disease causing germs and their vectors. The most notorious one is the Anopheles mosquito that transmits malaria, a disease scattered all over the country as seen in the map below. Malaria has become the biggest health concern. The World Health Organisation in its year 2001 recommended that visitors to a malaria zone should be aware of the constraints and

take appropriate precautions. There are majorly two factors that can increase malaria epidemic, they include: natural (climatic variations, topography, natural disasters like landslides, soil erosion), and man-made (for instance agricultural projects, dams, mining, deforestation). These factors most times modify the physical environment, hence opening up suitable areas that can support the mosquito vectors, thereby increasing the capacity to transmit malaria (Malaria Consortium, 2010). Some factors also result in massive population movements that expose non-immune populations from the Mountain areas to malaria prone areas. In Bududa district many people move to and from lower slope which is suffering from high mosquito vectors due to many breeding grounds.

4.1.3 Altitude and Malaria Endemicity

Uganda's geography is very diverse in that it consists of volcanoes, hills, Mountains and lakes. The country sits at an average of 900 metres above sea level. Both the eastern and western borders of Uganda have Mountains (highland areas) which is the most endemic area with highest malaria transmission, the Rwenzori Mountain ranges contains the highest peak in Uganda, which is named Alexandra and measures 5,094 metres and Elgon Mountain which is the fifth highest Mountain area in East Africa raises to 4321 metres. Uganda also has a plentiful amount of lakes, including lakes Victoria, Albert, Kyoga and Edward (http://www.ag.ohio-state.edu/~ockint/studentpapers/Uganda_profile.htm, 08/03/2011).

Population is not evenly distributed in the country but rather concentrated in the low endemic areas in the South west, 87.9% of the population (about 27.2 million in 2005) are exposed to moderate to very high malaria transmission, 62.5% or 16.8 million in *hyper-* and *holo-endemicity* (Bududa town or Buwanabisi where malaria transmission occurs all year long) and 25.4% or 6.8 million in *mesoendemicity* (regular seasonal transmission) while 12.1% or 3.3 million live in the areas of *hypoendemicity* (where the higher altitude village of Bufukhula is located) and unstable malaria occurrence and with very little or no malaria. In this case, *holoendemic* implies that malaria incidence is very high, hyperendemic (high incidence), *mesoendemic* (moderate incidence), and *hypoendemic* (low incidence which mostly occurs in the area with high altitude above 2000 meters) (President's Malaria initiative Uganda, 2009). A number of pregnant women living in malaria endemic areas (lower altitude areas) are anaemic and sometimes suffer from severe complications such as stillbirths and miscarriages. Many children suffer more from malaria than any other disease which may affect them from developing physically and mentally. Malaria is contributing a lot

to both child and maternal mortality. The Maternal Mortality Ratio (MMR) is at 435 per 100,000 births while the Infant Mortality Ratio (IMR) is at 88 per 1000 births (Twinomugisha, 2008).

In the three study areas of Buwanabisi, Bumakuma and Bufukhula villages, malaria transmission and spread is different. This is due to the location and the role it plays in creating favourable conditions and environment for mosquito survival. In the lower altitude area of the *hyperendemic* Mountain (1400 metres above sea level), malaria transmission is high (regular seasonal transmission) than the higher altitude (2500 metres above sea level) where it is *hypoendemic* (very intermittent transmission). The lower Altitude area (Buwanabisi village) is located at a height of 1400 metres where flooding commonly occurs and temperature is usually warm compared to the higher altitude area (Bufukhula village) hence creating conditions suitable for the breeding of mosquitoes. The flooding is not possible at the higher part of the Mountain located at 2500 metres above sea level, due to the steep topography. The higher altitude area does not allow nor support the breeding of mosquitoes when temperature lowers, the low temperature does not favour the breeding of mosquitoes, even the eggs developing are destroyed during this time. Malaria occurs in the high altitude area mainly due to seasonal variations in climate that leads to the rise in temperature. The warm conditions created within the living and physical environment normally increases the breeding and growth of malaria vector as it increases the feeding frequency of mosquitoes. In the higher altitude area also the local people get exposed to malaria due to migration to the lower area for work, leisure, and need for better social services. The mode of transmission can be explained by the triangle of human ecology which points out the elements within the physical environment including climatic factors, built and social environment, population and human behaviours like poor dressing and moving to lower altitude areas at wrong hours.

All the three villages of Bududa district (Buwanabisi, Bumakuma and Bufukhula) under study are suffering from malaria infection but the lower altitude village (Buwanabisi) is more affected than the middle (Bumakuma) and the higher (Bufukhula) as mentioned above. The lower is more affected than the middle and higher altitude villages.

In the map below, most parts of the country including Bududa district, climatic conditions are suitable for transmission of malaria throughout the year. The maps show that the occurrence of changes in the ecology for the past 20-40 years has had influence on malaria transmission.

This is why most parts of the country have got high malaria transmission, the highland areas inclusive. Approximately 95% of Uganda's territory is exposed to moderate to very high malaria transmission. Just few areas experience low or unstable malaria transmission and are prone to epidemics. This is mainly the South west and the slopes of Mount Elgon in the East and the Ruwenzori Mountains in the West. More outbreaks of malaria have been noted in these areas often times every 2-3 years, larger scale epidemics are not quite as common.

Comparison of one of the historic malaria endemicity maps 11 with the most recent one based on available data.

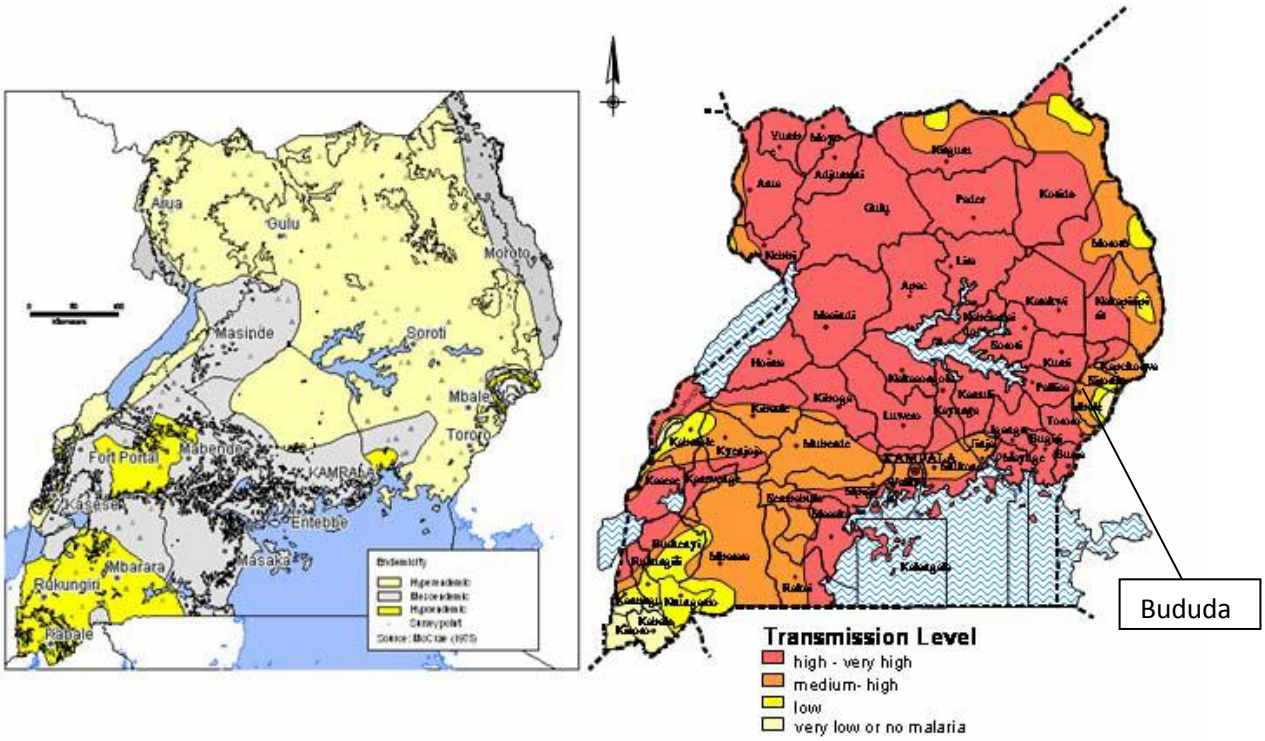

Figure 4.1: Uganda: Distribution of Endemic Malaria.

Source: (Uganda Malaria Control Strategic Plan, 2005/06 – 2009/10).

4.2 DESCRIPTION OF THE STUDY AREA.

Bududa district is a district in Eastern Uganda. It was named after its chief town, Bududa. Bududa is a relatively new district created in 2006, by Act of Parliament. It was originally part of the greater Mbale and then Manafwa district. The district consists of one county, seven (16) sub-counties and one town council. It is largely a rural district with eight urban growth centers which are in the process of turning into town councils. The eight urban centers in Bududa district are: Bududa, Bukalasi, Bushiika, Bumayoka, Bunamub, Kyikholo, Bulucheke, and Bukigai (http://en.wikipedia.org/wiki/Bududa_District, 12.08/2011).

The district is situated in an area where the lower altitude village of Buwanabisi is at 1,400 meters (4600 ft) above sea level and the highest altitude at 4321 meters above sea level. Majority of Bududa population are settled at the foot slope with the lowest altitude of 1400 meters. The Elgon highland like Bufukhula village which was free of malaria is now invaded with high and repeated malaria cases. This indicates a shift in the boundaries for malaria. This area has been having low temperature critical for mosquito breeding and survival. However, it is no longer the case; the temperature has risen hence bringing about warming that allows mosquitoes to breed. This temperature rise is attributed to the variation in climate that is influencing the rampant spread of malaria in the Elgon highland as presented in chapter five and six.

4.2.1 Location.

Bududa district is bordered by Sironko district to the north, Kenya to the east, Manafwa district to the south and Mbale district to the west. The district headquarters at Bududa are located approximately 23 kilometres (14 mi), by road, south east of Mbale, the largest city in the sub-region (http://en.wikipedia.org/wiki/Bududa_District,12/08/2011).

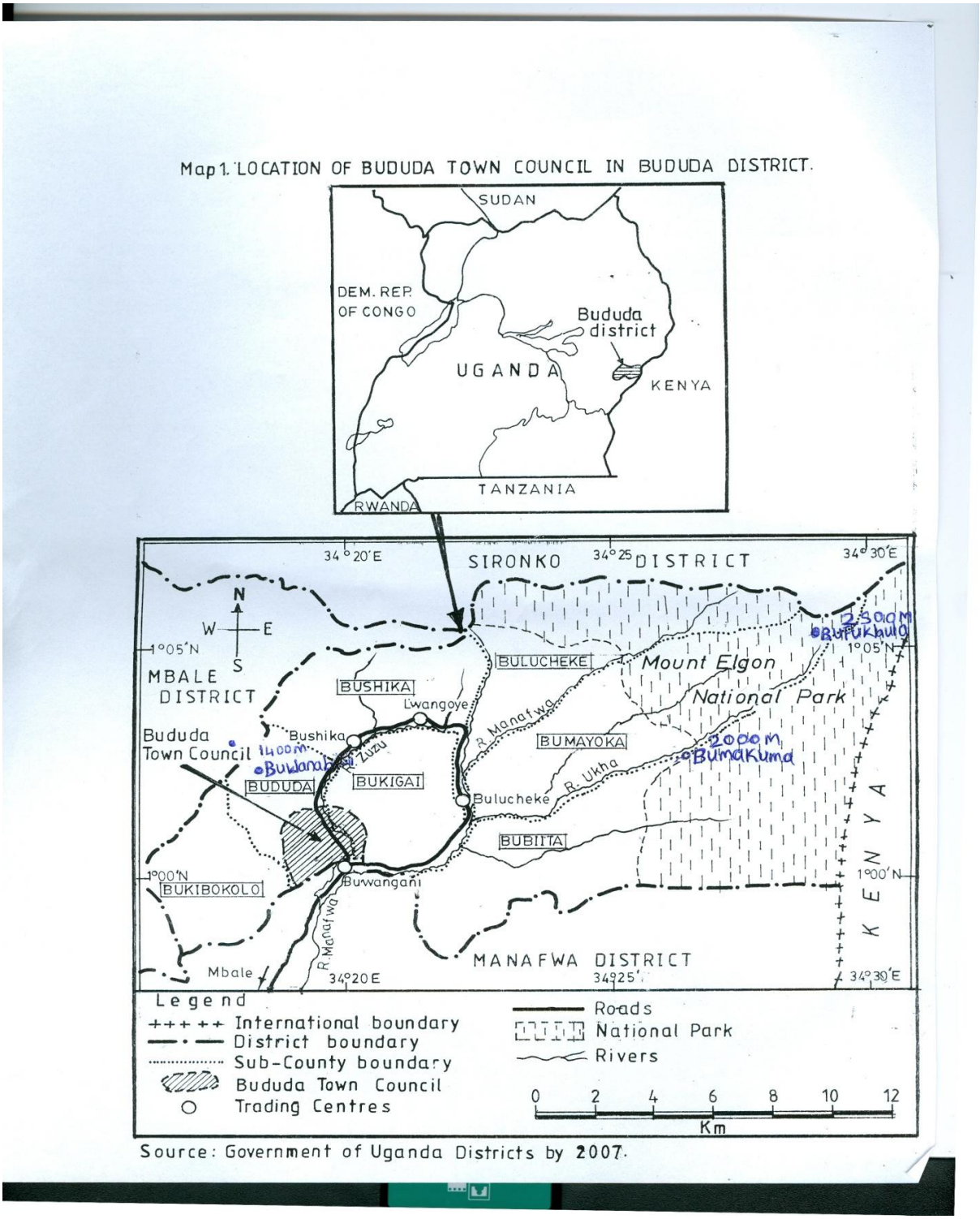

Figure 4.2: Map of Uganda showing the location of Bududa District, and Map of Bududa District showing the location of Bududa town council and other sub-counties including study villages.

Source: Mr Magaawa, Cartographer, Department of Geography, Makerere University.

4.2.2 Economic activity.

Agriculture is the backbone of the economy of the district just like it is for Uganda as a country. The fertile volcanic soils and the abundant rainfall (average 1,500mm per year), support the growth of both cash and food crops. Some of the crops grown in Bududa include: coffee, beans, bananas, matooke, cabbage, tomatoes and other green vegetables. Originally, it was a prosperous area for cultivation with very fertile soils but because of the variations in climate where temperatures are high and sometimes very low, rainfall is low and sometimes very heavy and destructive (http://en.wikipedia.org/wiki/Bududa_District, 12.08/2011).

Access to high fertile soils in the middle and high altitude villages of Buwanabisi and Bufukhula has been reduced due to soil erosion, landslides which have also claimed lives by burying people in the soil. The heavy rain has also caused flooding in the lower altitude villages (Buwanabisi). All this consequences resulting from climate variations has affected food and cash crop production leading to reduction in yield that has contributed to low income. This has therefore resulted into poverty which has increased vulnerability and health consequences as the people are unable to handle prevailing conditions and diseases like malaria. Poverty was so much cited and emphasised by majority of informants.

4.2.3 Population.

During the 2002 national census, Bududa district population was estimated at about 123,100. At the time the new district was created in 2006, the district population according to population census was 146,000. Today's exact total population of Bududa district is not known but is estimated to be 167,000.whereby 4,025 live in the small town centre which was newly turned into a district and 162,975 in the rural area. (A very high proportion densely populated area). The population in the rural area is higher than the urban because it covers a much larger part of the district unlike the urban area which covers a small portion of few villages. The male to female ratio is 1:1 (http://en.wikipedia.org/wiki/Bududa_District, 12/08/2011, Bududa District population report, 2009/2010) The lower altitude (Buwanabisi) village is located more in an open environment and space compared to the higher altitude (Bufukhula) which is covered by trees and bushes due to sparse settlements. The population in the lower altitude is much higher than the middle and the higher altitude village. The higher altitude has the lowest population. This is due to many people fearing some of the impacts of climate variability like landslides that can occur any time. In 2010, it killed and buried several people deep in the soil.

Table 4.1: Population of the three villages where the research was carried out

Village.	Altitude	Female	Male	Total
Buwanabisi or Bududa town Council.	Lower (1400 metres)	400	350	750
Bumakuma	Middle (2000 metres)	256	269	525
Bufukhula	Upper (2500 metres)	212	230	440

Source: Bududa district local government, Population office (2011).

In general, from the population table above, the upper altitude village (Bufukhula) with 2500 m asl has not been much affected by malaria because it is located at an altitude above the breeding zone for mosquitoes. However, according to the research findings, the district health officer for Bududa stated that the two upper most villages are affected due to mobility of people to and from the upper village to the lower village maybe for work, leisure and accessing social services. The local population is also digging ditches and trenches in the gardens and home compounds which create conditions for the survival of mosquitoes during warm season when the temperature rises.

4.2.4 Climate Information for Bududa.

Rainfall.

From the graph below it can be observed that rainfall in Bududa town varies substantially from year to year. This is according to data obtained from Bududa town meteorological station, the only meteorological station in the district. Rainfall was higher in the year 2005 as compared to other years measuring to 931.7mm and 2007 to 627mm. In 2009 rainfall was lower ranging between 131.1-353mm. In 2007 and 2010 rainfall was relatively normal.

Compared to the previous year's say from 1961-1990 average rainfall was quite normal ranging between 150-527mm. This shows that rainfall amount for the recent years (2005-2010) have been varying greatly. The difference in the amount of rainfall received in 2005 shows a wide variation from other years. Increased rain increases larval habitat and vector population size by creating new habitat and flooding. The reduction in rainfall amount means increase in temperature. The rise in temperature is leading to high rate of mosquito breeding during warm seasons resulting into high malaria prevalence. This has not only affected the

lower altitude village but also the higher altitude village though the lower area tends to be more affected.

Table 4.2: Average Annual rainfall for the year 1961-1990 and 2005-2010.

MONTHS.	AVERAGE PRECIPITATION.	PRECIPITATION/RAINFALL.			
	1961-1990	2005	2007	2009	2010
January	248	299	212.6		499.3
February	364	402	341.5		306
March	434	290	418.5		292.8
April	390	448.8	550.5	353.2	245.4
May	527	655	441.6	219	209.4
June	450	712.7	311.4	107.8	337.1
July	403	663.8	262.3	137.2	520.8
August	434	658.1	436.7	313.2	141.9
September	390	575.4	364.4	131.1	
October	217	931.7	267.4	306	482.9
November	150	347.4	386.4		277.9
December	155	208.7	627		521.6

(http://www.yr.no/place/Uganda/Mbale/Bududa/statistics.html, 12/08/2011) and *Department of Meteorology (Kampala-Uganda).*

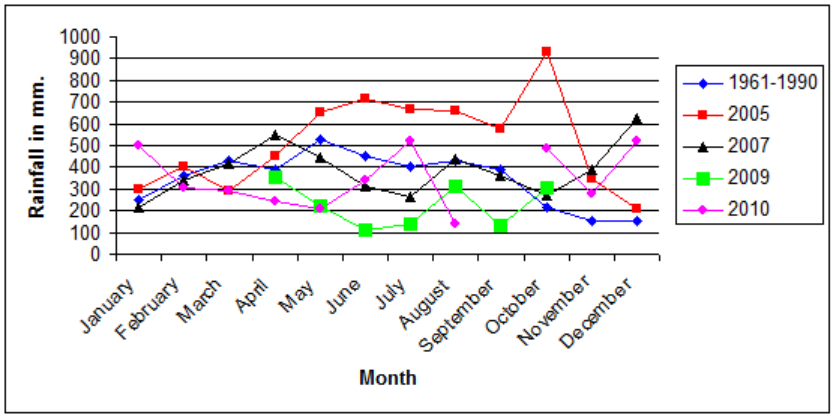

Figure 4.3: Average Monthly Precipitation for Bududa Town in the period 1961-1990 and 2005-2010.

Figure prepared by the author based on statistics in table 4.2 above from: (http://www.yr.no/place/Uganda/Mbale/Bududa/statistics.html, 12/08/2011) and *Department of Meteorology (Kampala-Uganda).*

Temperature.

Since 1990, the temperature measurements recorded are solely for the year 2010. This is because there was no funding to facilitate the work and people responsible in recording and preparing the climate data. The recorder mainly concentrated on rainfall data where even records weren't taken daily.

From the graph below in the period 1961-1990, the lowest temperature was 10.5^{o} when it is coldest and 27.7 when it is warmest. In 2010, the minimum temperature was ranging between 14-16^{o}C and maximum temperature ranging between 30-33^{o}C. Since the optimal environment and degree for malaria pathogen to survive is between 12^{o}C and 35^{o}C. It can be stated that the temperature degree is suitable for the survival of mosquitoes which is leading to increase in malaria cases. This increment can be confirmed by the figure in Bududa district annual malaria report (chapter 5). The malaria report indicated increase in malaria in the year 2010. Compared to the past 1961-1990, temperature was relatively low and stable critical for mosquito's survival. A weakness in this presentation is that temperature for the last years are measured by one year only.

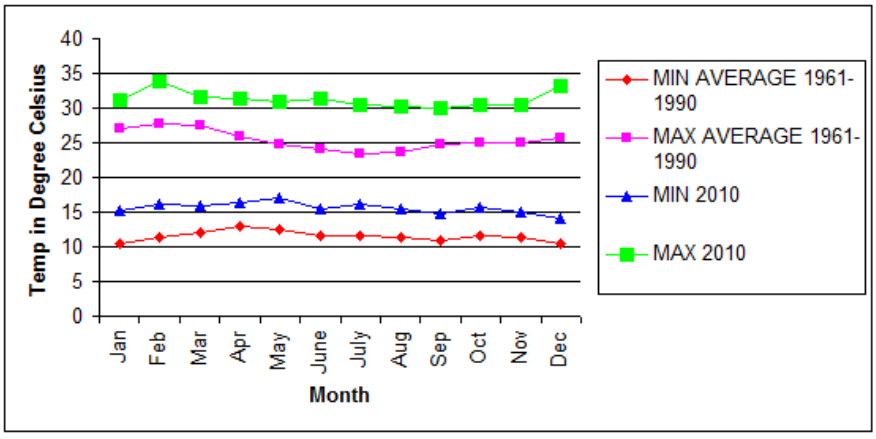

Figure 4.4: Average monthly minimum and maximum temperature for Bududa town for the period 1961-1990 and 2010.

Figure prepared by the author based on statistics from:
(http://www.yr.no/place/Uganda/Mbale/Bududa/statistics.html) and
Department of Meteorology (Kampala-Uganda).

The relationship between temperature and precipitation is that rainfall is a more influential risk factor than temperature. Among other things there are several breeding grounds for mosquitoes usually after rain stops. The breeding areas are mainly through flooded water

around and in small wetlands, stagnant water in home compounds, surrounding areas, bush lands and vegetation like banana plantations that harbour water in the leaves when it rains.

4.4 Climatic variation, physical environment and influence on health care.

The long term good health of populations depends heavily on the continued stability and functioning of the biosphere's ecological and physical systems. Climate variability affects the spread of vector borne diseases both directly and indirectly. Directly, local or global warming and increased rainfall contribute to the abundance and distribution of vectors such as mosquitoes and ticks although mosquitoes are the most common. Global or local warming leads to increased temperatures allowing mosquitoes to survive cold conditions where they would otherwise have perished. Subsequently, more mosquitoes are alive to breed and transmit disease during the dry and warm season. In addition, mosquito larvae develop much faster at higher temperatures and after ingestion of the virus become more infectious at higher temperatures. Indirectly, other factors such as deforestation and natural disasters like landslides, soil erosion, decreased hygiene and stagnant water beds, increase rapid multiplication and survival of vectors and hence the incidence of vector-borne diseases. This has also increased the incidence of infection by vector borne diseases and their transmission to high altitude villages like Bufukhula. This has affected the population in this high altitude village because they have low immune systems. The indirect impacts of climate variability like landslides and soil erosion also cause injuries and death. Besides that, it causes damage to the local infrastructure where the buildings are damaged hence exposing people to malaria through mosquito bites.

Uganda's climate has undergone changes in terms of temperature and precipitation, (seen from Bududa temperature and rainfall graph's in the period 1961-1990 and 2005-2010). Over the last few decades, Uganda as a whole has experienced variation in the frequency and severity of extreme weather and climatic events. This is greatly affecting the health sector at all levels by increasing the incidence and severity of various diseases. *Heavy and destructive rainfall that leads to flash floods has led to emergence of water and vector borne diseases such as diarrhea, malaria, cholera, and typhoid fever* (Uganda: National Adaptation Programmes of Action, 2007:7). Climate variation has also influenced the local health care system in Bududa (According to key informants. See chapter 4.4.2 below).

4.4.1 Altitude and Malaria transmission.

In Bududa district and the three study villages, it was noted that the people settled at the foot slope, (lower altitude village of Buwanabisi) suffer more from malaria as compared to those settled in the middle (Bumakuma) and upper altitude (Bufukhula). This is because of flooding resulting from heavy rain and many areas experiencing stagnant water. The flooding and stagnant water have predisposed the population to increased incidence of malaria through conditions created for mosquito vectors which invade houses especially at night. The local people suffer effects of malaria as they cannot afford to buy insecticides and nets to protect themselves from mosquitoes. "*The overall malaria prevalence in the Mount Elgon region showed infection prevalence at 30.3%. At lower altitude, the malaria prevalence was shown to be 14 times greater than at a higher altitude, with infection proportions at 56.7% and 4.0%"*. See Table 4.2. The difference in malaria prevalence at altitude showed significant association for the respective areas year in general for the region.
(Davis. undated: 32, http://www.cntd.org/pdfs/Davies.pdf ,08/04/2012).

Table 4.3: Proportion at low and high altitude of those testing positive for malaria.

Mount Elgon Region.

Infection	**% Proportion at Low Altitude.**	**% Proportion at High Altitude.**	**Total % proportion**
Malaria	56.7	4.0	30.3

Source: (Davis-undated: 32, http://www.cntd.org/pdfs/Davies.pdf, 08/04/2012).

4.4.2 Malaria treatment and health care in Bududa District,

Health care and treatment in Bududa district as regards to malaria diseases starts from individuals who administer self treatment when they feel feverish. Usually the local people use local herbs for treatment especially in families that cannot afford modern drugs and treatment. Those who can afford to buy modern drugs from clinics or may have managed to get drugs like coartem (Anti-malaria drugs) distributed from the hospital use for treatment. When the condition of the fever persists, some of the local people visit the traditional healers who have special herbs for malaria treatment. Others especially those who can afford the bills, visit the nearby clinics and hospital in Bududa town for modern treatment and health care. (Refer to chapter six, 6.2.3 for information on traditional curative measures and malaria). The hospital in Bududa town is a regional referral hospital with 120 beds where

malaria patients and patients with several other diseases are admitted when the condition of illness or sickness persists. In the hospital they are usually monitored and cared for by doctors and nurses till they get well and are discharged.

In Bududa district hospital, there is no initial prioritization of diseases but the various diseases can be prioritized in situations where there is increase. For example malaria cases in Bududa district hospital is received daily. About 40% of patients admitted daily (in-patients) are malaria cases (personal information according to the district health officer-focal person in charge of malaria). Although malaria may be prioritized because it is on the increase; the patient can be helped and treated faster if the drugs and medical staff are available (vacancies and work overload is a persistent problem). At the referral hospital in situations where the drugs free of charge are not available, the medical personnel's will only prescribe the required drugs and the patient buys from the clinics and pharmacies in Bududa town. The drugs are usually available there, however patients have to pay. Those who cannot afford to buy drugs from clinics when admitted in the hospital will be monitored and treated in other ways. Other diseases too like cholera, diarrhea, typhoid fever and respiratory diseases resulting from the climatic variations and the physical environment are handled.

CHAPTER FIVE: CERTAIN IMPACTS OF CLIMATE VARIABILITY ON MALARIA OUTBREAK.

5.1 INTRODUCTION.

This chapter explores the impacts of climate variability in influencing malaria in villages of Buwanabisi (lower altitude), Bumakuma (middle altitude), and Bufukhula (upper altitude) in Bududa district, Uganda. The triangle of human ecology model adopted by Meade and Emch (2010) was used as the main analytical tool to discuss the impacts of climate variability (temperature and rainfall) in influencing malaria and other risk factors (population, environment and behaviour). The concept of risk factors of disease, causes of climate variability, climate change and health, controlling and preventing malaria is also used where applicable to help in supplementing and discussing the issues analyzed in this chapter. Information obtained through qualitative methods like field observation, individual and key informant interviews, focused group discussion and informal discussions will be presented in the empirical and analysis chapter five and six.

5.2 CLIMATE VARIABILITY IN BUDUDA

The Chairman Local Council Five stated that, the climate in Bududa has greatly changed due to unexpected and increased heavy rainfall (for example in March to December 2010) there was heavy and unexpected rain). Continued heavy rains and flooding has raised fear with believe that similar landslides may occur in neighbouring districts *(*Hyun, 2010*). "Over 300,000 people in the Mount Elgon region and the neighbouring lowlands of Butaleja, Budaka and Tororo districts have been displaced following the landslide that devastated Bududa in eastern Uganda last week",* says the state minister (New vision, 2010). The Chairman Local Council Five further mentioned that even in the years 1996 and 1997, there was heavy and destructive rain. This rain has always brought about coldness and muddy roads. Flooding (for example over flooding in 1995) in the lower altitude where Bududa district lies has become rampant, hence creating habitats suitable for mosquito breeding leading to increased malaria cases. Mosquitoes usually develop during warm times of the day when temperature rises. The higher altitude that used not to harbour mosquitoes now is also affected. All this, is attributed to the variation in climate.

The variation in climate is due to several factors as mentioned by informants. Some of these factors include; poor farming methods, increase in population leading to other factors like deforestation, land reclamation which contributes to temperature rise. Road construction is

yet another factor as it also leads to cutting down trees and other existing vegetation, and water bodies like swamps, rivers that would instead moderate climate of the area. The climate is no longer like in the past. In the past there was constant and more daily rain that created cold conditions critical for mosquito breeding and development especially in the higher altitude. Unlike today where rain is low and warm conditions arises anytime. Besides the infrequent rainfall, when it comes, it is heavy and destructive. The Chairman Local Council Five states: "*In the past, rain was normal but not now any more".*

Bududa district health officer, focal person in charge of malaria further pointed out that, about 40% patients admitted in Bududa district government referral hospital are malaria cases. In the past there were no much cases of malaria, cough, diarrheal and typhoid fever as it is today. The variation in climate in Bududa is also seen through increased catastrophic events like mudslides and droughts, long periods of sunshine and famine. There is also increased perceived witchcraft as a result of lightening which is killing people. This lightening wasn't heard of in the past but in recent years due to climate variation, it is not a surprise in case it killed someone. Change in planting seasons leading to low food and cash crop production. The low food production has increased the level of poverty hence making poor families unable to buy mosquito nets, get proper malaria treatment and eat balanced nutritious food among others.

The variation in rainfall and temperature may lead to reduction in staple food production especially in the poorest countries by up to 50% by 2020 in some African countries including Uganda. This will in turn lead to increase in malnutrition and under nutrition prevalence that is leading to 3.5 million deaths every year (World Health Organisation news, 2010).

A man in his forties expresses: *"we only eat beans; there is even poverty and a lot of death, increase in prices due to low yield, loss of soil fertility due to soil erosion" Nowadays people are even sicklier".*

The above expression points out the effects of climate variation especially rainfall in contributing to poverty. It shows that the heavy rain has led to loss in soil fertility that is bringing about low crop yield, more so with long term crops which has to spend some period of time like five month and above in the garden. With beans, since it takes a short time to mature, many may prefer to cultivate in order to at least have what to eat in the family. This condition affects individual's health because eating the same type of food lowers body

immune system, and making many especially the children, elderly and pregnant women prone to diseases like malaria.

5.2.1 Climate and seasonal variation of malaria.

For this study, only two climatic indicators have been considered as most important in influencing malaria epidemic and their pattern. This includes temperature and rainfall in all the three altitudes: lower (Buwanabisi), middle (Bumakuma) and upper (Bufukhula). Many diseases including malaria prevalence is closely associated to climatic conditions. Its indicator's temperature and rainfall help determine where malaria parasites and vectors can breed and develop. The most influential climatic factors for vector borne diseases include temperature and precipitation though wind, sea level elevation, and daylight duration also have upper hands as additional factors (http://www.who.int/globalchange/publications/climatechangechap6.pdf, 17/03/2012).

In the whole of Bududa district, much rainfall and temperature rise during warm seasons and time of day has led to increase in the breeding places for mosquitoes. Floods and stagnant water created in broken pots, containers, tins around houses after the rain has stopped become breeding grounds for mosquitoes during warm days. This has always led to increase of vectors. This therefore explains the reason why most times pattern in malaria cases are associated with rainfall pattern. Temperature as a climatic factor also determines survival rates of both the vector and the parasite, besides influencing the speed of larval development as mentioned above (Research by Protopopoff et al., 2009).

From the table below, one notes that there has been increase in malaria cases from 2006 to 2010 especially for children aged below 5 years and above 6 years (including adults). Malaria cases for the population aged 6 years above has had a steady increase with 66683 in 2009-2010 and 5 years below also increased to 35625 compared to other years (1960-2000).

Table 5.1: Bududa District Annual Malaria Report from the year 2006 to 2010.

Year	0-5 Years	6 years and years 70+	Total
2006-2007	34493	64130	98623
2007-2008	31919	65355	97274
2008-2009	25148	49889	75037
2009-2010	35625	66683	102308

Source: Bududa district regional referral hospital.

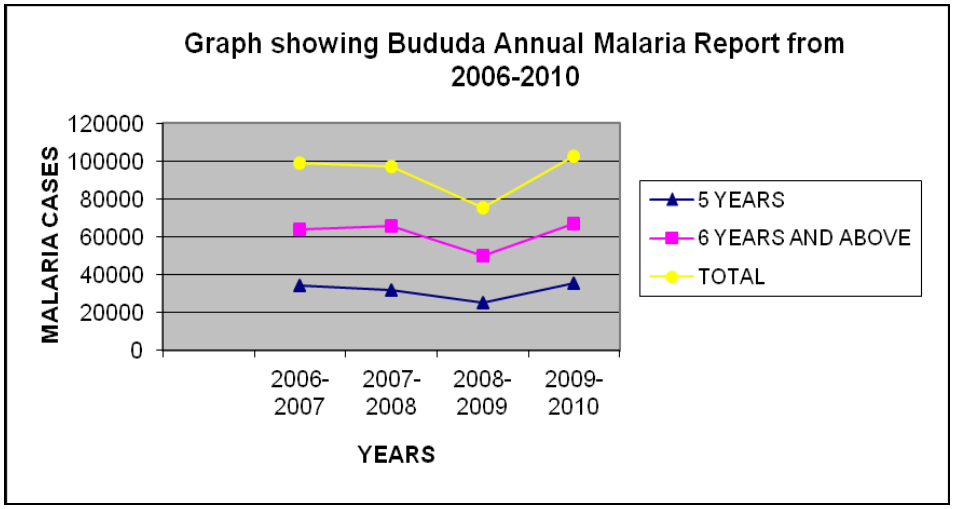

Figure 5.1: Graph showing annual malaria report for Bududa from 2006-2010.

Source: Prepared by the author by use of figures from table 5.1 above.

5.2.2 Changes over time 'before and after'.

Before 1990-2000 (10-20 years ago), there wasn't so much variation in climate especially rainfall and temperature in Bududa district in general. Most of the areas were covered with vegetation like trees and bush land which is not the case today. Today most of the vegetation that existed has been cleared in search for agricultural land, settlement land and other developments like urban centres, road construction which has contributed to the changes and variation in climate experienced today. Population growth since Bududa was changed into a district and increased welfare and economic growth are also factor's that has contributed to clearing of the forests and vegetation that existed.

Abundant and dense vegetation leads to increment in rainfall as it influences rainfall formation through evarpo-transpiration. Vegetation was dense in all the three villages at different altitudes in the past that is why rainfall was constant and normal with low temperature that mosquitoes could not easily survive. In the past years (10-20 years ago) in the higher altitude, mosquitoes could hardly survive due to critical temperature. In the middle altitude, though there were some mosquitoes, it was low and not in all areas of the village. In the lower altitude, due to flooding of some areas, dug trenches, surrounding wetlands and vegetation, any slight temperature rise could lead to breeding of mosquitoes. Therefore in the past there was little variation in climate; rainfall was much that is normal and constant but not

heavy and unexpected like today where it is even destructive. *"There is drastic change in climate today than in the past"* say's the Chairman Local Council Five, Bududa district. The coldest temperature was 10.5^{o} in the lower altitude and in the middle and upper altitude temperature was less than 10^{o}. (Estimates according to rainfall data for the year 1961-1990. Refer to table 5.2 below).

Malaria occurrence in Buwanabisi, the lower altitude was moderate but now it is high. Malaria is a disease that is widely common within the lowland areas of most mountainous areas (Lankinen et al., 1994). Bumakuma village in the middle altitude before was low but now it is moderate, and Bufukhula village in the higher altitude had no malaria cases but now there are some malaria cases though low.

"The optimal environment for the malaria pathogen, the plasmodium occurs in areas with temperatures between 12^{o} and 30^{o} and it cannot survive under 10^{o}. The mosquito vector anopheles thrives best between 12^{o} and 35^{o}" (Aase & Habarugaba, 2006:3). The higher altitude that had no malaria cases is now affected though with low prevalence as stated above. *"The warming increases the breeding rate"* says the district health officer, focal person in charge of malaria for Bududa district.

Informants also stated that death resulting from malaria disease in Bududa district these days is very common. People take it to be normal, they no longer fear hence says "*you are born once and you die once, tomorrow it's me, so don't cry"*. In the past though death from malaria disease was there, it was not much and neither common. If one died of malaria disease, it was like a surprise compared to today. Death from malaria disease is more common in the lower altitude of Buwanabisi than the higher altitude of Bufukhula village. The higher altitude is relatively affected due to mosquito breeding as a result of seasonal variations that brings about rise in temperature and also movement of people to and from the lower slope which is highly infested with mosquitoes. The people from the higher altitude are easily attacked by malaria after mosquito bites because their body has not developed a strong immune system to resist the malaria parasite.

Table 5.2: Tabular view for Temperature and Precipitation for Bududa District by Month from 1961-1990.

MONTHS	TEMPERATURE			PRECIPITATION
	Normal/Average	Warmest	Coldest	Normal
January	18.8°C	27.0°C	10.5°C	8
February	19.5°C	27.7°C	11.4°C	13
March	19.8°C	27.5°C	12.0°C	14
April	19.3°C	25.8°C	12.9°C	13
May	18.7°C	24.8°C	12.6°C	17
June	17.9°C	24.1°C	11.7°C	15
July	17.4°C	23.3°C	11.6°C	13
August	17.5°C	23.7°C	11.3°C	14
September	17.9°C	24.8°C	11.0°C	13
October	18.3°C	25.1°C	11.5°C	7
November	18.1°C	24.9°C	11.3°C	5
December	18.1°C	25.7°C	10.5°C	5

Source: (http://www.yr.no/place/Uganda/Mbale/Bududa/statistics.html)

5.3 HABITAT FACTORS ASSOCIATED TO MALARIA AND ITS TRANSMISSION.

Habitat is one of the important elements that explain the environmental and climatic factors that influence malaria. These environmental factors can be natural, social and built. Since this study focuses mainly on rainfall and temperature as most vital climate variability factors in the physical or natural environment, they will be presented under the natural environment element in the human ecological triangle. Human behaviour and his attempts to control

malaria, contributes to the epidemiology of malaria disease. Hence make malaria endemicity to vary from endemic to epidemic based on these factors (Lankinen et al., 1994).

5.3.1 Natural Environment.

Rainfall, temperature vegetation are discussed under the natural environment of habitat element of the human ecology triangle.

Rainfall and humidity

Rainfall is one of the natural environmental risk factor that can be explained under the natural environment or habitat element of the human ecology model adopted by Meade and Emch (2010). Rainfall is a potential risk factor in influencing malaria epidemic. This rainfall factor can be due to variation in climate as observed in Bududa district.

In Bududa district rainfall is the most important in influencing malaria epidemic. Rainfall was cited by most informants in the lower and part of the middle altitude villages. The local communities and key informants emphasized it as the most important risk factor in influencing malaria disease in combination with warm temperatures. "*Breeding sites are more common on the valley floor after rain stop than the steep valley slopes, while the colder nights at higher altitudes restrict the dispersal of adult mosquitoes from these sites*" (Lindsay & Martens, 1998:36). Bududa being located on the Mountainous side of Elgon receives high daily rainfall compared to many other districts in Uganda. One of the informants in her forties from the lower altitude stated that, *"More rainfall, more breeding ground especially in the lower altitude of the Mountain".*

Rainfall and humidity influence malaria spread through their direct effects on breeding and on duration of the vector population respectively. Rainfall plays a crucial role in malaria epidemiology because it provides the medium for the aquatic stages of the mosquito life cycle. Rain may prove beneficial to mosquito breeding if moderate, but if excessive it may flush out the mosquito larvae. *"Rainfall may also increase the relative humidity and hence the longevity of the adult mosquito"* (Martens et al., 1995:460).

Temperature.

Temperature is also another important factor in influencing the breeding sites for mosquitoes. This temperature is majorly determined by altitude because it determines the parasite development and the frequency of the feeding vectors. Altitude above 2000 meters normally

are critical for the survival of mosquitoes, this is because at this altitude and above, it is too cold that mosquito larvae is usually destroyed. However temperature below 1800 meters above sea level, mosquitoes are able to survive.

As altitude increases, temperature declines and both the development and survival of the mosquito vector and parasite are critically dependent on the ambient temperature. As the temperature drops so does the risk of infection, and there is a typical threshold below which transmission ceases. Below 16 °C the aquatic stages of tropical anophelines fail to develop or breed. While Plasmodium falciparum fails to develop between 16 °C and 19 °C (Lindsay & Martens, 1998:34).

Bududa district health officer further stated that *"There used to be no malaria at the higher altitude but now, it is so rampant due to changes in climate. The warming also increases the breeding rates for mosquitoes".*

This statement confirms some of the literature about the impacts of climate variability in influencing malaria in highland areas of Africa more so higher altitude being invaded with malaria cases in recent years, East Africa in particular where Mount Elgon is located. For example; (MARA, 1998: Chapter four) points out that "*recently there has been much speculation on the issue of highland malaria in Africa. Highlands or Mountains have always been regarded as areas of little or no malaria transmission mainly because of low temperatures. However this appears to be changing due to the changes and variations in climate. There is substantial evidence that shows an increase in the number of epidemics in highland areas, as well as a spread of endemics in highland fringes".*

Breeding of Anopheles mosquito's normally surfaces in clear shallow water especially if the day time temperature is high. Even at altitudes of up to 2000 meters above sea level. Variation in temperature may lead to change in the geographical distribution of disease carrying vectors especially when they get used to the conditions. For example the emergence of malaria in the cooler highlands of African maybe due to mosquito vector altering the environment so as to get used to the increase in temperature and atmosphere. (http://www.who.int/globalchange/publications/climatechangechap6.pdf, 17/03/2012).

Bududa district is experiencing variations in climatic conditions as exemplified and manifested through rise in temperatures. In areas of low temperatures like high altitude areas

of Bufukhula, any small increase in temperature can greatly increase the risk of malaria transmission.

Vegetation.

Vegetation like bushes, trees and banana plantations has become one of the natural environment risk factors to malaria in the three villages of study area. Most of the areas in the lower altitude are swampy and flooded besides the bushes, trees and banana plantations harbouring mosquitoes when temperature rises. Vegetation in the swampy areas is one of the most prominent breeding grounds for mosquitoes in the lower altitude. Be it during wet or dry season. In the higher and middle altitude villages, mosquito breeding starts mainly when the temperature rises and also during dry seasons. When it is rainy and cold, the mosquitoes can hardly survive.

Besides other multiple risk factors like human behaviour, biological or population and environmental determinants, infectious diseases are occurring and re-emerging due to climatic factors. Increase in global temperatures has been observed by climatic scientists and expected to rise by approximately 2.0 degrees C by the year 2100. Since the outbreak of mosquito-borne diseases, including malaria is among those diseases most sensitive to climate. The change in temperature can lead to the introduction and spread of many severe infectious diseases like diarrheal, typhoid fever. Climate variability for both temperature and rainfall has direct indirect effects on disease transmission. They can alter the spread of mosquito vectors in time and space; increase their growth and biting rates too.
(http://www.ncbi.nlm.nih.gov/pubmed/8604175, 17/03/2012).

Additional factors leading to malaria spread like human behaviour, population and environment to climate variation mentioned in,
(http://www.ncbi.nlm.nih.gov/pubmed/8604175) above, will be presented below. These factors were adopted by (Meade & Earickson, 2000; Meade & Emch, 2010) as illustrated in the triangle of human ecology model.

5.4 OTHER RISK FACTORS TO MALARIA.

Besides temperature and rainfall as climatic parameters influencing malaria transmission under the natural environment element of the human ecology triangle, there is also a complex

interaction of many other factors identified through the triangle of human ecology model adopted by (Meade & Earickson, 2000; Meade & Emch, 2010).

These risk factors to malaria identified through the triangle of human ecology model include factors within the built and social environment, population and human behaviours as presented below. All the above factors were taken into consideration during research because they interact together and shape one another. The study of the factors was not in depth because it would require a lot of discussions, hence taking too much time.

5.4.1 Built Environment.

The built environment is explained under the habitat element of the model that presents factors like poor housing or poorly constructed houses, poor hygiene, and road construction. These risk factors seem to be the most important built environment factors within the study areas (villages).

Poor housing or poorly constructed houses.

Through observation and interviews with the local people, the researcher noted that most of the houses that people lived in, in all the three villages of Buwanabisi, Bumakuma and Bufukhula were poorly built houses from mud and unburnt bricks. Besides the roofs licking, they are so old that can easily be blown by heavy wind. One of the female informants in the lower altitude between the ages of 30-45 years said, *"Look at my house, even last month heavy rain and wind blew off the roof, it was fixed but not even sure how long it can take. We are just suffering with this rain, because when it comes it is heavy and destructive*".

The above statement shows that the local people in the three villages especially the poor are worried for their houses due to the effects of heavy rain which is causing more harm than good. They see that if the situation continues, there is nothing to do other than suffering with it.

The role of poorly constructed houses is of great importance in causing malaria amongst the poor people, because the poorly constructed houses are normally weak, with cracked and licking roof's, poor window's and worse still using the same house as a kitchen. This circumstance can create good breeding places in the house for mosquitoes hence becoming risk factor which later on cause's malaria. This scenario happens in all altitudes of the Mountain and villages of Bududa district but the lower villages are more affected when the rain comes with heavy wind. The poorly constructed houses can even be damaged or

demolished. The lower village is so much open (no trees to protect houses from strong wind) as compared to the upper village which is covered by trees and bushes due to sparse settlements. Household and socio-economic factor have also an impact on malaria transmission by influencing the human vector contact. For example, more mosquitoes were found in poorly constructed houses as compared to good ones. Other factors such as keeping livestock inside the house, type of roof, open ventilators, same kitchen with the living and sleeping house were also associated with increased malaria risk (Protopopoff et al., 2009).

Figure 5.2: Poorly built house near a wetland.

Source: Field data, July 2011.

Poor hygiene.

Some people tend to have very poor hygiene in the home. When it rains they do not mind about clearing away areas with stagnant water, removing broken containers, pots and dishes from the compound, solid waste closer to the compound and living houses. Besides the water collected in broken containers and compound after it has rained, food particles are also poured anywhere in the compound hence making the compound filthy. This condition leads to the rampant breeding and development of mosquitoes especially when temperature rises. This situation has made many family members to suffer from malaria disease as the mosquitoes easily enter houses in the night through the broken windows, roofs, and doors. Now that many people lack mosquito nets, they are bitten by the mosquitoes hence leading to malaria. This situation of poor hygiene can be attributed to the "I don't care attitude" by some people who are even aware and not taking action. There are also local people in the study

area who lack knowledge and are not aware that the filthy home condition with stagnant water anywhere in the compound can act as breeding grounds for mosquitoes.

The people at the lower slope suffer most due to this factor of poor hygiene. This is because the landscape is a little flat, hence harbouring water that becomes stagnant suitable for mosquitoes breeding and development when temperature rises either during dry or wet season. Though the higher altitude too may harbour mosquitoes from stagnant water created in unhygienic homes when temperature rises due to seasonal changes, it is not so rampant like the lower slope. Unless temperature rises, the cold from low temperature is usually critical for mosquitoes to develop and mature. Below is a picture of one of an unhygienic home in the middle altitude.

Figure 5.3: An unhygienic home that easily harbors mosquitoes.

Source: Field data, July 2011.

Transportation and housing.

Since Bududa became a new district to date, there has been construction of infrastructures like roads, urban centres, schools. Some informants especially those settled next to the main road and market expressed that; *besides the roads being marrum, they have very large pot holes that when it rains, they hold stagnant water suitable for mosquito breeding. Have you seen the road as you are coming towards the market? They have very large pot holes. They are so bad.* Opening up new roads, land clearance for construction of buildings, moulding bricks for new homes and collecting material for road construction has produced numerous hollows which filled rapidly with water, creating yet more mosquito breeding sites. A woman in her late thirties stated that; *"If you are to go where the new district offices have been constructed just below the play ground, there are a lot of dug hollows and channels where*

mosquitoes are breeding. Worst still this area is near the flooded area being planted with eucalyptus trees". Most of these pits are near people's homestead, hence increasing the ease with which mosquito vectors could locate a house. In the nearby highland settlements of the lower altitude village of Buwanabisi, growing human and animal activities paved many new opportunities for the Anopheles gambie mosquito to breed. This mosquito typically breeds in small hollows, such as those formed by feet, and wheels all of which existed around the expanding communities and Bududa urban centre. Originally most of the African highlands were heavily forested, creating an environment which is critical for the Anopheles gambie mosquito. The cutting down of trees within the highlands has occurred at a rapid rate, with 2.9 million hectares being cleared between 1981 and 1990. This has represented a reduction of 8 % in forest cover in one decade. Furthermore clearance of forests to create more open land for growing crops and pasture has led to suitable breeding sites for mosquitoes. This is due to trampling of land by humans and animals which leaves hollows that can easily collect stagnant water during rainy season (Lindsay & Martens, 1998).

5.4.2 Social Environment.

Mobility, food security and income are social environment factors identified through the human ecology model during interviews as risk factors to malaria.

Mobility.

Mobility is important in exposure to and transmission of disease. Mobility implies that people are exposed to risk factors at various places. It is also an element of behaviour (Meade & Emch, 2010).

In Bududa district many people from the higher part of the Mountain area move to and from the lower slope for different reasons like work, marketing, accessing services like treatment in Bududa referral government hospital, entertainment within the town area, associating with friends. This regular and irregular movement to and from the lower altitude village has also become a risk factor to malaria especially for people who are settled in the higher altitude. When they move to the lower slope very early in the morning and late evening or night for work, entertainment, socializing with friends they are bitten by infected mosquitoes that transmit the malaria parasite. The neighbouring lowlands of the Mountain are characterized by high malaria transmission due to higher temperature and rainfall and several breeding

places. The breeding places can be in the flooded areas of the lowland, broken pots, containers and wetlands around. Regular and irregular mobility was cited by some of the informants as one of the important risk factors to malaria transmission for people in the higher altitude where malaria is not common. The district health officer also emphasized the factor of mobility so much stating that; *nowadays even the higher altitude population are affected; this is because they are bitten by mosquitoes when they move to and from the lower altitude villages that harbours mosquitoes a lot*. Population movement by those from both the higher and lower altitude villages increases the risk of contracting malaria. This is because when these people come together with their families, they transmit malaria. Malaria transmission can be among the infected people, infected mosquitoes and the biology of the parasite in both of its hosts. The parasite can either be in people or in the mosquitoes.

The projected increase in climate variability could indirectly contribute to disease transmission due to human migration and damage to health infrastructures http://www.ncbi.nlm.nih.gov/pubmed/8604175, 17/03/2012). Reports of malaria cases are becoming high in many countries and in areas thought free of the disease like the high altitude regions. Human migration is one important factor contributing to malaria prevalence. People move for a number of reasons, including environmental degradation where the fertile soils are washed, economic necessity like jobs to earn income for a living, conflicts, and natural disasters like landslides. Since many of the poor people live in or near malarias areas, they are most likely to be affected. It is therefore important to know and understand the reasons for these human movements, in order to come up with appropriate malaria control measures and programs (Martens & Hall, 2000).

Poverty.

Due to the effects of heavy rain and floods, food and cash crops tend to be destroyed in the garden by soil erosion, landslides hence leading to low agricultural production. The rain flattens grain or grass and crops in the field. This therefore affects their level of income hence resulting into poverty, which affects families' nutritional status making them even prone to disease attack such as malaria. This is a risk factor in such a way that when a family lacks enough food and money, they are unable to handle certain situations like treatment and prevention of malaria disease. The family will also be unable to provide good and nutritious food, good and protecting clothing's, and buy mosquito nets as well as repellants that could

protect them against mosquito bites. Poverty is a cause of malaria and malaria on the other hand is a cause of poverty.

Poverty seems to play a great role in making the communities prone to climate variability impacts. Poverty makes the communities lack effective strategies for coping with climate-induced shocks such as disease and weather extremes. Lack of food due to rampant floods and droughts contributes to malnutrition especially among the poor leading to a situation that makes one feel sickly due to weakness. This situation makes individuals prone to diseases such as malaria (Wandiga et al., 2010). Although there is an increase in the use of mosquito nets in the lower altitude village of Buwanabisi, many households are unable to afford sufficient mosquito nets for all household members. In the higher altitude village of Bufukhula since mosquito vectors are not common, many do not use nets. However, those who use nets, use for the sake.

5.5 POPULATION FACTORS RELATED TO MALARIA AND HOW IT IS TRANSMITTED.

Within the human ecology model by Meade and Emch (2010), population element has played part in explaining risk factors like gender, age and genetics in influencing malaria as explained below.

5.5.1 Gender.

It is important to explore how gender is a risk factor to malaria. This helps to know which sex is the most vulnerable to malaria as a result of the effects of climate variability. During the study, informants argued that the female's especially women suffer most compared to men in all the three villages. This is because usually women keep working for a long time outside, be it on rainy or sunny days. It can be very early in the morning as they have to go to the gardens to dig, weed and harvest and in the evening still it is women outside. At these times, morning and evening the mosquitoes are so active that the women end up being bitten. By the time they go to bed, they will have already been bitten besides the more other mosquitoes in the house that bites them when they go to bed early.

Some informant's males and females agreed upon that *"when you go to the hospital, you can find mostly women; their numbers are higher than that of men"*

Women especially those that are pregnant are among the vulnerable groups to the impacts of climate variability on malaria. Much as the unpregnant women are affected, they are not so much like the pregnant one's when they work out for long and get exposed to mosquito bites. This is because the pregnant women later develop lower immunity than before. "*At altitudes above 1,800 meters localized outbreaks of malaria registered approximately every 2-3 years, pregnant women and children are the most affected groups"*
(http://www.health.go.ug/mcp/index2.html, 24/04/2012).

5.5.2 Age.

Age is also an important risk factor to malaria that is explained under population from the human ecology triangle. Many areas with high malaria incidences including Bududa, it is noted that elderly people and children are so prone to malaria (says informants). For the children under the age of five years, the immune system is low. Malaria is strongly influenced by climate and transmitted by Anopheles mosquitoes. It kills many people in that about 1 million die every year worldwide but the Sub-Saharan Africa dominates. Climate variability impacts are most likely to affect all populations, though some are more vulnerable than others. An example is seen with children (mainly African children under five years old) living in poor countries. These children are among the most vulnerable to the resulting health risks and will be more exposed to the health impacts. The elderly people and those people with pre-existing medical conditions are also expected to suffer severely by the health effects (World Health Organisation news, 2010). "*In most highland areas, local communities have little or no immunity against malarial parasites and thus the disease affects both adults and children. This contrasts with the lowlands where immunity is high among most adults and malaria morbidity is confined largely to young children. As a consequence of the low immunity in highland communities, epidemics in the mountains are characterized by high morbidity and mortality among both children and adults"* (Lindsay & Martens, 1998:33).

Children who are a little grown up say from 6 to 12 years suffer from malaria because they keep moving from place to place (can be early in the morning when going to school, during day and late evening), hence end up being bitten by mosquitoes which later result into malaria. The elderly are also attacked by malaria due to body weakness in the three villages of study area, (the lower (Buwanabisi, middle (Bumakuma) and upper (Bufukhula) altitude villages). Children are the most affected at the higher altitude and the elders not so much

because the long time of exposure improves their body immunity but in the lower altitude, the level of severity is high in children and the elderly all, This is because in the lower altitude, there is high mosquito breeding compared to the middle and upper altitude villages. So they are easily attacked by malaria after mosquito bites.

5.5.3 Genetics.

Genetics is one of the risk factors under the population element in the triangle of human ecology. This factor is majorly determined by immunity of the population living in the study area. It can be among children, elders, and pregnant women.

The population that has lived in the higher altitude village is also prone to malaria disease because their body has not developed strong immune system that can resist malaria parasite as mentioned already. However, much as genetics is a risk factor, it is not so much important in social science study (including this study). It is more of a topic in the science of pure medicine.

5.6 BEHAVIOURAL FACTORS.

From the human ecology of disease model, the behavioural element looks at risk factors like social network or organization, beliefs and technological or protective measures as important factors in influencing the spread of malaria.

5.6.1 Culture.

Cultural factors especially related to ceremonies and funerals, circumcision are also risk factors to malaria in Bududa district.

Circumcision is a culture in "Bugishu land" Bududa district inclusive. This is a culture that has been and is still common due to the fact that when any boy or man is discovered not circumcised, he has to do so or else he is considered unclean in the society and within the family. During circumcision people move, dance and sleep anywhere in the compound and bushes around a particular home where the circumcision is taking place. During this time, there is a lot of excitement, drinking crude alcohol in that many do not even bother to protect themselves from mosquito bites. Many end up being heavily bitten by mosquitoes leading to malaria. This situation is “more common now than before” in all the villages and other parts of Bududa because it is a culture that cannot be broken or regulated.

Awareness of sources of stagnant water.

Although many (almost all) people in the study area know that malaria parasite is acquired through mosquito bites, some lack knowledge about the breeding places suitable for mosquitoes like solid waste, wetlands, broken pots, dug holes around houses with clear stagnant water and vegetation. They do not know that these sources are the one's harbouring mosquito's that enter houses in the evening especially after the rain has stopped. This remains a risk factor in all the three villages of Buwanabisi, Bumakuma and Bufukhula. This is one reason that explains why the higher altitude harbours mosquitoes at present. The people do not know that water collected in dug holes used as garden trenches and ditches are the ones where mosquitoes breed. Otherwise at the higher altitudes, rain water rarely gets flooded like in the lower slope. The lack of awareness is also due to the fact that many people settled in these areas are of low education levels. Out of the forty informants interviewed, 14 were at least above primary level (four for secondary level education, 10 were certificate, diploma and degree holders) from the 14 informants, majority were key informants and 23 informants especially from the individual interviews and focused groups were primary level or none. This therefore means that since the majority of the people with low education levels were the local informants, one can say a large part of the population in the study area aged 30 years and above have low education. However, it is difficult to conclude because of the small sample which may not be suitable in representing the whole population.

Perception and Attitude about malaria disease.

Many local people have attitude that malaria has become a common everyday disease that should be expected at anytime with the increase in rainfall and rise in temperature. It cannot be prevented. This has made many not to even be bothered about protecting themselves from mosquito bites.

A female informant from the lower altitude in her forties observes that; *"Malaria today is common and increasing unlike the past". People are no longer scared or worried. People are used to death especially from malaria disease, hence taken to be normal: death is taken to be a relay. When somebody dies, people no longer cry and even use statements like "even this one has been given the stick, who next".*

According to the informants, malaria is seen to be very normal that when one dies, they feel another death case will be shortly heard of. Death is taken to be a race that is continuous and occurs one after another. This statement points out that malaria is a never ending story.

5.6.2 Social network

This is a risk factor to malaria spread in the three villages of Buwanabisi, Bumakuma and Bufukhula. In these areas there is no any proper way of preventing and controlling the conditions that lead to malaria spread by the community. The only measure that a group of local people within the lowland village of Buwanabisi have tried is planting eucalyptus trees in the flooded lowland area. This is a social network group taking initiative to reduce the risk of malaria by draining the flooded area which serves as mosquito breeding ground. This being the only measure tried by the community as a social network cannot be effective and efficient to malaria control and prevention. If the community people would cooperate in various activities like clearing bushy areas, filling pot holes, ditches, maintaining hygiene in public areas of rubbish collection as malaria control strategies, there would be some control against mosquito breeding grounds. This factor is a risk in all the three altitude villages mentioned above. The role of a social network group in an area is of great importance in the transmission, diagnosis, treatment and prevention of diseases like malaria, but often not taken seriously. This measure towards malaria control is being practiced by only the social groups in the lower altitude village of Buwanabisi. The measure in the lower altitude village is not effective and efficient since several activities to control mosquito breeding grounds are left undone. In the higher altitude village, such a network towards malaria control is not there. The people are unbothered due to the fact that the area has low mosquito infestation that occurs only when temperature rises.

5.6.3 Technology.

Technology is an element that explains or influences human behaviour according to the human ecology triangle model. There are different human behavioural factors that influence malaria. This includes dress code, treatment and preventive measures, and vector control measures as discussed below.

Dress code and hours of work in the garden.

Most people have poor dressing codes especially in the morning (6:00am) when going to the garden (because they feel garden clothes are supposed to be those that are dirty and torn, hence they see no need to wear clean and long sleeved clothes) and late in the evening when outside. (In the evening some do not wear protective clothes and sweaters because they do not own one and cannot afford). This has caused many to be bitten by mosquitoes which are also contributing to the malaria epidemic in Bududa district. People are rarely using

clothing's to cover their entire body. Body parts like the arm, legs, neck and head are exposed to mosquito bites. There is a higher risk of being bitten by mosquitoes when one dresses poorly. This has been a risk factor because many are not aware that dressing poorly when going to the garden in the morning exposes body parts to mosquito bites.

One of the female informants in her forties expressed that; "*Normally we go to the garden at 6:00 am. When we go to the banana plantations, sometimes we smear ourselves with mud trying to hit the mosquitoes. Sometimes we just laugh at the mosquitoes because they can be all over one's head and legs. Don't you look at my face how mosquitoes have bitten me? The surroundings especially the banana plantation, swamps and trees harbour mosquitoes. The bush around rivers like Tsutsu and Manafwa at the lower altitude of the Mountain harbour mosquitoes too".*

Due to the prevailing and increasing poverty situation, the people feel it is a must for them to go to the garden in the morning because if they don't dig, they will harvest less food that will not be enough to cater for members in the family. Since most families in Uganda including Bududa depend on agriculture for survival, they have to dig otherwise there are no better and simpler alternatives.

Treatment behaviour and protective measures.

Usually when people fall sick, they tend to seek medical attention late when in critical condition. Besides some malaria patients also have behaviour of fear and delay to take drugs, not because they don't want but maybe a natural fear since some people think all drugs are bitter. *Chloroquine* which has been and still used for malaria treatment is known to be very bitter. The local people end up not taking medicine in time, later resulting in fatalities. This can be discussed under the technology element from the human ecological triangle model. Local people tend to have different behaviours when it comes to health seeking, protective measures and treatment. The local people normally follow certain treatment behaviours when they feel ill. Many people associate fever and general body weakness to malaria. Usually the local people with their treatment experience and behaviour tend to perform self medication. Most of them visit the traditional healers before going to the hospital to seek for modern treatment (Refer to chapter six: 6.2.3 for information on traditional curative measures and malaria). The behaviour of delaying treatment and fear to take drugs are some of the risk factors to malaria.

Vector control and prevention behaviour.

Due to I don't care attitude and behaviour, many families do not burn garbage, dig rubbish pits, cover food stuff, clean drainage channels for water and slash nearby bushes around the houses. This poor vector control behaviour has always increased the breeding sites for the mosquitos in many homes in the three villages of the lower (Buwanabisi), middle (Bumakuma) and the higher (Bufukhula) altitude as broken bottles, plastic garbage seems to collect much water. The breeding of mosquitoes will continue even more with the increasing impacts of climate variability hence becoming a serious risk factor in influencing malaria.

Use of mosquito nets and repellants.

It is much easier to prevent malaria than it is to prevent various other diseases. One primary method that can be used to prevent malaria is to use mosquito nets and repellents. These nets are very useful to keep the mosquitoes away when the person is sleeping. Other than the time of sleeping, a person needs to protect him or herself from getting malaria by use of mosquito repellents. The covering of the exposed parts of the body when the person is going out door is very important. If any parts of the body are exposed, then it too can lead to the incidence of malaria. In principle, it is very easy to prevent malaria by taking certain simple precautions like using mosquito nets and mosquito repellents but because of poor human behaviour towards net and repellent use besides not affording, it is turning out to be an inadequate method.

In Bududa district, the lower altitude of Buwanabisi, middle altitude of Bumakuma and the upper altitude of Bufukhula, though people maybe lacking mosquito nets and repellants, those that have tend not to use. This is because some feel lazy to lay the net and some may have misplaced them in the house; hence fail to use them at the time of sleeping. Misplacement of nets happens but not often times. It happens when some families have washed clothes, moved to new homes. There are people also who completely do not like to use mosquito nets. According to informants, pregnant women and children below five years were given insecticide treated nets by Red cross organization but some do not use because they feel the nets will become old, hence keeping them in their packets. This behaviour of not making the best use of mosquito nets has made many to fall sick of malaria especially in the lower altitude which has high mosquito infestation. Besides their own behaviours of not using

the available nets and repellants, in Bududa district, repellants are cheap (1000 Ugandan shillings, equivalent to 0.04 USD) and can be used by many people (all household members) for a certain period of time. Most of the people in the three villages may buy the repellants but not use. Some people find it time wasting especially men to smear the mosquito repellants, hence end up not using.

In the higher altitude many do not use mosquito nets because mosquitoes are not there during cold days but those who use just like or feel one has to use a net while sleeping. They also hardly use repellants. In the lower altitude, though some people have the behaviour of feeling lazy and uncomfortable to use mosquito nets, many would want to use if they are available due to high mosquito breeding around homes to protect themselves from being attacked by malaria. Many local people in the study villages find it expensive to buy mosquito nets say for the whole family

In many vector-borne disease systems, human behaviour in general is a major and important factor due to the fact that it influences exposure to mosquito vectors and thus the transmission of pathogens. Human movement or migration has got different influences on disease dynamics at specific places and time (Stoddard et al., 2009).

CHAPTER SIX: LOCAL AWARENESS AND CORRESPONDING COPYING STRATEGIES TO CLIMATE VARIABILITY AND MALARIA.

6.1 INTRODUCTION.

This chapter gives information about informant's awareness levels and perceptions on the impacts of climate variability in influencing the spread of malaria. Awareness levels and perception helps the researchers, district and national local government authorities, health authorities to know local individual and community understanding and knowledge or awareness levels on how climate variability impacts is leading to the spread of malaria. This information therefore provides them with a basis on how and what should be done, including prevention and control strategies that can be implemented depending on the prevailing situation. Copying strategies to the impacts of climate variability influencing the spread of malaria will also be presented in this chapter. The copying strategies investigated catered for different levels ranging from individual, community and district or national.

Through the human ecology model under the cultural element, and belief systems, values and perceptions arise. It is through being aware on the impacts of climate variability that individuals and communities develop different perceptions. The different perceptions shape the way in which human beings choose to interact with their environment.

6.2 AWARENESS, PERCEPTIONS AND PRACTICES OF MALARIA.

6.2.1 Local awareness and malaria.

Concerning awareness about the association of malaria with climatic variation, most informants interviewed from all villages, thirty in number reported that they were aware of the relationship between malaria and climate factors. This was shown only in their understanding that malaria outbreaks occur during periods of drought or dry seasons which is often warm and also the availability of flooded and stagnant water after the rain has stopped. The informants stated that the stagnant and flooded water serves as breeding grounds for mosquitoes when temperature rises as already pointed out in chapter five. Ten informants out of forty from at least one of the three villages (Buwanabisi, Bumakuma and Bufukhula) were partly aware of the association between malaria and climatic factors. A woman in her early forties in the lower altitude village stated that; "*In the past, even though the level of awareness on malaria in relation to climate variability was lower than today, frequent*

sickness and death from malaria disease was unheard of. In case any death from malaria occurred, it was kind of a 'surprise' to the village people. It would be mainly in the lower altitude village that was somehow characterised with mosquito prevalence though not much like today".

According to the interview with key informants, it's to a large extent that (the key persons) are aware about the impacts of climate variability in influencing the spread of malaria. The Chairman Local Council Five Bududa district and one of the sub-county chief pointed out that according to the district plan, they intend to conduct sensitization programmes to create more awareness among the local communities and individuals who do not have much knowledge at least every month. Though some local communities and individuals are aware and partly aware of the possible association between climate variability and malaria, the level is low. The low level of awareness is attributed to low levels of education and sensitisation by the district authorities and the health officers. Bududa local health inspectors in the lower and higher altitude expressed that, they normally visit communities once a month and have education programmes through radios four times a year depending on government funding. If there is no funding, there may not be any sensitization programme. The herbalist in his forties in the lower altitude who was interviewed explained that he tries to create awareness about climate variation impacts in relation to malaria daily, weekly depending on his capacity due to the number of patients who visit him for treatment. From the higher altitude village of Bufukhula, the herbalist in her seventies stated that, she normally has chats with malaria patients hence in the process; she explains to them some of these impacts of climate variability that influences malaria. She has no time plans when to further educate the malaria patients. She educates only those patients who visit him. "*I (*traditional healer in the higher altitude village in her seventies*) normally tell the patients how they should recognise malaria in children and care for themselves to avoid mosquito bites".*

However, much as the awareness programmes is in plan as stated by the district authorities like Chairman Local Council Five and sensitization programmes conducted by some of the health officials, the district health inspector for Bududa, focal person in charge of malaria argued that, there is need to fill some essential knowledge gaps through increased level of awareness programmes, massive sensitization programmes and the need for further research in developing malaria vaccines.

6.2.2 Perceptions and malaria.

Local awareness and perceptions about malaria was gathered through individual interviews using an interview guide. According to the local people, malaria invaded the highland parts of the study area way back in 1990's. This has become a serious problem, particularly in Bududa district.

Temperature and rainfall.

Some informants from the three villages at different altitudes and health officials from Bududa district expressed that malaria was particularly serious towards the end of the rainy season and during the dry season when temperature rises. The district health officer for Bududa, focal person in charge of malaria further argued that high rainfall periods do not usually have many mosquitoes because breeding grounds are disturbed and washed away by the heavy rain. Rainy periods usually are cooler periods of the year, the mosquito population increases significantly as temperature increases after the rains. The high malaria prevalence during this time can be linked to the fact that dry seasons are often warm, a factor that suits the high incidence of malaria mosquitoes.

A considerable increase in temperature in the highlands of up to $0.6^{o}C$ has been observed hence enabling malaria vector mosquitoes to find new habitats in the highlands; the mosquitoes find new habitats in the highlands, all resulting into increased malaria cases in higher altitudes like those of Bududa district (Wandiga et al., 2010).

Malaria outbreaks are sensitive to maximum temperature. This can be noticed when one compares the maximum temperature in 2010 (refer to chapter 4, temperature graph for Bududa and Bududa district annual malaria cases in 2010 as reported by Bududa local government hospital). Climate variability is occurring on a warmer mean climate state, leading to a higher net temperature that would otherwise not occur in the absence of a general climate variation. It seems that there are possibilities of epidemics increasing from the usual 2-3 months to 4-6 months, as has been observed in Kabale, Uganda. Such conditions lead to very high mortality and morbidity rates of malaria. The highlands are warming at an alarming rate as compared to the lowlands, and this has an important effect on malaria transmission and spread. It further proves that either the maximum or minimum temperature is rising in the highlands. The observed temperature increase has enabled malaria vector mosquitoes to find new habitats in the highlands hence resulting into high rates of malaria disease in the highland areas and communities of East Africa (Wandiga et al., 2010).

The local and district health officers of Bududa district stated that mosquitoes would only breed in stagnant water. "*Mosquitoes breed in water that is not flowing"* (Werner et al., 2004:187). It was unlikely that people living close to flowing local rivers like Tsutsu and Manafwa suffered from malaria. Some female informants in the lower altitude reported that mosquitoes breed in hollows, solid waste, vegetation, particularly in banana leaves that trap and accumulate sufficient water where mosquito would lay eggs and breed.

During individual interviews and informal discussions in the three villages, fever was reported as the most common symptom of malaria, especially in children who are always moving and playing everywhere even during rainy seasons at any time. A woman in lower altitude of Buwanabisi village in her early forties states; "*oh my God children, they cannot be controlled, they move from place to place, by the time they come back home, they are feeling so cold and shivering".*

In Bududa district, flooding has increased the rate of diseases like malaria, cholera, and typhoid fever especially in the lower slope. In the higher altitude village, some informants stated that, with the great variation in climate where rainfall is so heavy, they feel there is nothing to do; *it is only God who knows*. Though some informants in the lower altitude village suggested that the people in the upper slope need to be resettled in the lower slope to be saved from landslides and soil erosion, some informants in the higher altitude stated that, people who were born and those who have lived in the higher altitude village are reluctant to migrate or be relocated to another village in spite of the landslides and soil erosion. One of the female informants aged between 30-45 years in the lower altitude stated that:*"With this kind of heavy and unexpected rainfall, people are living in fear and they normally tell their children that when the situation continues, what will happen, we have no option apart from enduring and waiting for death".* Another informant in the lower altitude in his forties also expresses; "*we are preparing for death, I feel the world is ending".*

With this view, one notes that the variation in rainfall pattern has become more destructive than before. This has made many people helpless with a belief that even if they are to work hard say with agricultural activities (backbone activity that many depend on for livelihood and income), there is no hope for high yield. This therefore keeps many in poverty that when attacked by malaria disease are unable to provide or get the necessary items like treatment, balanced and enough food, and mosquito nets. The local people feel even if they try their

level best, the same thing will continue. Hence expressing a sign of helplessness and resignation ready to face and live with the consequences

Figure 6.1: Heavy rains caused the landslide in Bududa district, Uganda.

(BBC News, 2010).

Figure 6.2: Red Cross volunteers and community members identifying the bodies of persons killed as a result of landslide.

Source ;(International federation of Red Cross and Red Crescent societies, 2010).

According to the local communities in all the villages, they think and feel the severity of malaria in the three villages from lower, middle and higher altitudes is not only attributed to climatic factors. Among other factors, social and built environment factors, human behaviour like poor and late treatment seeking, poor vector control measures, population factors like age

and gender where children, elderly and pregnant women have low immune system to resist malaria are all contributing to malaria spread.

Gender and age

Most informants in the lower altitude had a view that women (especially pregnant women) and children are the most vulnerable to mosquito bites as compared to men. This is because women and children are the ones ever working in the gardens early in the morning. They also go to sleep much earlier in the evening yet during this evening time mosquitoes are so active. When the women and children sleep without mosquito nets, they cannot easily protect themselves. This happens in families where nets are not available. In some poor households where children are not cared for, men or husband and wife use the available mosquito nets. The researcher explains: some poor families in Africa, men take themselves as heads of families who deserve respect, so instead of letting the children use the few available nets, they instead use. However, the informants reported that men spend much of their time in the evenings in the local drinking joints and pubs in Bududa town centre and some homesteads, hence come home late in the night. Late in the night, the men have low exposure to mosquito bites. This also partly explains why the men especially in the lower altitude where mosquito prevalence is high are less vulnerable to malaria. Men not going to the garden and banana plantations in the morning, also make them less exposed to mosquito bites. Many households and families too stated that they were unable to buy mosquito nets that are enough for all family members, insecticide and repellents like coil. With the repellents, some families can afford to buy but becomes expensive in the long run, hence getting exposed to mosquito bites.

Poverty as a distal risk factor and malaria.

Individuals and local communities also attributed malaria to poverty. This is because poverty has made many families not to afford mosquito nets and repellents, proper clothing, proper treatment in time and eat good balanced diet. This has therefore made many people weak and vulnerable to malaria and other diseases like typhoid fever, diarrheal and cholera. The pregnant women and the elderly were cited as most vulnerable too, to the conditions brought about by poverty. This is because they lack the energy to fully get involved in constructive activities that can earn them income and a living.

Climatic variability induces poverty through landslides, soil erosion which create place poverty in terms of resources and environmental degradation in the area. This affects

cultivation, cause damages to houses and infrastructures, extra time used to repair effects of soil erosion that could have been used for cultivation alternatively. Poverty is in a way the cause of many causes like risk behaviour and poor housing.

Most of the informants had strong feeling that poverty is contributing a lot to malaria and even worsening the situation.

6.2.3 Local practices and malaria.

During individual interviews with the local communities, several view points were raised concerning ways in which malaria can be controlled or treated. A woman in her forties from the lower altitude stated that; there is an increasing use of mosquito nets and repellents to protect against mosquito bites. This increase is mostly in the lower altitude and part of the middle altitude villages which are suffering a lot from high rates of mosquitoes. On the other hand, informants especially in the lower altitude village argued that not many people are able to buy mosquito nets for all the family members. Some informants also expressed their views that some people even when they have nets, they have behaviour of not making the best use of these nets. Even some pregnant women, children and elders who were given nets by Red Cross organization have never used. This is because they fear that the nets will get old hence keeping for 'special' circumstances. A woman in her forties stated that; "*some people still have these nets sealed in the distributed packets"*. Other people in the study area especially the lower altitude village believe that malaria is a normal and everyday sickness that cannot be prevented; hence saying statements like *we live with it every day so it is still only God who knows*. Since many have a belief that malaria cannot be prevented and it is a normal everyday sickness, they end up having 'I don't care attitude' and poor behaviours towards protecting themselves from mosquito bites and malaria control. It is only when one is attacked by malaria that one goes for medication which is usually delayed. It is well known that malaria can be prevented; thus, the local perception among the informants in the three different villages regarding malaria makes one to think that the local people have little awareness and knowledge about malaria disease.

Traditional curative measures and malaria.

Many people in the three sampled villages use traditional curative measures (like local herbs)

to treat malaria rather than going to hospitals for modern medicine. Most of the informants argued that almost all the malaria patients are cured after using these traditional medicines. One of the signs that the local herbs are effective is when he or she starts diahrreting. Some of the examples of plants mentioned as malaria cures of varying efficacy include; *Nalongo, omululuza, ekigai, and omubirizi* (all in Luganda language, spoken by most people in Uganda) among others. These local herbs are taken orally. The researcher noted that in Bududa district, there are several traditional herbalists and the local community people believed so much in their performance as regards to treatment of diseases including malaria. According to the traditional healer from the higher altitude village of Bufukhula, the majority of the people living in the rural areas of Bududa district including Buwanabisi, Bumakuma, and Bufukhula believed and depended on their local herbs for their primary health care in treating different diseases and some relied entirely on herbal remedies in the treatment of malaria. There are different views among individuals and members of the local community regarding belief in that traditional healers know the symptoms of malaria hence give treatment to those who are actually suffering from the disease.

The traditional healers interviewed from both the lower and higher altitude villages of Buwanabisi and Bufukhula argued that most of the cases in the hospital are now malaria; there are many patients. The herbalists (traditional healers) keep sensitizing those who contact them for malaria treatment. This therefore means that the traditional healers also play an important role as far as educating and raising awareness about malaria and risk factors are concerned. Most malaria patients visit them for first aid before going to the hospital and health care centres. Some of the explanations given for visiting the traditional healers for local herbs to treat malaria included; they are always available, the patient does not need to wait by following a long line of people to get treatment. The traditional healers are many, about 5 to 15 in each village. They are well known, and familiar to most people, they are also less expensive as compared to the hospital; pregnant women using these herbs do not complain nor encounter problems during and after giving birth.

Many people, especially in the rural areas make the best use of the services of traditional healers because they are more accessible and less expensive. Traditional medicines are commonly used during pregnancy and birth in Uganda. The use of traditional medicine has so far been there for quite a long time and partly still continues due to inadequate modern medical services and inadequate drugs in health centres and hospitals (Twinomugisha, 2008).

From figures below (6.3 and 6.4), it's noted that the traditional healers have different kinds of herbs and traditional medicine, and equipments for treatment of different diseases including malaria and some difficult life and health problems as seen below.

Figure 6.3: Traditional healer from the lower altitude.

Source: Field data, July 2011.

Figure 6.4: Traditional healer from the higher altitude.

Source: Field work, July 2011.

Figure 6.5: One of the malaria treatment herbs.

Source: Field work, July 2011.

6.3 COPYING STRATEGIES TO CLIMATE VARIABILITY IN RELATION TO MALARIA.

According to the illustration below, the adaptive strategies to cope with the impacts of climate variability was classified in two ways; this include: types (*adaptation*, *acceptance* and *migration*), and levels (*individual*, *community* and *national*). Within each type of strategy, different actions in relation to the human ecological model elements of population, behaviour and environment adopted by Meade and Emch (2010) will be discussed. These actions or voices were based at different levels or scales ranging from the individual and, community levels of organisation, district and national levels as presented below.

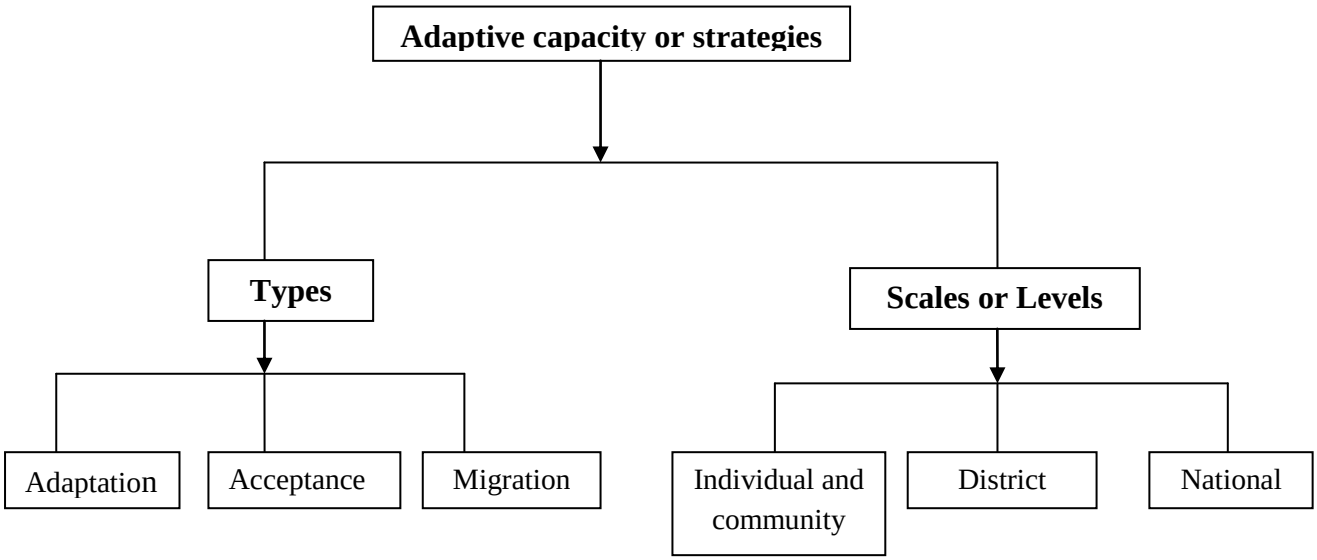

Figure 6.6: Illustrates different classification of adaptation strategies.

6.3.1 ADAPTATION AND ACTIVE ADJUSTMENTS.

Adaptation refers to a kind of strategy either in natural or human system to cope with the real or anticipated climatic effects, which makes use of opportunities or controls (Burton et al., 2002). As pointed out in the illustration above, adaptative capacity or strategies can be assessed at a range of scales from the individual household and community levels of organisation, district to national assessments to climate induced health hazards like malaria. The focus here is at individual and community, district and national levels.

Individual and community level.

During interviews different ways of adapting to the impacts of climate variability influencing malaria spread was mentioned and explained by individuals in the local community. Most of the informants who explained the adaptation strategies well were those who stated that they were aware of the association between climate variability and malaria. These were at least educated individuals, among were a university graduate and some diploma and certificate holders. Most of the individuals who seemed to be at least aware were from the lower altitude and part of the middle altitude villages of Buwanabisi and Bumakuma respectively. The informants stated that, households are trying to protect the family population especially the most vulnerable considering age and gender which children and pregnant women are among. The children and pregnant women who have low immune system are being protected by not allowing them to work for long and at awkward hours outside when the mosquitoes can bite and in risky places like flooded, bushy areas, and any place where there is high mosquito breeding. As individuals, though they lack insecticide treated mosquito nets, those who own at least one are changing their behaviour by making the best use at night to protect themselves from mosquito bites, maintaining hygiene like disposing solid wastes in the right place distant from the home compound. Some members of the focused group in the lower altitude village stated that; "*some people in this village are so dirty that even if mosquitoes were not there, they will start breeding. Look at the woman near that water point, she is so dirty. She throws rubbish and pours water anywhere in the compound with pigs and cows droppings everywhere in the compound. The health officers need to talk to that lady". "She sells molokony (cooked meat from a cow's leg) and people buy all".*

Other suggestions included the need to slash the compound to avoid mosquito breeding during warm seasons, getting tested for malaria and after get early treatment. The majority of the local people visit the traditional healers for primary health care and some of them prefer using local herbs for malaria treatment. The researcher therefore concludes that the use of mosquito nets to avoid mosquito bites and use of local herbs has become one of the main local individual's adaptation strategies in treating malaria since it is affordable. Modern medical treatment, though an effective adaptation method, is out of reach of most households due to cost and distance to the nearest health centre. The higher and middle altitude villages are far from Bududa local government hospital and the health centres too. It is only the lower altitude population that easily access the hospital services because it is nearer and part of Bududa town. Individuals are also modifying habitats like the physical environment, housing,

and places that harbour stagnant water. Modification of habitats is being done by the communities and individuals through planting eucalyptus trees that can help in draining away the flooded water and protect houses from being destroyed by the strong rain. The eucalyptus trees are distributed by organisations like National forestry authority (NFA), and Forest initiative for the community (FIFOC). However, the eucalyptus trees have got some side effects like hardening the soil and lowering its fertility. With time the soil colour is even changed to brown indicating low soil fertility which is even hard to cultivate. This side effect of eucalyptus trees on soil doesn't allow those who own land in the flooded areas to cultivate crops, hence end up using a small piece of land if available. This too contributes to low food production and income. An informant in the lower altitude village of Buwanabisi in his late forties stated that to cope with the impacts, the government needs to help them more; "*they should really help us and give us money, we are so poor that we cannot manage to do anything"*.

Though population and environmental ways of adapting to the impacts of climate variability applies to the individuals and community levels too, individual and collective change in behaviour through taking action to reduce risks of exposure to malaria seem to be more suitable and effective.

District level.

At the district and regional level, local government and non-governmental organisations like Red Cross have provided the most vulnerable population like the children and pregnant women with mosquito nets that can protect them from mosquito bites. Food, shelter and clothing is also being given to the local people especially the population at the higher slope who are suffering from the effects of landslides resulting from heavy rainfall. The food, shelter and clothing provided help them fight against malaria in case they are attacked. The people at the higher altitude have low immune system in that when they move to the lower slope to resettle, carryout some activities and search for jobs, they can easily be attacked by malaria.

To change bad human behaviours at the individual and community levels, the district, and regional authorities are providing sensitization programmes and awareness campaigns on health issues and climate variability through radios and community visits especially when there is funding. The awareness campaigns are conducted by the district health officers as part of their jobs, organisations like Red Cross who are known by most of the people, hospital staff and traditional healers. The doctors, nurses and traditional healers educate patients

mostly when they visit them for treatment. The major issues covered during the awareness campaigns are mainly concerned with protection against mosquito bites and how to control mosquito vectors around homesteads. Some of the pieces of advice during campaigns include; sleep under mosquito nets, maintain sanitation and hygiene by slashing the bushy compounds where mosquitoes could easily breed, dress up well and children too during cold weather, stop children from playing in stagnant water, be weather prepared and dig channels that can drain away stagnant water. This campaign, though still to a small extent, is helping to make the local communities aware about the impacts of heavy rainfall and high temperature as climate factors that can be suitable for mosquito breeding. The campaign also helps them to know the risky behaviours make one fall sick of malaria and other factors like gender and age under population element within the human ecological model. Encourage the people especially those at the lower slope to plant trees like eucalyptus along the slope to drain away the flooded water. The eucalyptus trees are very inexpensive besides being distributed for free to the local people. The trees therefore offer protection to the physical and built environment and help the lower altitude population where flooding is always taking place. However, the eucalyptus trees have some side effects (refer to individual and community copying strategies above).

National level.

Since Bududa is a new district, there are no organised plans and adaptation strategies to cope with the impacts resulting from climate variability. This is due to lack of national financial support. However, sensitisation and awareness campaigns are provided through local government officials at the district but still to a small extent. This campaign is mainly to help in changing behaviour and regulate actions that may bring about changes in the natural environment like deforestation, draining wetlands that are contributing to the variation in climate being experienced today.

All in all, malaria preventive and curative programs carried out by governments majorly depend on external sources of assistance like through Non-governmental organizations whose long-term sustainability or operation is not guaranteed. Therefore, the capacity of the local people to develop adaptive strategies to cope with climate variations and extremes is still very low, at all levels, hence remaining a big challenge.

6.3.2 ACCEPTANCE OR RESIGNATION.

This is a state where local individual, communities and the government either accept or resign from suffering with the impacts of climate variability in relation to malaria. If the individual accept to live with the impact of the varying climate, then he or she has to adjust accordingly to be able to live. Or else if the individuals or communities have not decided to resign, then they have to migrate as the next copying strategy.

In Bududa district including the villages of Buwanabisi, Bumakuma and Bufukhula, at the individual and community level, individuals have tried to take actions as mentioned above (refer to individuals and communities under adaptation type of strategy above). The government and non-governmental organisations too have provided measures (refer to district level under adaptation type of strategy above) to help individuals and communities live and survive since they have accepted to suffer with such impacts.

As a way of coping with the impacts of climate variability in influencing malaria, the young children and the elderly (old) accept to live in the three villages affected. This is because they feel they do not have any option due to the low capacity in terms of finance and energy. This also explains why the young children and the elderly were often times mentioned among the most vulnerable groups of people in all the three villages. The population that has chosen to live also feel they cannot change behaviour because of the prevailing impacts of climate variability. The failure to change behaviour is not because they do not want. The people feel changing behaviour cannot change the situation that is resulting from the impacts of climate variability hence resigning with statements like "*there is nothing that we can do, even if we change our behaviours, it will not change the situation. It is only God who knows. We wish the government could do something for us".* As regards the affected environment, the people accept that there are ponds, stagnant water and flooded areas though mainly in the lower altitude village. They just accept the environment with all the consequences since they do not see any way out for themselves. More resignation seems to occur in the lower than the upper area though the elderly also resigned in the upper area. In this environment situation, much as they drain away the stagnant water, ponds and flooded areas that harbour the mosquitoes, the variation in climate that brings about heavy rainfall will still create new habitats that can serve as breeding grounds for mosquitoes and any slight rise in temperature will increase the breeding rates of mosquitoes. One of the informants in the middle altitude in his late forties states; *we are used to death, it is not new. We have to bear with all this situations. No one can*

stop nor control this heavy rain, even the traditional healers with their magic cannot though they usually deceive people that they can make rain to fall.

6.3.3 MIGRATION.

Due to the constant effects of climate variability in the spread of malaria, heavy rain destroying homes and shelters, some local individuals and communities from the villages of Buwanabisi, Bumakuma and Bufukhula who feel they cannot adapt to these conditions have been forced to abandon their traditional homelands for more accommodating environments and nearby districts like Tororo, Mbale town to seek shelter, and livelihoods. This migration for some individuals and families is either temporary or permanent depending on one's social-economic status and feeling. The factors for migration are both pull factors and push factors. Pull factors include better standard of living, employment opportunities, entertainments, available and accessible social services. push factors especially among the youth include those factors from the home village like landslides, soil erosion that always wash the soil and crops leading to low crop yield. Since most of the families in Uganda including villages of Buwanabisi, Bumakuma and Bufukhula depend on agriculture for income and survival, once the soil is infertile and crops washed, poverty and famine results in. Besides the mentioned diseases like malaria resulting from the impacts of climate variability, it has also forced or pushed many out of the study district Bududa to places that do not harbour too much mosquitoes like the lower altitude of neighbouring districts. According to a woman in her late thirties in the lower altitude village, "*there are some people who have migrated to the higher altitude village due to the fact that there are no flooded areas that harbour mosquitoes"*. Many informants from the higher altitude village of Bufukhula stated that there are people who cannot accept to leave their original or traditional homes, however much the variation in climate is causing deadly impacts from the landslides experienced. The decision to migrate is taken at the individual level as a way of coping with the prevailing impacts of climate variability that can directly lead to the spread of diseases like malaria, cholera, typhoid fever. And indirectly through events like landslides, destruction of houses and soil erosion that leads to low crop production and costs of rebuilding houses hence affecting income levels yet they are already poor.

As a strategy to cope with the impacts of the varying climate, at the district and national level, local government is trying and continuing to provide incentives like land, temporary

houses, food, clothing and medical treatment to help the individuals and family resettle either in the lower slope for those who do not want to move out of Bududa district or any other nearby districts where the government can find free land like Manafwa and Butaleja districts

Migration can become quite challenging for individuals who have low income and lack necessary items to start a new living. The incentives offered by the government like land, temporary houses, food, clothing and medical treatment to resettle are not enough to cater for all needs. Besides getting used to the new place may also be a challenge. An elderly man in the middle altitude explains; *oh it is not easy to leave our original homes for a new place because life in the new place can be very difficult. Here in Bududa we are used to at least the cool weather and our soil is fertile though it is being destroyed by the heavy rain through soil erosion. Nakasongola where the government wants us to migrate to, is horrible.....hahaha.* Usually many people who migrate to different places to settle tend to carry some customs and behaviours to the new place yet they may not be suitable for healthy living. For example a behaviour that may be protective in the area of origin maybe harmful in the new place. A good example is *geophagy*, the practice of eating earth. This practice is common in Africa where pregnant women eat earth formed into moulds and sold in the markets. This earth usually has some nutrients that one may not be able to get from cooked food. Mobility to another area may not correspond with custom in the area of origin (Meade & Emch, 2010). In Bududa an example can be seen from a person who may have migrated from the lower altitude village of Buwanabisi, he or she may start planting eucalyptus trees yet there are no floods. It could be in a dry flat land. This practise and behaviour will be harmful to the soil by making it infertile thereby affecting one in terms of fertile land and crop yield which maybe poor and reduced.

Permanent versus temporary migration.

Migration to and from the three study villages or outside the study district can either be permanent or temporary. Most of the people who move away from the villages of Buwanabisi, Bumakuma and Bufukhula villages of Bududa district move due to push factors as explained. The people in the upper village usually move due to push factors like soil erosion, lack of land, damage of houses resulting from landslides. They either move to the lower village or outside the study district. However, those from the lower altitude village migrate due to flooding, swampy areas that result into a strong increase in mosquito and malaria risk.

Usually the whole household do not migrate, it is mostly the youth. As already mentioned, the elders and children have low capacity financially and energy wise. Some of the rich households can also decide to all migrate because they can buy land somewhere else outside the district and live comfortably. The youth when they migrate, they get involved in any activity and jobs that can earn them income and a living. When the whole household migrate after buying land somewhere else, they can live in the new place permanently and just come to visit the grandparents who may have not accepted to move with them. When the grandparents migrate with all the household members, they can decide to live permanently and not return to the study villages of Bududa district (original home district). The youth who migrate due to push factors like landslides, soil erosion, flooding and diseases like malaria live temporary outside the study district of Bududa. When the situation in the villages of Buwanabisi, Bumakuma and Bufukhula improves and normalises they go back to the villages or buy land in the district town of Bududa (study district) and get settled. Some households with low income may also migrate because of the prevailing situation but live temporary because they are unable to afford many basic needs. Life in the new place too may be much expensive and not convenient like the area or village of origin.

There is more migration from the higher altitude village of Bufukhula than the lower especially among the youth. This is because of soil erosion and landslide that claims lives and destroys properties, houses, infrastructures and crops grown.

CHAPTER SEVEN: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS.

7.1. INTRODUCTION.

In this chapter, summary of the findings, conclusions and recommendations are presented. The summary presented is from the empirical findings in chapter five and six corresponding to the objectives and research questions investigated during the field study. The two empirical chapters illustrate diversity about climate variability in relation to malaria spread in the villages of Buwanabisi (lower altitude of 1400m above sea level), Bumakuma (middle altitude of 2000m above sea level), and Bufukhula (higher altitude of 2500m above sea level) in Bududa district. Altitude is important in determining the climate especially the temperature of a particular area. It sets limits for mosquitoes and parasite growth and development. The general conclusions are presented as well as recommendations according to the researcher's interaction with the local people regarding the impacts of climate variability on malaria spread are also discussed.

7.2. SUMMARY OF FINDINGS.

The study focused on how climate variability has influenced malaria epidemic in three villages of Bududa district around the highlands of Mount Elgon. The villages included; Buwanabisi, Bumakuma, and Bufukhula. It also explored people's awareness of the possible association between climate variability and malaria, and corresponding copying strategies in their communities.

The study was based on the theoretical and analytical framework of human disease ecology model adopted by (Meade & Earickson, 2000; Meade & Emch, 2010). Concepts of risk factor, causes of climate variability, climate change and health, controlling and preventing malaria were employed. Besides the specific objectives above, the study also attempted to find out the most vulnerable categories of people to the impacts of climate variability in relation to malaria.

The first of the specific objectives to be studied *was to explore certain impacts of climate variability influencing malaria epidemic.* Two research questions were employed for this objective. H*ow does the variation in temperature and rainfall influence malaria epidemic?* The second question was *what are the environment, population and behavioural risk factors influencing the spread of malaria?* This research question investigates the role of other types of risk factors influencing malaria spread. As pointed out in chapter five, these risk factors do

not work in isolation; they interact. This makes it difficult to solely focus on one element of the model.

The second specific objective of the study was *to explore people's awareness of the possible association between climate variability and malaria, and corresponding copying strategies in their communities.* Under this objective, there are two research questions. The first research question was; *what are the informant's awareness levels and perceptions on the impacts of climate variability in relation to malaria?* This research question explores the informant's views and local practices as regards climate variability and malaria, other risk factors, prevention and the cure of malaria disease, and copying strategies to the impacts of climate variability. The second research question was *what are the copying strategies to control the impacts of climate variability in relation to malaria epidemic?* The last question tries to find out what the individuals, local communities and the district authorities are doing to cope with the prevailing impacts of climate variability.

7.2.1 Temperature and rainfall factors.

Rainfall plays the most important role in influencing malaria epidemic both directly and indirectly, though the rise in temperature also contributes. Directly it has created many breeding grounds and sites for mosquitoes and indirectly, strong and more concentrated rains have induced landslides, erosion and degradation of the soil and fields in the higher altitude villages. The effects of heavy showers compared to the continuous drizzling effects of rainfall definitely influence the harmful effects of rainfall run-off. These effects are not captured in the daily statistics showing rainfall for the whole day. All these impacts of climate variability influencing deterioration of the soil and degradation of cultivated land have indirect impacts on the prevalence of malaria. They force some people to leave the higher altitude village of Bufukhula to the lower altitude village of Buwanabisi either to settle or look for work, entertainment, or access some social services like health centres and schools. The lower altitude village is infected with high mosquito vectors and the people from the higher altitude having lower protection from their immune system are more attacked by malaria.

Climate variability plays an important role, in that seasonal weather and climatic conditions indicated through heavy rainfall and high temperature have been varying, hence increased susceptibility to diseases like malaria.

Findings reveal that malaria epidemics have increased in areas originally considered malaria-free zones like the higher altitude village of Bufukhula. This shows that there have been

variations in climatic conditions especially temperature, which have enabled mosquitoes to find suitable habitats in areas that historically did not face malaria risk. This has resulted in climate variability-induced malaria. The population in this high altitude is vulnerable due to low immunity. The change in temperature in recent years has also played a role in the breeding and survival of mosquitoes. This partly explains the reason why the population at the higher altitude is now affected with malaria epidemic. In 2010, the minimum temperature was ranging between 14-16^{o}C and maximum temperature ranging between 30-33^{o}C.

In the lower altitude village all age groups are at equal risk of being attacked by malaria. This is because of the (increasing) breeding of mosquitoes which bites at anytime in the evening and early morning when they go to the gardens and banana plantations. In Bududa in the past the cycles of epidemics seem to suggest an epidemiological transition from lower to higher malaria endemicity which may be associated with climate variation.

7.2.2 Built and social environment, population and behavioural risk factors influencing the spread of malaria.

The apparently worsening and increasing malaria situation in Bududa district including villages of Buwanabisi in the lower altitude, Bumakuma in the middle altitude and Bufukhula in the higher altitude should not only be attributed to climate variability. Other factors like social and built environmental factors, human behavioural factors such as late treatment seeking behaviour, poor dressing code and poor vector control measures and population factors of age and gender contribute significantly.

Though several risk factors were cited by the local communities as contributors to malaria spread, poverty as an important indirect and underlying factor due to the variability in climate is caused by the effects of landslides, soil erosion and land degradation that influence cropping and farming possibilities. The indirect effects of landslides, soil erosion and land degradation has brought about displacement of people, destruction of crops, and low crop yield. Poverty as a risk factor was the most mentioned and emphasised by the informants. Most of the families in the villages of Buwanabisi, Bumakuma and Bufukhula cannot afford mosquito nets, have access to modern medication, and restricted opportunities for eating balanced and nutritious food, and construct good and protective houses. When a household is poor, it is more vulnerable to malaria disease than the rich because rich households possess more control, they can prevent malaria or protect themselves in several ways for example, they can decide to move to a better place to resettle themselves, buy bed nets and repellants.

It is difficult for one to judge poverty as uniform in all the three study villages. However, because of landslides and soil erosion, people's homes are demolished, fertile soils washed away and crops destroyed. The higher altitude village, followed by the middle altitude village can be judged as being more affected in terms of poverty than the lower. The lower is not so much affected by poverty as compared to the two upper villages because the soil in the lower altitude village is fertile that when crops are grown, there is at least high yield. What may limit the people in the lower altitude village is land. Since some people have got very small pieces of land that they only grow crops for home consumption. This still makes such households poor and unable to afford other basic needs and protect themselves against diseases like malaria.

7.2.3 Informant's awareness levels and perceptions on the impacts of climate variability in relation to malaria.

Generally, there are low levels of awareness on issues of climate variability and health including malaria in the villages of Buwanabisi, Bumakuma and Bufukhula as well as the whole of Bududa district. The low level of awareness in all the three villages is attributed to low levels of education and sensitisation by the district authorities and the health officers. In terms of awareness levels, there is more low level among the local population in the higher altitude village (Bufukhula). This is due to the fact that they are not accustomed to handle the mosquito problem. They have less experience in handling association between malaria and the mosquito vector.

It is the perception of individuals and families in the study area that malaria is normal and everyday disease that cannot be prevented hence causing high rate of mortality today. This perception has resulted into powerlessness or apathy reigns which have made many local people to give up in protecting themselves from mosquito bites and feel malaria cannot be prevented with the poverty levels brought.

Perception of other risk factors like social and built environment, population and behaviour was different. This is because some informants did not mention the risk factors related to either social and built environment, population and behaviour due to lack of awareness. They did not imagine that these elements can be risk factors but after probing later on during informal discussions, their response was the same. Perceptions about the severity of malaria in the lower altitude were similar among individuals and community members of the lower

altitude village. The informants at the higher altitude are kind of surprised that there are more malaria cases in the higher altitude village today than in the past.

7.2.4 Strategies to cope with the impacts of climate variability and malaria spread.

Different types of strategies have been adopted. They include: *adaptation and active adjustments, acceptanc*e and *migration* at different levels ranging from individual and community, district and national with some actions employed. Although some individuals and communities, district and the national authorities have tried to carry out some activities and take actions that can help to cope with the impacts of climate variability, they are limited. Individuals copying strategy is some kind of treatment given by traditional healer for cure and care for malaria and bed nets to avoid mosquito bites. Some social groups among the communities in the lower altitude are trying to cope by planting eucalyptus trees to drain the flooded area that harbours mosquitoes. Some local people have accepted to live with the impacts of climate variability in the villages because they have no option, for example the elders. Others especially the youth and a few able bodied persons have decided to migrate either temporarily or permanently rather than suffer with the impacts of climate variability that ends up causing malaria. Other than carrying out some sensitisation programmes to create awareness among the local people in the three study villages as well as Bududa district, Bududa district and national authorities that needed to contribute more for the local communities have given much response to the risks and threats caused by climate variability in relation to malaria. This is because of limited economic resources and equipment and expertise to cope with malaria epidemics and other emergencies resulting from the severe impacts of climate variability, like landslides which have made some people in the higher altitude to shift to other places including the lower altitude village of Buwanabisi. The major constraint mentioned in solving health impacts of climate variability included lack of and inadequate awareness, limited and poor health infrastructure including working facilities, poverty and limited numbers of health workers both at the district and the hospital level.

7.3 MOST VULNERABLE GROUPS TO THE IMPACTS OF CLIMATE VARIABILITY.

Response from local individuals and communities indicated that the most affected population groups by malaria disease are children under five years, pregnant women, and the elderly. The children, pregnant women and the elderly are vulnerable because they have low immune

system. Children below five years contribute to a larger percentage of death cases from malaria disease.

They are also not engaged in constructive or developmental projects like agriculture, businesses that may involve moving from place to place and in activities that could reduce mosquito vectors like slashing the compound, draining away stagnant water with in the living environment. These categories of people are already weak, hence need the help of those who are strong and have the capacity to be able to change behaviour that exposes them to malaria. For example, the children need to be left to sleep under the mosquito nets and also should be dressed well when outside in the evening hours and any other time when the mosquitoes are active. They shouldn't be exposed out or in risky environments like swampy, bushy areas where mosquito's always inhabit for long.

7.4 SOME LIMITATIONS ENCOUNTERED DURING FIELDWORK.

7.4.1 Primary data

During my fieldwork study, there were problems encountered with both primary and secondary data collection either directly or indirectly.

The study was limited by bad weather. It was always rainy in the afternoon hours and sunny in the morning.

Language was a problem whenever the local language (Lugishu) was used in clarifying issues and making questions clear.

Funding to facilitate movement, food and necessary materials to aid research was not enough hence partly compromising the quality in terms of the amount of time spent with informants.

During the study also, the informants had high expectations of being rewarded in terms of money after giving out the necessary information.

7.4.2 Secondary data.

I was not fully contented with the secondary data especially those that involved figures like rainfall figures from the year 2005 to 2010. The figures seemed to be forged.

7.5 MOST IMPORTANT FINDING.

One of the most important finding to the researcher was malaria invading the population living in higher altitude of Bufukhula due to population movement to and from the lower altitude village of Buwanabisi, which is highly infected with mosquitoes. This risk factor of population movement is surprising because the researcher did not imagine the mechanisms of heavy rainfall leading to landslides, soil erosion and loss of land with following migration to highly exposed mosquito areas. The researcher after critically analyzing later, concluded that population movement is one of the major cause of malaria in the higher altitude villages like Bufukhula. When people move to and from the lower village, they are easily bitten by mosquitoes along the way in wetlands, hollows and bushes. The affected individuals later go back to the higher altitude village; any temperature rise that can favour mosquito breeding will make the mosquito to be available. The moment the mosquito bites an individual affected with malaria and bites those that weren't bitten by the mosquitoes. The cycle continues, hence transmitting the malaria parasite.

7.5 CONCLUSION.

In conclusion it is clear that malaria epidemics are one of the serious health problems affecting people in the study area. Climate variability through its temperature and rainfall factors in terms of heavy showers is responsible for major malaria epidemics. *Directly* it influences the breeding grounds for mosquito vectors and *indirectly* it is causing landslides and soil erosion which has led to low crop production and at the same time displacement of people. These indirect effects of landslides and soil erosion have forced many to leave their original home areas in the higher altitude village of Buwanabisi and middle altitude village of Bumakuma to the lower altitude village which is characterised by high mosquito prevalence. This movement of people has become more frequent and common because of the need to access arable, fertile land as well as access to certain services like entertainment, schools, health centres since the main Bududa hospital is located in the lower slope. Landslides and soil erosion too is reducing the cultivation possibilities in the higher village.

Besides climatic factors, other risk factors in the built and social environment, behaviour and population are also influencing the spread of malaria. The human ecology model and field findings, give support to the different factors contributing to the spread of malaria disease differently at the three altitudes of the Mountain. The effect of climatic factors in the spread

of malaria is more felt in the lower altitude as compared to the higher and middle altitude. This is because the lower altitude harbours more mosquitoes from the stagnant water, wetlands and vegetation around homes. The lower altitude normally also has warmer temperature compared to the higher altitude where temperature is usually low critical for the survival of mosquitoes. The warm temperature plays a more paramount role in the development of mosquitoes in the lower slope than the middle and the higher altitude villages due to the general fall in temperature by height.

The higher altitude population that was not used to suffering from malaria disease due to low temperature critical for mosquito breeding in the past like from the year 2000 backwards have been now affected. This is because of the seasonal variations in climate that brings temperature suitable for mosquito breeding. Besides the rise in temperature, the movement of people to the lower slope that is more invaded by mosquitoes was also a factor mentioned to be increasing malaria prevalence in the higher altitude. However, less people in the higher altitude village of Bufukhula would have been affected if soil erosion, landslide conditions wasn't there. Due to recurrent extreme events, they are forced to leave the area. Poverty is an underlying risk factor, both in the lower and the upper area.

The perceptions and low level of awareness of the possible association between malaria and climate variability puts the population in the three villages at more risk to contracting malaria. This is because they are unable to employ appropriate measures to both malaria and vector control. The perception that malaria is normal and cannot be prevented makes them relaxed towards malaria control. There are three types of strategies adopted by the population of Bududa district including the three study villages of Buwanabisi, Bumakuma and Bufukhula. They include: adaptation and active adjustments, acceptance or resignation and migration at different levels ranging from individual and community, district and national levels. However, copying strategies to the impacts of climate variability are not well developed at all levels due to limited economic resources, equipments and expertise as mentioned above.

7.7 RECOMMENDATIONS.

District authorities, herbalists and the local community members or individuals from the lower, middle and upper altitude villages had several suggestions which they felt can help control and curb the impacts of climate variability that is causing malaria. These people’s

suggestions as regards the recommended measures could be related to the framework of the human ecological triangle that puts focus on climatic factors of temperature and rainfall. They lie under the natural or physical environment element in the human ecological triangle, and are heavily contributing to malaria spread. In addition, there are other factors of social and built environment, population, and human behaviour. The researcher also gives her own view of the possible recommendation that can be of great importance at all levels as discussed below.

7.7.1 Natural, social, built environment and malaria prevention.

Members interviewed especially those more aware of the impacts of climate variability in relation to malaria suggested measures that can be suitable for both direct and indirect impacts. The suggested measures include; the need to build drainage channels that could easily let rain water out rather than flooding, the need to manipulate and control the local habitats by removing hollows, small ponds, pools containing water for breeding. District local government should conduct regular cleaning campaigns for sites and places where mosquito vector is abundant. Some educated informant in the middle altitude in his thirties, who was aware of the sources of mosquito breeding sites, suggested that the government should encourage development of proper waste disposal methods to minimise existence of vector breeding habitats. More appropriate local protection methods towards malaria prevention have been adopted. This protection method partly focuses on controlling mosquito breeding grounds and also emphasise the use of insecticide-treated mosquito nets which all contribute in reducing the number of mosquito bites for particular mosquito population (Guerin et al., 2002). "*Malaria occurs more often during hot, rainy seasons. If everyone cooperates it can be controlled. For malaria to be controlled there is need to destroy mosquitoes and their young, drain or put little oil on pools or marshes where mosquitoes breed"* (Werner, et al, 2004:187). Local informants further suggested that eucalyptus tree seedlings should not only be distributed to the people in the lower slope to control flooding but also to those in the middle and higher altitudes to curb other effects of rainfall like destroying houses and washing away soil and landslides that is making people from the higher altitude village to be vulnerable to malaria attack. Though the eucalyptus tree seedlings help in draining the flooded water in the lower altitude village, it has side effects like hardening the soil and lowering its fertility. They also suggested that the village people in all the three altitudes be given loans (micro credit) such that they get involved in businesses

that can generate more income besides agriculture. For instance to eradicate poverty which is among the main factors that makes people vulnerable to malaria attack.

7.7.2 Population and malaria prevention.

It is important to target malaria prevention and control to the population focusing on gender and age groups. Priority should be given to females, infants, young, pregnant women and the elderly. This is because it can help improve efficiency in malaria control and prevention. For example the women (including pregnant women), children and the elderly are the most affected. Different individuals also felt that the government and health organizations should provide more and free mosquito nets, heavy jackets, gumboots and blankets to the vulnerable groups of the population like women who are always participating in outdoor activities. The heavy jackets, gum boots, blankets and mosquito nets can help during rainy seasons and protect them from mosquito bites. The mosquito nets should be provided to all age groups and gender in all the villages instead of only children, pregnant women and the elderly instead of ignoring them like it has been. An informant in the lower altitude village expresses, *the mosquito will not say this person is pregnant, a child or old. It does not segregate all people who are sick of malaria need to be treated and helped.* The state should have plans and develop a policy framework that targets vulnerable groups such as pregnant women and under-five children. The policy framework must cover all those individuals or groups who are unable for reasons beyond their control to know the right of access to malaria treatment by the means at their disposal. Policy makers must consider gender in the design, implementation of programmes and interventions on malaria control (Twinomugisha, 2008).

7.7.3 Behaviour and malaria prevention.

There is need for massive and frequent health education and awareness campaigns at the community and individual levels. This will help bring positive behaviours at work and leisure at home towards malaria prevention and control. For example proper dressing behaviours while going to the garden in the morning, in the evening hours at home and when going to sleep, early and proper treatment seeking, vector control, and moving at good times of the day when mosquitoes are not active. Whenever possible it is important to wear suitable clothing's especially after dusk, thorough check inside houses in the evening and use bed nets to avoid Anopheles mosquito bites. All these methods of personal protection are of great importance when well practiced (Chwatt, 1987). During awareness creation, emphasizing the benefits of changing behaviour will improve livelihood conditions and quality of life.

To improve health care and malaria treatment, the herbalists suggested the need to; set up a health unit for traditional healers or herbalists so that more people can come to them for treatment. Some people within the villages and new people do not know that they exist and contribute in curing illnesses like malaria since they keep in their homes. The herbalists also stated that they request for a machine to help crash the herbs and traditional medicine for treating malaria. The government should also provide them with award within the hospital where they can easily monitor their patients. The two traditional healers interviewed argue that traditional medicines have been used to treat malaria for several years and can be used in making modern anti-malarial drugs like artemisinin and quinine. Traditional medicines are considered as an important, effective and sustainable source of treatment due to drug resistance in addition to affordability and access to anti-malarial drugs. The district health officer suggested that the national government should conduct research programme on the use of biological control of mosquitoes and more modern malaria medicine should be made available and affordable.

The district health officer's suggestion is good. This is because biological control measures can be used as alternatives to chemical control of mosquito vectors. It aims at reducing the target population to an acceptable level and at the same time avoid side effects to the ecosystems. This implies that biological control measures has got double benefits of destroying mosquito eggs, larvae and pupae, at the same time conserve biodiversity in different habitats. Conducting research as suggested will lead to efficient and better understanding of biological measures that can be used. Biological control measure if it is to be implemented in future can save the poor people who are unable to control mosquito vectors by use of insecticides. Insecticides are expensive for most of the population living in the villages of Buwanabisi, Bumakuma and Bufukhula.

7.7.4 Bududa district authorities.

Bududa district health authorities like the district health inspector suggested that national government should plan funding for various district activities in time such that they as district leaders in charge of health can try to handle the climate variation impacts in case they occur.

The district health officer suggested this because, in Uganda national government requires each department to have a plan for the year as regards to the different activities that will be conducted. When these plans are drawn, they are not implemented because of lack of funds and if at all the funds for the particular year is released, it is late. This therefore affects the

smooth running of activities. For example in Bududa district, they have been unable to move and conduct frequent sensitization programmes as regards malaria issues. This is attributed to the lack of funds. The local health care provider in the lower altitude village states: *even if we plan sensitisation programmes on malaria and other health issues, there is no funding. Last year (2010) we conducted only two awareness programmes. We are just there in offices without funds to run planned programmes and activities.*

7.7.5 Researchers Suggestion.

Bududa remains sensitive and vulnerable to climate variability. This is because the impacts of climate variability to the health sector and the general population have been very strong in terms of malaria cases, loss of lives, and economic loss due to landslides. The major and reasonable option to at least change the situation is to integrate climate variation issues in the health policy and sector and ensure that all programmes take climate variation concerns in all their plans and operations. Through this, the sector shall be able to adapt and minimize the direct and indirect impacts. Since climate variation occurrences are cross-cutting, the health sector must cooperate with other sectors so as to have an effective and efficient adaptation mechanism and structure, and cross sectional strategies. This is because climate will continue to vary in the foreseeable future.

All the suggested recommendations above are helpful in reducing malaria prevalence and spread as they play great role in reducing the numbers of adult mosquitoes, destruction of mosquito larvae, reduction of mosquito breeding sites and prevention of mosquitoes from feeding on man. Naturally, each of these methods is not exclusive, and usually all or most of them are used either sequentially or jointly.

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APPENDIX 1.

Interview Guide for ordinary people or Local communities living around the Elgon highlands.

A. Background Information

1. Age.
2. Village:
3. Sex:
4. Occupation:
5. Level of Education:

B. General information about climate variability and malaria outbreak for the ordinary people.

6. In your own opinion, how do you understand climate variability?
7. Do you see any changes and variations in climate? How do you notice or see these changes?
8. What are the factors causing variations in climate from your own observations?
9. Is there any way in which these factors can be avoided?
10. How is climate variability impacts leading to malaria spread?.
11. From your own observations, what are the other environmental, population and human behavioural risk factors to malaria outbreak other than climate variability? Mention and describe them.
12. In your own views and opinions, what are your perceptions on the impacts of climate Variability in relation to malaria outbreak?
13. Do you think climate variability has increased?
14. Can you tell me some of the problems caused by this variation in climate?
15. How are these changes and variations affecting men, women and the youth?
16. Are you aware of the possible association between the impacts of climate variability and malaria?
17. How did you know, identify and explain some of the impacts.
18. Is there any organisation or institution that creates awareness on the impacts of climate variability?
19. What issues do they share or educate the individuals or households and communities with as regards the impacts of climate variability in relation to malaria?
20. Who are the most affected categories of people by the impacts of climate variability?
21. As a result of the impacts caused by climate variations on malaria outbreak, how do you compare the current death rate to the past?

22. What strategies are being put in place by individuals and communities to cope with the impacts of climate variability in relation to malaria?
23. What has the government done to reduce the mortality rate resulting from malaria outbreak? Which services have they provided to the local communities living around the highland?
24. Do you think these services will strengthen the situation resulting from the climate drive malaria?
25. In your opinion, what strategies would you recommend as a way of coping and adapting to the future impacts of climate variability in influencing malaria?

Thank you for your time and response!!

APPENDIX 2.

Interview guide for Focused Group Discussion. (FGD)

C. **Background Information.**

1. Age:
2. Sex:
3. Occupation:
4. Level of Education:

D. General information about climate variability (past and present), climate variability and malaria, perceptions and strategies.

5. Have you ever heard views or opinions on climate change?
6. How do you understand climate variability?
7. For the past years till now, have you observed any changes and variations in climate?
8. How has it been varying from the past? (10-15 years ago).
9. What are the most important occurrences that have taken place as a result of this change?
10. How are they impacting the villages living around? Explain.
11. Are you aware of the impacts of climate variability influencing the spread of malaria epidemic? If yes, how, describe them.
12. How do you see malaria in relation to other non-climatic change factors?
13. How are these non climatic factors in the built and social environment, population and human behaviour influencing malaria spread?
14. From daily observations, which climatic factors mostly affect the transmission of malaria disease?
15. What are your views and perceptions about the impacts of climate variability in relation to malaria?
16. As a result of the impacts caused by climate variations on malaria outbreak, how do you compare the current death rate to the past?
17. Which categories of people are the most affected or vulnerable to this impact of climate variability? Explain why.
18. In your own opinion, what measures do you suggest to be put in place to cope with the impacts of climate variability influencing malaria outbreak?
19. Explain the factors limiting the local communities, district and national authorities in addressing the health impacts of climate variability in relation to malaria.

Thank you for your time and response!

APPENDIX 3

Interview Guide for key informants.

E. Background information

1. Age:
2. Sex:
3. Occupation:
4. Level of Education:

F. Information on climate variability, awareness, and measures to cope with the impacts of climate variability.

5. How do you understand climate variability?
6. Have you observed any changes in climate for the time you have been or worked here? Do you think it is increasing?
7. In the last 10-15 years, what are your views about malaria spread?.
8. What are the major causes of this malaria disease?
9. Are you aware of the impacts of climate variability in influencing the spread of malaria epidemic? If yes, to what extent are you aware?
10. Do you run awareness programmes on health issues and climate variability in the spread of malaria?
11. Through which media's and channels do you run the awareness programmes?
12. Have you tried to assess the effects of climate variability on the communities health focusing on malaria disease?
13. How are the climatic factors influencing the spread of malaria? Describe them.
14. As a result of the impacts caused by climate variations on malaria outbreak, how do you compare the current death rate to the past?
15. Explain other risk factors in relation to human behaviour, population, social and built environment influencing the spread of malaria.
16. According to your own thinking and observation with the prevailing situation, what essential knowledge gaps must be filled fully to understand the possible impacts of climate variability on malaria?
17. Is there anything that has been done for the local communities to cope and adapt to the impacts of climate variability?
18. What measures has been put in place for the local communities and the most vulnerable categories to cope with and adapt to the impacts of variations in climate?

19. In your opinion, what strategies would you recommend as a way of coping and adapting to the impacts of climate variability in influencing malaria?
20. As district authorities and health officers, what is limiting you in addressing the health impacts of climate variation?

Thank you for your time and response!

APPENDIX 4.

Interview guide for traditional healers.

Background Information

1. Age:
2. Sex:
3. Occupation:
4. Level of Education.

G Information on traditional Curative treatment and Malaria.

5. Have you ever heard of climate variability?
6. In your own opinion and knowledge, what is climate variability?
7. What is the health situation in Bududa including villages of Buwanabisi, Bumakuma and Bufukhula?
8. Do you receive patients suffering from various diseases?
9. Mention the diseases that you treat.
10. How often do you receive these patients?
11. Among the patients who visit you, are there malaria patients?
12. What is the percentage of those who come for treatment?
13. How do you know that somebody is suffering from malaria?
14. Which herbs do you use for treating malaria?
15. Do they have a particular dosage?
16. Are you aware about the impacts of climate variability in influencing the spread of malaria? To what extent?
17. Do you also sensitize malaria patients about the impacts of climate variability in influencing its spread? If yes, what issues do you share with them?
18. Explain the role of climate variation in influencing malaria spread.
19. As a result of the impacts caused by climate variations on malaria outbreak, how do you compare the current death rate to the past?
20. Why do you think patients visit you for treatment instead of going to the hospital for modern drugs?
21. How effective is the treatment you give?

Thank you for your time and response!