LUND UNIVERSITY

Land use change and health: A case study of fish farming impacts on malaria prevalence in Kabale district, Uganda.

Thesis submitted in partial fulfilment of the requirements for the Master of Science degree in Environmental Studies and Sustainability Science (LUMES)

By

Kiirya David

dlavinco@yahoo.com

Supervisor:

Dr. Nicodemus Mandere, PhD
Lund University Centre for Sustainability Studies (LUCSUS)
Lund University, Sweden
E-mail: nicodemus.mandere@lucsus.lu.se

16th May 2011

ABSTRACT

Malaria is a major global problem affecting mostly developing countries. Recently, malaria has been expanding geographically into new spatial areas mainly due to climate and land use change. One of the new geographical areas where malaria has been observed is Kabale district in Uganda. This study was conducted with the aim of assessing the role of fish farming in the prevalence of malaria in Kabale. The study was conducted using primary and secondary data sets and the results were analysed qualitatively and quantitatively using SPSS and content analysis. The results show that malaria is a major problem in the study area. Relationships between fish farming and malaria existed among households whose fish ponds and homestead sites were characterised with crops such as coco yams, cabbages and sugarcanes, *Dracaena fragrans* live fence, abandoned fish ponds and in some cases those living in close proximity to fish ponds. It was found that fish farming is only one of the factors that contribute to malaria prevalence in Kabale. The other factors include other land uses such as brick-laying, sand mining and stone quarrying, wetlands and swamps reclamation for arable land, changing climatic conditions, ignorance, susceptibility and compromised immunity. Therefore, to effectively tackle the malaria problem, the government should address problems with fish farming and all the above factors outlined.

Key words: *Malaria; land use change; fish farming*; *fish ponds; prevalence; Kabale; Uganda.*

ACKNOWLEDGEMENT

I thank European Union (Erasmus Mundus External Cooperation Window) for awarding me a scholarship and the Swedish Erasmus coordinator Prof. Petter Pilesjö for prompt payments and mentorship. I am very grateful to my supervisor Dr. Nicodemus Mandere for guiding me through this work. Special thanks go to the study community for its cooperation and hospitality and Prof. Lennart Olsson the Director of LUCSUS for funding my field study. I also thank Associate Professor Mwanjalolo Majaliwa and Dr. Efitre Jackson of Makerere University for the wonderful support and guidance they extended to me throughout this work.

Table of contents

List of figures

List of tables

List of acronyms

MDGs	Millennium Development Goals
UN	United Nations
CDC	Centre for Disease Control
WHO	World Health Organization
DALYs	Disability Adjusted Life Years
UBOS	Uganda Bureau of Statistics
GDP	Gross Domestic Product
ITNs	Insecticide-treated mosquito bed nets
IRS	Indoor Residual Spraying
FAO	Food and Agricultural Organization
ACT	Artemisinin-based Combination Therapy
UNDP	United Nations Development Programme
ODP	Out-patient Department
USAID	United States Agency for International Development
PFA	Prosperity for All
NAADS	National Agricultural Advisory Services
SES	Social–ecological Systems
GPS	Geographical Positioning System
HIV	Human Immunodeficiency Virus
AIDS	Acquired Immune Deficiency Syndrome
UNMS	Uganda national medical stores
RDTs	Rapid Diagnostic Tests
DCP	Disease Control Priorities
UGX	Uganda Shillings
UNAS	Uganda National Academy of Science
Km	Kilometre

1.0 Introduction

Combating malaria is one of the priority areas under the millennium development goals (MDGs) that were adopted by the United Nations General Assembly (UN 2000). Malaria persists as a major public health problem globally. The Centre for Disease Control and Prevention (CDC) in United States of America estimates half of the world's population to be living in areas where malaria is transmitted. These include mostly parts of Africa, Asia, Middle East, Oceania, Hispaniola, Central and South America (CDC website 2010). The most vulnerable are people living in the poorest countries especially children below five years of age and pregnant women (WHO 2010).

In Africa, a child dies of malaria every 45 seconds and about 10,000 pregnant women are estimated to die of malaria every year (UN Foundation 2010). Malaria has also caused miscarriages, premature births and low birth weight babies. It is also ranked the eighth and second highest contributor to the Disability Adjusted Life Years (DALYs) globally and in Africa respectively (Snow et al. 2003).

Malaria costs African countries $12 billion a year in economic losses (UN Foundation 2010). Malaria is considered the major contributor to the vicious circle of low social, human and economic development in highly endemic countries. Malaria hinders socio-economic development in most countries with intensive malaria transmission. It causes an average loss of about 1.3% of economic growth (WHO 2010). According to Kiwanuka (2003) malaria was responsible for 33-54% of absenteeism at work and school. It also accounts for as high as 1% in terms of cost of Uganda's GDP in economic losses. Therefore malaria does not only cause ill health to people but also has socio-economic impacts and exacerbates other global challenges such as poverty and hunger.

Despite efforts by the African leaders to control and prevent malaria, the 2007 United Nations report, conducted in 2005-2006 indicated that very few African countries have come close to the set goal of halving its transmission (UN 2007). This has been attributed to socio–economic factors which result into people not affording the medication, limited access to health care, demographic factors, poor quality of drugs, misdiagnosis, self treatment and increased use of insecticides in agriculture which have increased drug resistance in *plasmodium* among others. In addition, the current

methods such as the use of insecticide-treated mosquito bed nets (ITNs), indoor residual spraying (IRS), mosquito coils, treatment using Artemisinin-based combination therapy (ACT) have not been efficient and others not implemented due to their environmental implications.

Like any other endemic malaria affected countries, malaria is the main cause of morbidity and mortality in Uganda (UNDP 2007; UBOS 2009). Additionally in the recent years malaria outbreaks have been detected in formally malaria-free areas such as Kabale (Abeku et al. 2007) and Bushenyi districts (Mugisha 2006) making such areas the hardest-hit. Githeko (2007) highlighted that people living in areas with low malaria transmission such as highlands are vulnerable because their immunity is low. The expansion of malaria into new geographical regions has been attributed to climate change, prolonged heavy rainfall (El Nino), land use change, deforestation, floods and temperature rise (Zhou et al. 2004; Tanser and Sharp 2005; Patz and Olson 2006; Masahiro et al. 2009; Country survey on health and climate change, 2009; Paaijmans et al. 2010). Most of the foregoing factors contribute to favourable conditions for mosquito breeding and multiplication which in turn increases risk for malaria morbidity and mortality.

African highlands were historically considered malaria free (Lindsay and Martens 1998; Lindblade et al. 2000; Zhou et al. 2004; Shanks et al. 2005; Mugisha 2006; Cox et al. 2007; Baliraine et al. 2010). Kabale is one of the highlands in south western Uganda. Malaria prevalence in Kabale has been sporadic until 2005 when Abeku et al. (2007) findings revealed two serious outbreaks in 2005 and 2006. Thereafter, malaria has been on the increase subjecting 93% of the population to malaria risk in the district (USAID 2006). This increase in malaria incidence in Kabale has been attributed to changing climatic conditions, drug resistance and land use change (Kiwanuka 2003; Abeku et al. 2007; Cox et al. 2007).

Increased malaria outbreaks in Kabale coincided with a period of rapid expansion of fish farming[1] in the district following the government's effort to rejuvenate fish farming

[1] Fish farming refers to "the production of fish under controlled conditions such as ponds or cages so that it is readily available to the farmer whenever needed" (Rutaisire et al. 2009).

as a means to improve people's livelihood (FAO 2010). The coincidence between malaria outbreaks and fish farming in the district raises one question; did its development play any role in the malaria outbreaks? It is in this context, that this thesis study is conducted with the aim of assessing whether there is a relationship between fish farming and malaria in Kabale district in Uganda. To meet the aim of the study, the following research questions are tackled;

1. Has fish farming development in Kabale affected malaria morbidity and mortality?
2. What factors or practices in fish farming in the district contribute to increase in malaria?
3. What are the social economic burdens of malaria in the study area?
4. What are the implications to the preparedness for malaria prevention and control?

2.0 Theoretical background

2.1 Malaria in Uganda

Approximately 95% of the Ugandan population live in malaria endemic areas (UNDP 2007; UBOS 2009; Kiwamuka 2003). Pregnant women and children bear the highest blunt of malaria impacts particularly in terms of mortality (UNDP 2007; UBOS 2009; Kiwamuka 2003). For these vulnerable groups malaria can also cause severe anaemia and miscarriages in pregnant women (Kiwanuka 2003).

Malaria is also considered to be the major health problem in Uganda where it contributes to over half of the total out-patient population as well as to a third of total population of patients that are admitted into hospital/clinic wards (UNDP 2007). Malaria prevalence has been on the increase in the past two decades (Kiwanuka 2003; UBOS and Macro International Inc. 2007). The main factors that are contributing to increase in malaria prevalence according to Kiwanuka (2003) include; resistance to malaria drugs and land use change. Between 2004 and 2008, it was established that 10.7 million malaria cases were reported annually throughout Uganda (WHO 2009). The malaria endemic regions in Uganda are shown in Figure 1.

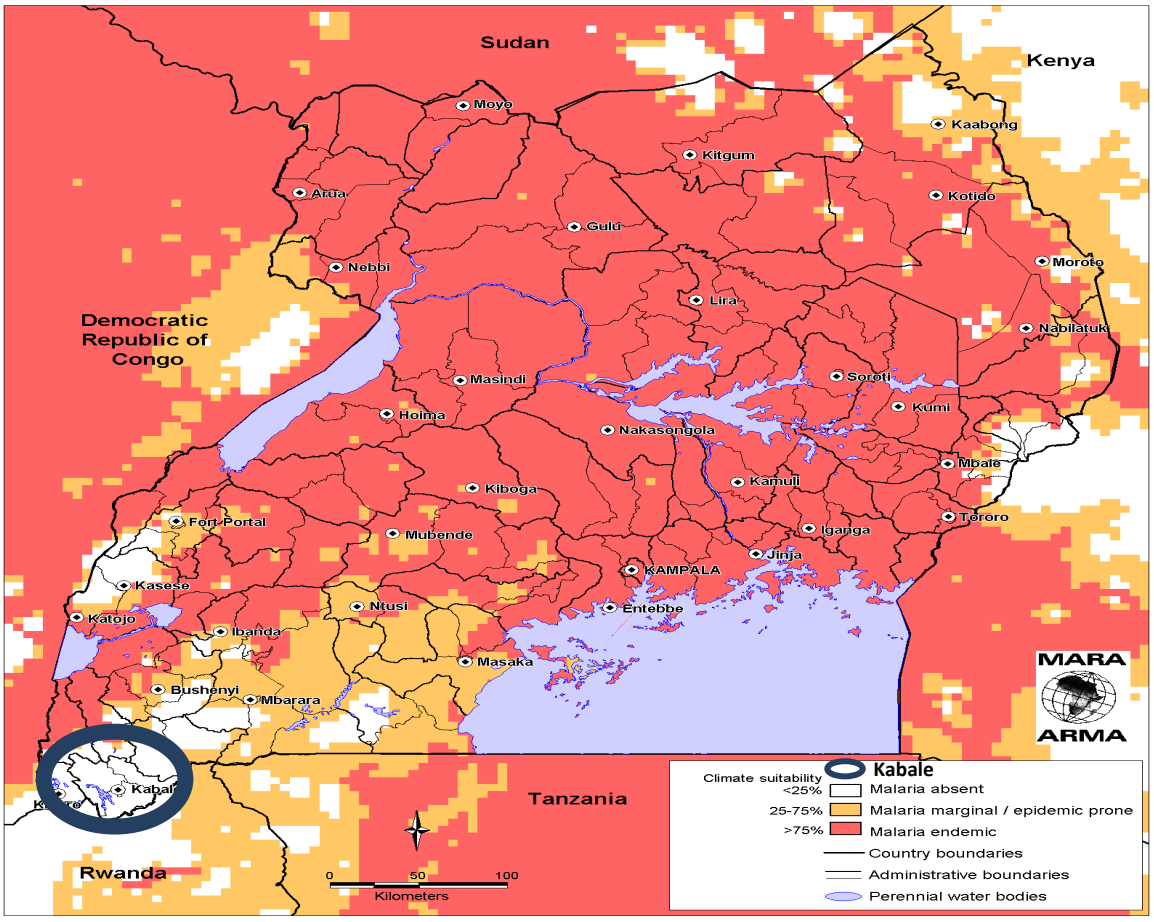

Figure 1: Malaria endemic regions of Uganda as per year 2001

Source: MARA/ARMA (Mapping Malaria Risk in Africa / Atlas du Risque de la Malaria en Afrique)

2.1.1 Malaria in Kabale

Kabale neighbours Rwanda as shown in the figure 1 and as indicated, malaria risk in Kabale was very low by 2001 regardless of the two serious malaria epidemics highlighted by (Lindblade et al. 2000; Tumwesigire and Watson 2002). But in the years 2005 and 2006 serious cases of malaria outbreaks were experiences in Kabale particularly in Bufundi sub-county (Abeku et al. 2007). Approximate 93% of Kabale's population was estimated to be living in malaria risk areas as per 2006 (USAID 2006). However, since then the malaria trend in the district has been on the rise with more than 100 malaria cases being recorded per 1000 people (WHO 2009). Most (95%) of these malaria victims were infected by *Plasmodium falciparum* (USAID 2006)- *Plasmodium falciparum* is known to have fatal malaria impacts if not treated in time.

2.1.2 Land use change and malaria transmission

Tanser and sharp (2005) publication relating climate change to the distribution of malaria transmission at larger spatial and temporal scales sparked a debate about the relative importance of environmental and social factors underlying spatial distribution of malaria. Reiter (2008) and other scholars criticised them for neglecting non-climatic factors and drawing deductions based on a study which only modelled a malaria transmission season.

One important non-climatic factor that has been observed to affect malaria distribution is land use change (Lindblade et al. 2000). The most common land use practices highlighted in relation to malaria are draining swamps for cultivation or wetland reclamation, brick laying pits, forestry, livestock activities, urban agriculture and aquaculture (Kiwamuka 2003; Takken et al. 2005; Matthys et al. 2006).

A number of studies such as (Matthys et al. 2006; Mugisha 2006; Maheu-Giroux et al. 2010) have conducted research on aquaculture and malaria. Maheu-Giroux et al. (2010) found a relationship between malaria prevalence and fish pond density in the Peruvian Amazon. Matthys et al. (2006) found a correlation between malaria prevalence and living close to permanent man-made water bodies. Matthys et al. (2006) using the case of a town in CoteDivore found that urban agriculture through smallholder irrigated rice areas and mixed crop system contributed to increased malaria prevalence.

In addition, the study demonstrated that the risk of malaria transmission among children staying in temporary farm huts with their parents was over 17-fold higher compared with those that were staying in permanent homes. It further indicated that there was no spatial correlation of malaria infection in children staying in houses which were beyond 3.9 meters distance between each other.

Mugisha (2006) demonstrated that in Bushenyi, the poorly managed or abandoned fish ponds contributed to mosquito proliferation. The various cultivated plants around the fish ponds contributed significantly to vector reproduction for example water accumulation at the base of the stem of manioc (yam) leaves used as fish feed was an important site of mosquito reproduction.

Most of the researchers have highlighted poor management of the fish pond, abandoning of the fish ponds and associated forms of agriculture as the main factors relating fish farming to increase in malaria prevalence. However, Mugisha did not consider fish pond numbers or fish pond density making interpretation a bit elusive, Matthys and Maheu-Giroux did not take site characterization as an important factor which very much relates to the pond management strategy they proposed as a potential intervention towards malaria control in their respective study areas.

This study will consider all the above factors; also look into gender relations and other socio-economic factors. This will help me integrate all these aspects to fully understand and appreciate the interplay and dynamics involved in the malaria transmission, prevention and control in the study area.

The results from this study will help the health sector to develop appropriate measures and improve on their intervention approaches and preparedness to the risk of malaria transmission in Kabale. The results will also increase awareness among the farmers about fish farming malaria prevention and control strategies.

2.2 Fish farming in Uganda and Kabale

2.2.1 Fish farming in Uganda

Fish farming started in 1941 with the aim of encouraging rural development. Following this initiative, common carp fish was imported into Uganda by the colonial government.

A first experimental station for fish farming was later established at Kajjansi to evaluate performance of the various fish species. Common carp was the main type of fish kept but due to the controversies that surrounded it such as its adverse impacts on the indigenous aquatic environment in case it escaped from the confined fish ponds,[2] the scientists recommended Tilapia over carp and hence Tilapia was stocked (FAO 2010).

Through vigorous fish farming campaigns, 1500 fish ponds were constructed by 1956 in the central and south western parts of the country. In Uganda, most ponds are earthen because they are cheap to construct and their bottoms allow growth of natural foods for the fish (Rutaisire et al. 2009).

The comparative evaluation study conducted by FAO between 1959 and 1960 endorsed and restored common carp in the system. By 1968, fish farming had expanded in Uganda with approximately 11,000 fish ponds that were operated around the country mainly for subsistence (FAO 2010).

However, this subsistence farming practice was not sustainable because seed supply was from farmer to farmer, besides the changing policies by the successive governments were also a stumbling block, lack of stocking materials, limited technical guidance and excessive government regulatory regimes and these hampered fish farming. Consequently, the number of functioning fish ponds reduced to approximately 4,500 producing about 285 tonnes of fish annually (FAO 2010).

In 2005, the current government policies with support from other developing partners such as FAO rejuvenated fish farming with the aim of transforming Ugandans from peasant farmers to prosperous, modern and industrialised people in a stable and peaceful environment under the umbrella of prosperity for all (PFA) (President's speech 2007).

This government intervention was also aimed at restoring the declining wild fish stock and yet the demand for fish products was increasing. Additionally, increased fish

[2] Fish ponds are earthen, concrete or plastic lined shallow depressions confined with water where fish can be kept (Rutaisire et al. 2009).

production would improve the health and livelihood of the local communities by providing an affordable source of animal protein, increase food security and serve as an alternative source of income to the non-environmentally sound land use practices such as deforestation (Rutaisire et al. 2009).

Currently, there are about 12,000 farmers involved in fish farming spread in most districts located around Uganda's major water systems including lakes Victoria, Kyoga, Edward, George and River Nile catchment. Based on FAO fisheries statistics, figure 2 below show the total fish farming production in Uganda from 1950 to date.

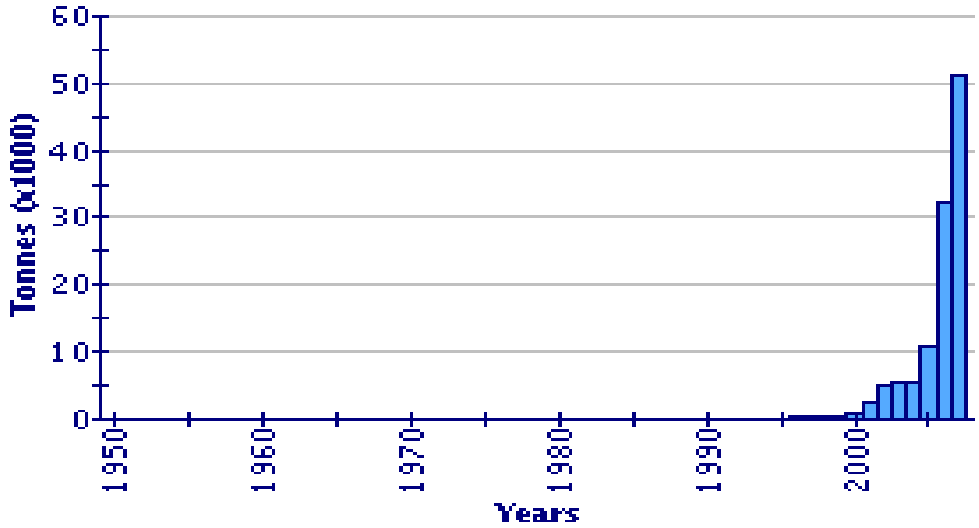

Figure 2: Shows reported fish farming production in Uganda since 1950 (FAO fisheries Statistics)

2.2.2 Fish farming in Kabale

Information obtained from the district NAADS coordinator of Kabale indicate that fish farming was introduced in Kabale in the 1950s by the Government Fisheries Field Extension Services. A fish fry centre (with 5 fish ponds) to supply farmers with fish fingerlings was established at Kyanamira while a demonstration centre, was established at Kitanga in Rukiga county. About 700 fish ponds were established by farmers in the then Kigezi district which was divided into the current Kabale, Rukungiri and Kanungu districts. However, due to the general decline in the economic and political conditions in the 1970s and 1980s, most of the infrastructure at these facilities broke down and most of the farmers left fish farming.

The re-introduction and expansion of fish farming in Kabale was one of the government's interventions to alleviate poverty and promote rural development. The government fisheries field extension services initiated the formation of Kitanga fish farmers association. The association had a total membership of about 70 small scale farmers, all of whom are household heads. They set up a demonstration farm in the area composed of four ponds each of about 1000 m^2. Unfortunately, the people did not get viable benefits from fish farming due to various constraints.

Mac group limited, a private company involved in fish farming partnered with the Kitanga fish farmers association to rejuvenate the fish farm. The partnership which is a ten year period is one year old and under this arrangement, Mac Group Company is required to provide technical management, farm maintenance, marketing, providing farm inputs among others.

Fish is reared in the swampy areas and valley bottom mainly in the three major wetland systems in the District. In addition, Lake Bunyonyi, one of the deepest lakes in the country was also restocked with fish by the District Local Government with support from NAADS. The major types of fish reared include; mud fish, *mirror carp, tilapia Zilli and Cat fish*. Tilapia was the first breed to be introduced in the district but the cold weather conditions did not favour its growth; maturity period become too long and farmers are disappointed but still keep it. Mirror carp performs better than Tilapia but it does not easily breed and getting fry for restocking becomes a problem.

Following these daunting challenges in the fish farming sub sector, *Catfish* was introduced recently into the district and the farmers who are rearing it are reportedly happy with the performance in terms of weight at maturity and growth rate. Presently, Kabale district has over 800 fish ponds located in 19 Sub–counties.

Ideally fish farming is perceived to be an environmentally friendly, economically profitable and sustainable alternative to the current wetland uses such as potato cultivation and exotic dairy farming. However, Mandere (2009) noted that un-planned and un-coordinated land use change can lead to tremendous externalities which may impact sustainability of ecosystems.

Mandere's remark forms the rationale of this study which is to establish the correlation between fish farming development and the increase in malaria prevalence in Kabale. Rutaisire et al. (2009) noted that the private sector has started to gain interest in fish farming thus increasing investment in fish farming projects. This might exacerbate the malaria transmission if the relationship exits not only to those living in areas with high fish pond density and number but also to the entire country.

2.3 Study area

Kabale district is situated in the southwest part of Uganda at the border with Rwanda (Figure 3). The district is made up of 4 counties, 19 sub-counties, 1 municipality and 3 town councils. The district has a total land area of 1,827km^2 most (93 %) of which is arable land – the rest being wetland or marginal land. It lies 2000 metres above sea level and surrounded by heavily cultivated hills which range from 1,219 - 2,347 metres above sea level. This altitude makes Kabale colder than the rest of the country with the average monthly temperatures of about 18 °C and sometimes it falls to 4 °C especially in the night. The district experiences a high relative humidity throughout the year. The location of Kabale and the sub-counties where the study was conducted are shown in figure 3 below.

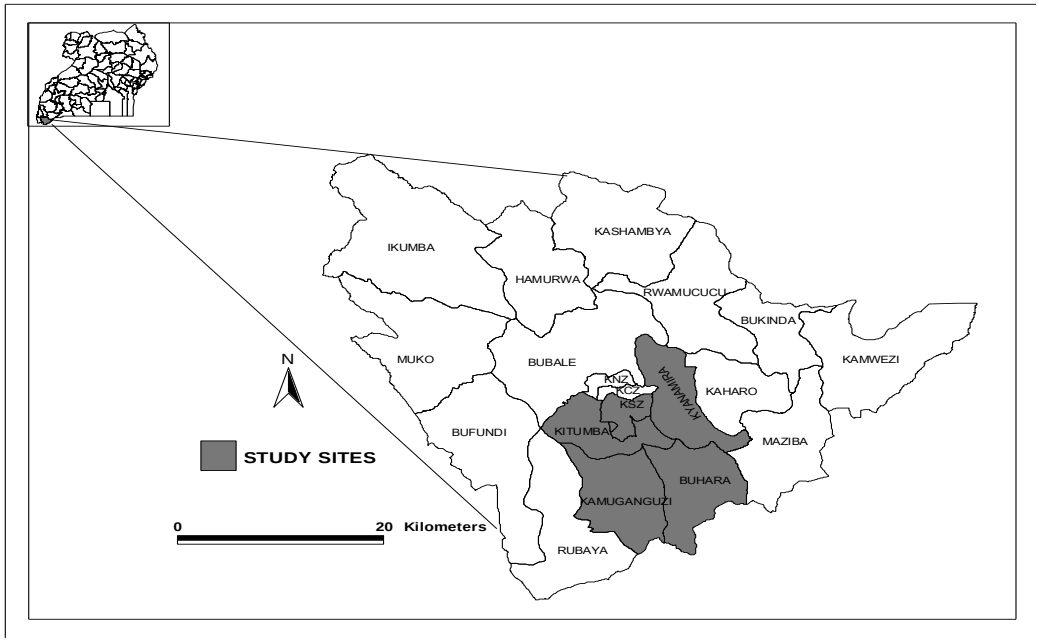

Figure 3: Map of Uganda showing the location of Kabale and sub-counties

The population of the district was 41,344 people as per the 2002 population census (UBOS 2002). Kabale district has a population density of about 258 persons per square kilometre. Majority (90%) of the people reside in rural parts of the district where their main economic activity is agriculture. The average family size is 5 persons and 33% of households are female headed. The geographical location from where the respondents were drawn is shown in figure 4.

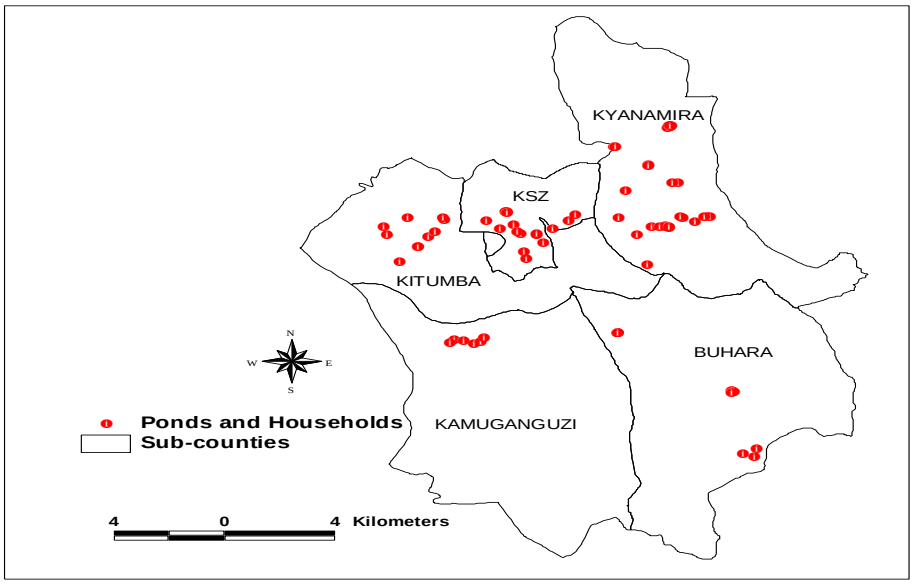

Figure 4: Map of the study area showing the location of the respondents

3.0 Methodology

3.1 Conceptual/ theoretical framework

In order for the fish farming approach that Uganda adopted in 2005 to be sustainable, it must improve rural development and nutrition, rejuvenate the depleted fish stocks in the water bodies but it must not cause negative externalities on social, economic and health wellbeing of the people in the country. This should not only cater for the current generation but also for the future generation (Carter 2007).

The people living in Kabale are very susceptible to malaria given the fact that in this region, malaria was sporadic up to 2005. Based on previous studies, malaria has been a major public health threat in Uganda and efforts to control and prevent it have not been

successful. Therefore there is a need for reframing the fight against malaria in endemic areas.

In relation to this, a new paradigm referred to as eco-health should be adopted. Eco-health tackles health problems using an ecosystem approach through understanding the dynamics in complex social-ecological systems (SES). This paradigm was identified by the International Forum on Ecosystem Approaches to Human Health, which was held in Montreal in 2003 as a "framework linking health, ecosystems, and sustainable development" (Plaen and Kilelu 2004). The forum emphasised that the approach as proposed by Forget and Lebel (2001) seeks to better understand the complex interactions within the components of an ecosystem. For example how they influence the occurrence of health problems as well as well-being among human populations which biomedical approaches cannot provide.

Through eco-health, proper management strategies can be developed which can improve both people's well-being and sustainability of the ecosystem on which they depend for livelihoods (Plaen and Kilelu 2004). To comprehend interactions and relationships, a systemic or holistic thinking is of importance especially for components which appear to be isolated as illustrated in figure 5.

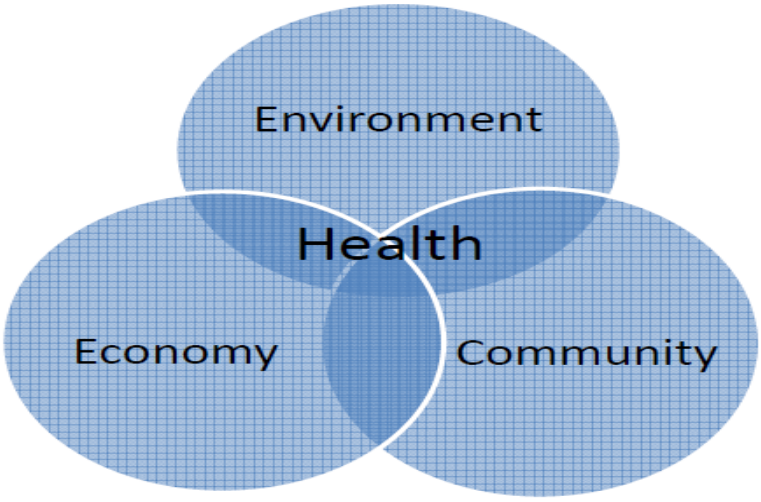

Figure 5: Eco-health approach

Source: (Lebel 2003)

On the basis of this eco-health framework, this study investigated the impacts of fish farming on malaria morbidity and mortality and socio-economic impacts of malaria to the households and communities. Matthys et al. (2006) argued that through ecological understanding at the local level, preventive strategies and vector control programmes that could easily be adopted by local agro-ecologic settings could be designed and implemented.

3.2 Study design

As mentioned earlier, this study was conducted in Kabale district, Uganda. The study focussed particularly on five sub-counties namely Kyanamira, Buhara, Kabale municipality (southern zone), Kitumba and Kamuganguzi. Kyanamira had 84 fish ponds; Buhara had 38 fish ponds, Kabale municipality (southern zone) had the least number of fish ponds (20), Kitumba and Kamuganguzi were the controls without fish ponds. The reason for selecting these five sub-counties was to ensure that both the people who were exposed to fish ponds and those who were not (control) were covered so as to assess whether there were any similarities or differences in regard to malaria prevalence or impact.

3.2.1 Data collection

3.2.1.1 Secondary data

Secondary and primary data were both applied. The secondary data was obtained from diverse sources such as: hospital malaria records, government reports on malaria, Fisheries department records, peer-reviewed sources, non-government organisation reports and metrological data (to establish temperature, humidity and rainfall in the study area). The above archives are stable, accurate and generated over a long period of time (Yin, 2009). The primary data sources were obtained through interviews (farmers, health officials, fisheries department officials, and agricultural extension officials), field observations, and measurements. Details on how the primary data was collected are provided below.

3.2.1.2 Primary data collection

The methods included both structured and un-structured interviews to respondents in the selected sub-counties. Since malaria is a complex challenge involving interplay of many factors, open ended questions gave the respondents a chance to express their opinions and closed ended questions helped to maintain consistency. Other respondents included the fisheries officer of the district, an agricultural extension officer, health workers from the health centres in the study area and private clinic operators in Kabale town. The respondents were drawn from five sub-counties namely Kyanamira, Buhara, Kabale municipality (Southern Zone), Kitumba and Kamuganguzi. The number of respondents interviewed from each sub-county is shown in table 1.

Table 1: Number of respondents interviewed per sub-county

Sub-county	Number of respondents (No=60)
Kyanamira	22
Kabale Municipality (Southern Zone)	14
Buhara	8
Kitumba	10
Kamuganguzi	6

In Kyanamira, Buhara and Kabale municipality (southern zones) both respondents who owned and did not own fish ponds were interviewed and in Kitumba and Kamuganguzi, only those who did not own ponds were interviewed since fish farming is not practiced in these areas. By the help of a handheld Geographical Positioning System (GPS), coordinates of the homesteads and fish ponds were recorded and site description was done. The health officials in charge of Kyanamira Health centre III and Kafunjo Health centre II were interviewed. Also a nursing assistant of Kabale parent's clinic (a private clinic) located in the city centre was interviewed.

A research assistant was used during the interviews to aid the interpretation of questions and responses whenever there was need. Interpretations were conducted

immediately after the exercise so as not to lose track of important information. The responses and findings were recorded in a notebook.

The main themes that were covered in the questionnaires are: impact of fish farming (including malaria and nutrition), malaria and its socio-economic impacts, current methods for malaria prevention and control, farmer's receptiveness to new ideas (including new strategies for malaria prevention and control), and other land uses which could be playing a role in increasing malaria prevalence.

Field observations were conducted in which the following data was recorded; settlement patterns, physical features, topography, other land uses and fish ponds site characterisation.

3.3 Data analysis

The data was analysed using a mixture of both quantitative and qualitative approaches. The aim was to capitalize on their strengths and offset their weaknesses. Also these methods complement each other which can help to discover paradoxes through triangulation between the datasets from both methods and this increases credibility, reliability and validity in research (Bryman, 2008). Descriptive statistics and content analysis methods were applied during analysis. Responses to closed and open ended questions were coded and subjected to SPSS statistical analysis program.

4.0 Results

4.1 Malaria trend and impacts

4.1.1 Malaria trend

Majority of the respondents had a perception that the malaria trend in Kabale has been on the increase (Figure 6). The figure further indicates that a substantial number of respondents were of the view that malaria in the study area has been on decline since 2005 when the first serious epidemic was experienced in Kabale. The malaria increase or decline responses did not show any unique pattern on the basis of sub-county as the responses seemed to take a random pattern.

The reasons the respondents provided for the perceived increasing malaria prevalence in the area are: fish farming; brick-laying, sand mining and stone quarrying; compromised immunity; negligence; problems with the healthcare system and changing climatic conditions. Those indicating the decline based their claim on increased sanitation and sensitization, availability and increased use of mosquito nets and increased availability of health centres.

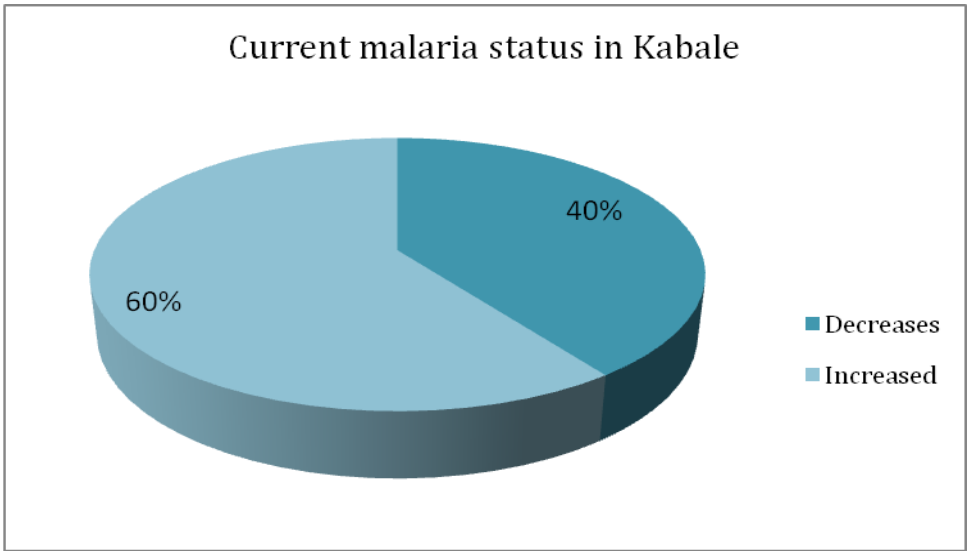

Figure 6: Current malaria status in Kabale

Majority of the respondents had a perception that fish farming is one of the main factors contributing to increasing malaria prevalence in Kabale. They attributed their reasoning to the claim that the fish ponds potentially provide mosquito breeding grounds since they contain stagnant water. However, there were a smaller proportion of respondents who had a feeling that fish farming has not played any particular role in malaria prevalence in Kabale. Despite of their claim this latter group did not have specific reasons in support of it - majority of them were fish farmers so they might have claimed so to protect the practice.

Brick-laying, sand mining and stone quarrying are common land uses practices in some parts of Kabale (Figure 7). These kind of land uses, leave ditches on the ground from where rain water collects either temporary or permanently. It is this stagnant water that respondents claimed to accelerate mosquito vector proliferation and consequently leading to increased malaria prevalence in the study area.

Figure 7: Impacts of other land use practices on malaria incidence

The medical personnel interviewed highlighted compromised immunity as one of the main reasons for increased prevalence of malaria. He attributed compromised immunity to poor nutrition, poverty and increased prevalence of HIV/AIDS in the community. Compromised immunity often makes the population vulnerable to various opportunistic and other infectious diseases.

Negligence and illiteracy were observed as other indirect factors affecting implementation of government policies to fight malaria. For example the government provided treated mosquito nets to expectant mothers in Kabale during 2008. But some of the mothers are using the treated nets for other household purposes such as covering cutlery. One interviewed woman said *"I am supposed to sleep under the treated mosquito net only when she is pregnant*".

Lack of consultation has resulted into misuse and mismanagement of drugs. One health personnel highlighted that officials from Uganda national medical stores (UNMS) do not consult them before supplying the drugs at the health centres. This has resulted into some drugs expiring before use and those that are important and commonly used not being supplied in time. For instance, he expressed his concern about the septrin drug which is used by HIV/AIDS patients but up to 16th march 2011, he had not received another consignment and yet he gave out the last dose on 17/December/2010.

They also highlighted the challenge of lack of space and medical equipment such as laboratory consumables and medical instruments and skilled medical personnel. This

was attributed to poor planning by the government. Many districts have been created without proper planning for example when a county becomes a district; it is supposed to operate using the existing infrastructure and facilities – yet it has to serve an extended population. The health personnel's highlighted that some establishments such as rapid diagnostic tests (RDTs) for malaria which were useful in rural areas failed in 2009 due to poor policy implementation and lack of monitoring and evaluation framework.

Changing weather conditions such as increase in temperatures and un-predicted heavy rainfall was another factor highlighted by the respondents. They emphasised that temperature increments are evident and rainfall are erratic and heavy in Kabale. They stressed that malaria incidences are rampant in the rainy months of March and April and October and November. Rainfall and temperature are vital in mosquito lifecycles development and hence increased mosquito vector proliferation - consequently leading to increased malaria prevalence in the study area.

4.2 Fish farming and malaria

4.2.1 Malaria incidence per a month

The responses revealed that malaria is a common problem affecting many households in Kabale. The responses show that during each month malaria is experienced in at least 55% of the respondent households (Table 2). In the affected households, it can be depicted that malaria can be experienced either once or twice in a month (i.e. the number of times malaria can affect either one or more household member(s) in a month). It is only two respondents who indicated that their households can be affected by malaria more than two times in a month.

It can also be depicted that there are many households where malaria was rarely experienced. In these households a month or more can elapse without any member of their households being affected by malaria.

Table 2: Malaria incidences per month per household

No. of times malaria affects at least a single household member in a month	No. of respondents (N=60)	Percentage of total respondents (N=60)
Rarely	27	45.0
1	18	30.0
2	13	21.7
3	1	1.7
4	1	1.7
Total	60	100.0

4.2.2 Malaria incidence per sub-county

The responses indicated that malaria is a problem in all the sub-counties that were covered in this study (Table 3). Most of the households were affected between once and twice during each single month. But a few households were affected by malaria more than twice during a single month. It can further be observed that there are a number of households that rarely experience malaria during this period. Kyanamira sub-county had the largest number of respondents that were affected by malaria in a month – coincidentally this sub-county also has the highest number of fish ponds.

Table 3: Malaria incidence per sub-county

Sub-county	No. of times malaria affects at least a single household member in a month (N=60)				
	Rarely	1	2	3	4
Buhara	4	3	1	0	0
Kitumba and Kamuganaguzi	7	6	2	0	1
Kyanamira	8	7	6	1	0
Kabale municipality (Southern Zone)	8	2	4	0	0

4.2.3 Homestead location distance to fish pond and malaria incidence

The responses revealed that malaria is experienced in all parts of the study area despite of the distance between the location of the household shelter and the fish pond. In some regions however, respondents residing closer to the fish ponds (<0.5 km) reported that they were affected by malaria more times compared to those living further. But in some other places this pattern was not clear- this would be an indication that besides the fish ponds there are many other factors in Kabale that do affect malaria prevalence. The distance between the location of the household shelter and the fish pond was estimated and not measured – results need to be interpreted with due attention to this limitation.

4.3 Fish pond site characteristics and management

4.3.1 Fish pond site characteristics

During the field studies, observations were made on the various land uses and sanitation in the immediate vicinity of each fish pond and homestead that was visited. There were varying land uses and sanitation levels from one fish pond to another.

The most predominant land uses that were common to most fish ponds were: crop production (food and cash crops), trees (eucalyptus and pine), grasses, sedges (papyrus), live fence (*Dracaena fragrans*) and bush/fallow land (Figure 8). It was observed that a single fish pond would be surrounded by a mixture of more than one land use type. For example it was common to find crop production, livestock, live fence and trees around a single fish pond.

However the food crops (cabbages, coco yams, beans and sorghum) were the most predominant in at least 68 % of all the studied fish ponds. The cash crops were mainly coffee and sugarcane with coverage of about 10 % of the fish ponds.

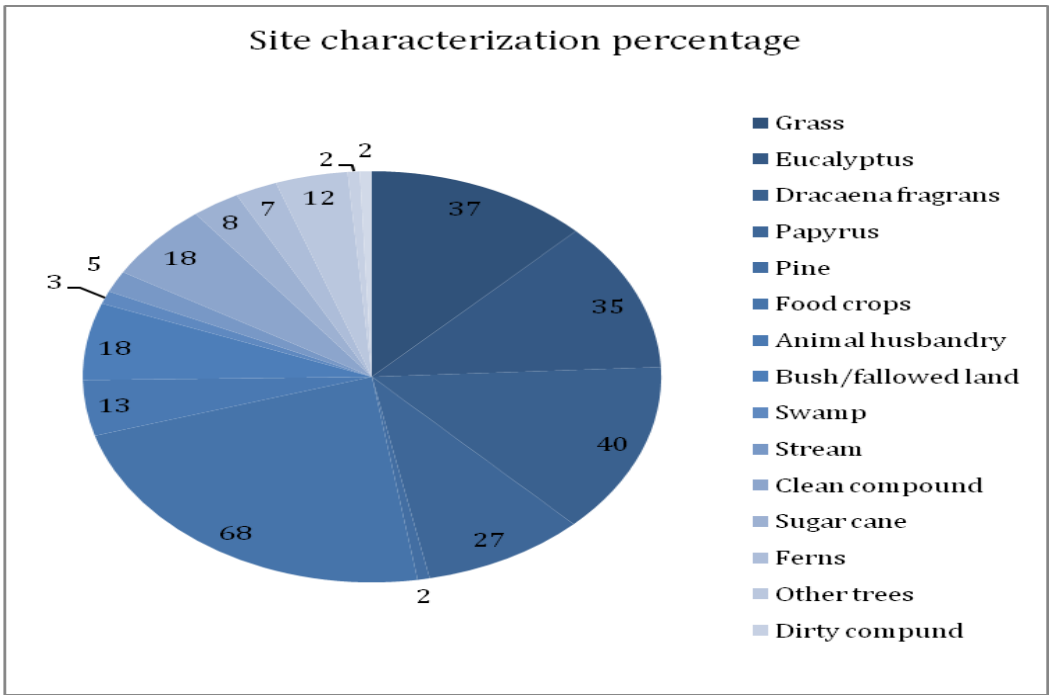

Figure 8: Site characterization percentages of the fish ponds and households

A content analysis of the results indicated that those households located in close proximity with fish ponds and that were surrounded with food crops and *Dracaena fragrans* live fence, suffered from higher malaria prevalence per a month. In figure 9 below are mosquito larvae at the base of the coco yam and *Dracaena fragrans* leaves. This implies that malaria prevalence in these households is not only accelerated by fish ponds but rather a multiple factors as already highlighted above.

Figure 9: Impact of growing crops near fish ponds and homesteads

4.3.2 Fish pond management

According to the responses fish farming is a complex process that requires expertise and training for successful implementation. For example fish pond management involves siting, stocking (3fry/m^2 for Tilapia and Mirror Carp and 4fry/m^2 for Catfish), pond fertilization, water quality maintenance (right pH, dissolved oxygen and temperatures), pond environment management, feeding techniques and formulations and fish sampling.

The fore-mentioned fish pond management requirements were a problem of concern particularly to those fish farmers who had attained lower levels of education (primary and even secondary) – approximately 72 % of the fish farmers were under these categories of education levels. Because of these management problems a few had abandoned fish farming, while a majority were still struggling to learn but they were achieving low fish yields.

According to majority respondents the abandoned fish ponds were a big health hazard since they provided fertile ground for mosquito breeding which in turn enhanced mosquito proliferation in the community. This is because the abandoned ponds remained uncovered and with resident stagnant water coupled with colonization with sedges and other water plants creating suitable mosquito breeding grounds.

Other fish farming management problems that were faced by most farmers are access to fish feeds particularly mash and fish meal that are sold expensively, unavailability of fry and presence of predators such as otter and birds. The expensive feeds have forced many farmers to resort to feeding the fish on cultivated crops such as cabbages, yams and weeds. But for many of the farmers, it is extremely difficult to access these feeds in sufficient levels for optimal fish yield. Thus most of them are not realizing higher benefits – and some of them have ventured into new income generating initiatives for additional income generation.

Figure 10: Impacts of poor fish pond management gaps on malaria incidence

4.3.3 Fish feed sources

According to the responses, the fish farmers obtain the fish feed from diverse sources as shown in Figure 11. These sources include cultivating the fish feed in their own farms, purchasing from shops or the neighbours crop, and in exceptional circumstances some accessed the feeds free of charge from the neighbours (particularly those without fish ponds – they would allow their neighbours to harvest weeds from their farms for fish feeding). The most common crops that were cultivated partly for fish feed are cabbages and cereals (the cereals were first ground into flour before using as fish meal). Additionally, leaves from other food crops such as coco yams, beans, potatoes and pumpkins are harvested and utilized as fish feed.

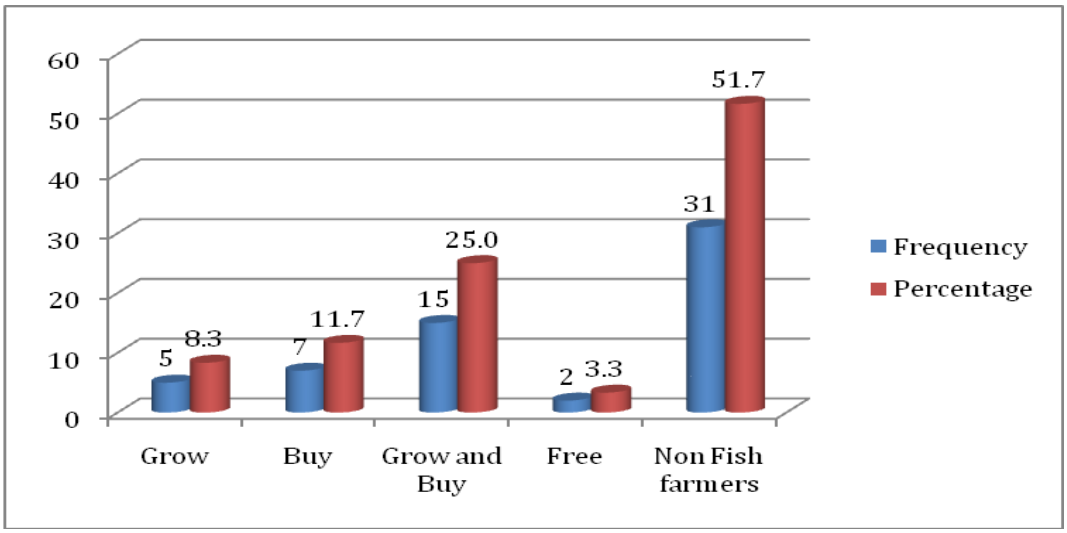

Figure 11: Fish feed sources

Some of these crops were found to be additional breeding grounds for mosquitoes. Furthermore, in some sites to create room for the cultivation of the crops entailed draining of swamps which in turn would pose adverse impacts on human health and the environment.

The cabbage crop is the one mainly grown partly for feeding fish as shown in figure 12.

Figure 12: Shows a cabbage crop that is grown partly for feeding the fish in Buhara sub-county.

4.4 Socio-economic impacts of malaria in Kabale

Besides the direct impact of malaria on health, the responses revealed that malaria also has several indirect health impacts that have been experienced in Kabale. The indirect impacts are missed school or work days, income lost through missed work days (Table 4), and expenditure on malaria treatment (Table 5).

4.4.1 Missed schools and work days

Results indicate that averagely a family member missed 7.6 days of school due to suffering from malaria and 11.2 days of missed work in a period of six months. Absenteeism from schools affects students' performance and hence lowers their chances to compete for opportunities in the society which is one of the main causes of

inequality[3]. Since most of the people in Kabale are employed in the informal sector and others self employed, absenteeism from work results in missed income which in turn leads to increased poverty and underdevelopment.

4.4.2 Lost income

The calculated average income lost due to absenteeism from work is 13,766.67 UGX (5.8 US$) per day. This is quite a lot of money on a village level because 1 US$) can feed a household for a meal in a day. Comparing the income and daily expenditures on basic needs such as food, fuel, health and so on, this is a big loss to a leader of a household who is the sole bread winner. Data shows the following statistics as indicated in Table 4 below.

Table 4: Income lost due to absenteeism from work due to malaria in six months

No. of days missed work	Rate per day (UGX)	Lost Income (UGX)	Lost Income (US$)
3	13,766.67	41300.01	17.40
4	13,766.67	55066.68	23.20
5	13,766.67	68833.35	29.00
7	13,766.67	96366.69	40.60
14	13,766.67	192733.38	81.20
30	13,766.67	413000.10	174.00
90	13,766.67	1239000.30	522.00

4.4.3 Expenditure on malaria

The average expenditure which is incurred for medical treatment if a family member in a household suffered from malaria in a month is 32,270 Uganda shillings (13.6 US$).

[3] Inequality is the differing shares of income and wealth, access to health care, education levels and power relations exhibited among the people of a particular country (Greig, 2007).

Table 5: Expenditure due to malaria in a month

Expenditure (UGX)	No. of respondents per expenditure in a month (N=60)	Percentage of total respondents (N=60)
0-6999	6	10.0
7000-20000	21	35.0
20001-33001	7	11.7
33002-46002	5	8.3
46003-59003	10	16.7
59004-72004	4	6.7
72005+	7	11.7
Total	60	100.0

5.0 Discussion

The results reveal that malaria is a major problem in Kabale. It has not only caused health impacts but also substantial socio-economic impacts. Fish farming is one of the main factors accelerating malaria prevalence in the study area. The main factor in fish farming playing a pivotal role in accelerating malaria prevalence include the use of *Dracaena fragrans* live fence, living in close proximity with fish ponds, cultivation of food crops which are sometimes also used as fish feeds near the fish ponds and fish pond management problems. However, due to some unclear patterns in some of the above factors such as residing close to fish ponds was an indication of other factors contributing to malaria prevalence in Kabale. The other factors accelerating malaria prevalence in the study area include brick-laying, sand mining, stone quarrying, wetlands and swamps reclamation, changing climatic conditions, ignorance and compromised immunity. Therefore, my discussion will be centred along the above issues.

Households located in close proximity with fish ponds that were surrounded by food crops such as cabbages, live fence composed of *Dracaena fragrans* and abandoned fish ponds suffered from higher malaria prevalence per a month. Matthys et al. (2006) and

Maheu-Giroux et al. (2010) have both shown that malaria prevalence was high in households that were in close proximity with the fish ponds – but though in this study a correlations was found in a few areas, in other areas no relationship was found between malaria prevalence and living proximal to fish ponds. Mugisha (2006) demonstrated that poorly managed and abandoned fish ponds contributed to mosquito proliferation. Also various cultivated plants around the fish ponds contributed significantly to vector reproduction for example water accumulation at the base of the stem of manioc (yam) leaves used as fish feed is an important site of mosquito reproduction. The abandoned fish ponds need to be refilled with soil to prevent resident stagnant water.

Most fish farmers had problems with fish pond management. Mugisha (2006) and Maheu-Giroux et al. (2010) highlighted fish pond management as one of the factors accelerating malaria transmission among the fish farmers. In this context, Maheu-Giroux et al. (2010) highlighted that malaria risks posed by fish farming could be alleviated by promoting good management practices which would make fish ponds a less favourable habitat for mosquito larvae. In addition to good management practices, fish pond suitability assessment needs to be ascertained before starting the practice.

The findings further show that the health care infrastructure in the district is constrained particularly in the aspects of availability of drugs, medical equipment, space and skilled health care personnel. According to Abaya et al. (2011) without adequate health care infrastructure, a country will have no capacity to respond effectively to increase in disease prevalence. This in turn implies that unabated rapid increase in malaria prevalence without matching efforts in provision for health care infrastructure could lead to a health crisis. To avoid crisis-end interventions, the government in collaboration with other stakeholders should strive to expand and develop the health care infrastructure in the district as a long-term pro-active strategy to reduce disease proliferation and their impacts on the community. According to Walker (2009) crisis-end interventions although desirable for addressing an immediate eminent disaster, they cannot be relied upon as permanent solutions to health problems.

In Kabale, one of the factor that were attributed to poor fish pond management was the levels of education among the fish farmers. Majority of the fish farmers had only attained primary and lower secondary education levels but due to the complexity of the procedures involved in fish pond management including siting, stocking, pond fertilization, water quality maintenance, feeding techniques and formulations. There is need for intensive education and training to bridge this management gap. The agricultural extension workers and farmers should periodically under take fish pond management refresher courses for better implementation, monitoring and evaluation.

In a few places respondents residing closer to fish ponds reported that they were much affected by malaria compared to those living in distal areas but in other areas this pattern was not clear. This would be a clear indication that besides fish ponds, there are many other factors that are contributing to malaria prevalence in Kabale. Among those highlighted by respondents include other land uses (brick-laying, sand mining, stone quarrying, afforestation, deforestation, wetlands and swamps reclamation for arable land), changing climatic conditions, ignorance, susceptibility and compromised immunity due to high prevalence of HIV/AIDS in the area. It can thus be concluded that fish farming is just one of the many factors affecting malaria prevalence in Kabale.

Similar findings have been highlighted by the work of Kiwanuka (2003) that man-made breeding sites such as construction work and brick pits in addition to poor environmental sanitation and anti-malarial drug resistance were responsible for malaria increase in Kabale. Matthys et al. (2006) urban agriculture has exacerbated malaria transmission in a medium-sized town in Cote d´Ivoire. Also work by Takken et al. (2005) indicated that anthropogenic activities such as agriculture, afforestation and livestock increased malaria incidence in the Amazon region in Brazil.

In addition to health impacts highlighted above, malaria has caused substantial socio-economic impacts in Kabale. According to UNAS (2007) the burden of malaria extends beyond deaths to missed school and work days resulting into personal and national economic losses. Mugisha (2006) indicated that averagely the number of missed days following a malaria crisis was between 5 and 7.5 in a period of one month. Ayieko et al.

(2009) found that the mean cost per admission at a national hospital in Kenya was US $ 95.58 for malaria. Sachs and Melaney (2002) demonstrated that malaria endemic countries have a lower rate of development because malaria impedes population growth, saving and investments, work productivity and increases medical costs. It is also estimated that a single episode of malaria costs the equivalent of 10 working days – socio economic loss (USAID 2006).

The study also revealed that there is a knowledge gap in prevention and control of malaria in Kabale. This was evident when majority of respondents indicated that one of the methods they use to control malaria was drinking boiled water. Additionally one mother indicated that she only sleeps under a mosquito net only when she is pregnant. In this context, intensive training and sensitization is required to increase awareness among the population on how to prevent and control malaria. Additionally, women should be given priority due to the fact that they encounter more contact hours with the home environment and ecosystems in most of the African countries. Empowering them with malaria prevention and control skills and knowledge would yield sounding results. For example some of the current methods used in prevention and control of malaria such as ensuring that children and pregnant mothers sleep under mosquito nets, early closing of windows and general household sanitation is mostly dependant on women.

Since malaria does not only cause health impacts but also causes socio-economic impacts leading to other global challenges such as hunger, poverty, under development and inequality, a holistic or systemic approach is required for it prevention and control. Malaria prevention and control, involves interplay of many factors which may partly be reasons why the current prevention and control methods have not been effective. The affected communities should not only take advantage of the various measures available to them but also reframe its fight. Weidong et al. (2006) argue that "reduction of aquatic habitats through environmental management mitigates malaria transmission not only by reducing emergence of host-seeking mosquitoes, but also by increasing the amount of time required for vectors to locate ovipositor sites". They further emphasise that the prolonged duration of the gonotrophic cycle is one of the important mechanisms underlying the effectiveness of environmental management interventions for malaria control.

The above insights further strengthen the need for the use of the eco-health approach to prevent and control malaria. The eco-health approach takes a holistic or systemic perspective thereby integrating different components of the ecosystem which appear to be isolated such as environment, health, economy and society. Plaen and Kilelu (2004) emphasised that through eco-health approach, individuals can understand better the complex interactions between the various components of the ecosystem which impact health as well as well-being among human populations. Understanding these complex interactions leads to development of proper management strategies which can improve people's well-being as well as sustainability of the ecosystem on which most of them depend for livelihoods.

6.0 Conclusion

Malaria was found to be a major problem affecting people in all the sub-counties in Kabale where the study was conducted. A relationship was found between fish farming and malaria prevalence in households whose fish ponds and homestead sites were characterised with crops such as coco yams and cabbages, *Dracaena fragrans* live fence and abandoned fish ponds. There was also a relationship in some areas between the distances from the fish ponds to the homestead where those living in close proximity to fish ponds exhibited a higher malaria prevalence compared to those living in distal areas – in other parts of Kabale however, such a relationship was not clear. It was found that fish farming is only one of the factors that contribute to malaria prevalence in Kabale. Other factors that contribute to malaria prevalence in Kabale include other land uses (brick-laying, sand mining and stone quarrying, wetlands and swamps reclamation for arable land), changing climatic conditions, ignorance, susceptibility and compromised immunity. Therefore, to effectively tackle the malaria problem, the government should address problems with fish farming and all the factors outlined above.

7.0 References

Abaya SW, Mandere NM, Winqvist N (2011) Health officials' perceptions of and preparedness for impacts of climate change variability on human health in the Somali region of Ethiopia. Mitig Adapt Strateg Glob Change DOI: 10.1007/s11027-011-9282-1

Abeku T, Cox J, Beard J et al. (2007) Detecting endemic malaria, Uganda. Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 13, No. 5, Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2738469/pdf/06-1410.pdf Accessed on 5th September 2010

Ayieko P, Akumu AO, Griffiths UK et al. (2009) The economic burden of inpatient paediatric care in Kenya: household and provider costs for treatment of pneumonia, malaria and meningitis. Cost Effectiveness and Resource Allocation 2009, **7**:3 Doi: 10.1186/1478-7547-7-3

Baliraine FN, Afrane YA, Githeko AK et al. (2010) A cohort study of *Plasmodium falciparum* Infection dynamics in Western Kenya Highlands. BMC Infectious disease 10:283

Bryman A (2008) Social Research Methods*:* Oxford University Press: Oxford

Carter N (2007) The politics of the environment: Second edition, Cambridge University press, New York

Center for Disease Control and Prevention (CDC) and malaria: Available at: http://www.cdc.gov/malaria accessed on 10th September 2010

Country survey on health and climate change (2009) Available at: http://www.thecommonwealth.org/files/191144/FileName/Uganda_2009.pdf accessed on 27th April 2011

Cox J, Hay SI, Abeku TA et al. (2007) The uncertain burden of *Plasmodium falciparum* epidemics in Africa. Trends in Parasitology, Volume 23 No.4: Elsevier Ltd. All rights reserved, Doi:10.1016/j.pt.2007.02.002

FAO © 2006-2010 (2005) National Aquaculture Sector Overview. Uganda. National Aquaculture Sector Overview Fact Sheets. Text by Mwanja WW In: FAO

Fisheries and Aquaculture Department [online]. Rome. Updated 19th July 2005. Available at: http://www.fao.org/fishery/countrysector/naso_uganda/en accessed on 5th September 2010

Forget G, Lebel J (2001) An ecosystem approach to human health. International Journal of Occupational and Environmental Health 7(2 Suppl):S3–S8

Githeko AK (2007) Malaria, Climate Change and Possible Impacts on Population in Africa. International Studies in Population 6 (1) 67-77, DOI: 10.1007/978-1-4020-6174-5_4

Greig A, Hulme D, Turner M (2007) Challenging Global Inequality – Development theory and practice in the 21st century, Palgrave/ MacMillan

Kiwamuka G (2003) Malaria morbidity and mortality in Uganda. J Vector Borne Diseases 40:16-19

Lebel J (2003) Health an Ecosystem approach: www.ecohealth.net

Lindblade KA, Walker ED, Onapa AW et al (2000) Land use change alters malaria transmission parameters by modifying temperature in a highland area of Uganda. 5 (4) 263-274

Lindsay SW, Martens WJM (1998) Malaria in the African highlands: past, present and future: WHO Bulletin OMS. Bulletin of the World Health Organization 76 (1) 33-45

Maheu-Giroux M, Casapia M, Soto-Calle et al. (2010) Risk of malaria transmission from fish ponds in the Peruvian Amazon. Acta Tropica 115 (1-2) 112-118

Mandere N (2009) Alternative agriculture and rural development: A case study of sugar beet cultivation in Kenya. PhD thesis, Department of Physical Geography and Ecosystems Analysis, Lund University, ISBN 978-91-85793-10-5

Masahiro H, Terao T, Minakawa N (2009) The Indian Ocean Dipole and malaria risk in the highlands of western Kenya PNAS 2009 106 (6) 1857-1862, Doi:10.1073/pnas.0806544106

Matthys B, Vounatsou P, Rosa G, et al. (2006) Urban farming risk factors in a medium-sized town in CÔTED'IVOIRE: Am J Trop Med Hyg 75: 1223-1231

Mugisha S (2006) Private Sector-led Aquaculture and Malaria in Western Uganda: Available at: http://www.idrc.ca/en/ev-83071-201_102155-1-IDRC_ADM_INFO.html accessed on 10th September 2010

Paaijmans KP, Blandford S, Bell AS et al (2010) Influence of climate on malaria transmission depends on daily temperature variation PNAS 2010 107 (34) 15135-15139, Doi:10.1073/pnas.1006422107

Patz JA, Olson SH (2006) Malaria risk and temperature: Influences from global climate change and local land use practices PNAS 2006 103 (15)5635-5636, Doi:10.1073/pnas.0601493103

Plaen RD, Kilelu C (2004) From Multiple Voices to a Common Language: Ecosystem Approaches to Human Health as an Emerging Paradigm: EcoHealth 1 (Suppl. 2), 8–15, 004, DOI: 10.1007/s10393-004-0143-1

President's speech (2007) on the official launch of prosperity for all themes: Available at: http://www.statehouse.go.ug/news.php?catId=2&&item=64 Accessed on 7th September 2010

Reiter P (2008) Global warming and malaria: knowing the horse before hitching the cart. Insects and Infectious Disease Unit, Institut Pasteur, 25-28 rue du Dr Roux, 75724 Paris, France. *Malaria Journal* 2008, **7**(Suppl 1)**:**S3doi:10.1186/1475-2875-7-S1-S3

Rutaisire J, Bwanika G, Walekwa P et al (2009). Fish farming as a business: Fountain Publishers Kampala-Uganda. ISBN 978-9970-02-964-8

Sachs J, Malaney P (2002) The economic and social burden of malaria: Center for International Development, John F. Kennedy School of Government, Harvard University, John F. Kennedy St., Cambridge, Massachusetts 02138, USA. Nature: Volume 415. Macmillan Magazines Limited. Available at: http://www.rollbackmalaria.org/cmc_upload/0/000/015/330/415680a_r.pdf accessed on 10th May 2011

Shanks DG, Hay SI, Omumbo JA et al. (2005) Malaria in Kenya's western highlands. Emerging Infectious Diseases: www.cdc.gov/eid. Volume 11, No. 9. Available at:

http://www.cdc.gov/ncidod/eid/vol11no09/pdfs/04-1131.pdf accessed on 5th May 2011

Snow RW, Craig MH, Newton RJC (2003) The public health burden of *Plasmodium falciparum* malaria in Africa: Driving the numbers: working paper No. 11, Disease Control Priority Project. Bethesda, Maryland: Fogarty International Centre, National Institutes of Health. Available at: http://archives.who.int/prioritymeds/report/append/610snow_wp11.pdf accessed on 5th September 2010

Takken W, De Vilarinhos PTR, Schneider P et al (2005). "Effects of environmental change on malaria in the Amazon region of Brazil" Available at: http://library.wur.nl/frontis/environmental_change/11_takken.pdf accessed on 25th March 2011

Tanser F, Sharp B (2005) Global climate change and malaria: The Lancet Infectious Diseases: Volume: 5 Issue: 5 Pages: 256-258

Tumwesigire S, Watson S (2002). Health seeking behaviour by families of children suspected to have malaria in Kabale: African Health Sciences Volume 2 No 3 Available at: http://ajol.info/index.php/ahs/article/viewFile/6785/13424 accessed on 3rd December 2010

Uganda Bureau of Statistics (2002) Uganda population and housing census report. Available at: http://www.ubos.org

Uganda Bureau of Statistics and Macro International Inc. (2007) Uganda Demographic and Health survey. Calverton, Maryland, USA: Available at: http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/Uganda%20DHS%202006%20Key%20Findings.pdf Accessed on: 7th September 2010

Uganda Bureau of Statistics (2009) Statistical Abstract on Uganda: Available at: http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/2009Statistical_%20Abstract.pdf accessed on 13th September 2010

Uganda National Academy of Science (2007) Malaria control and prevention strategies and Policy Issues. Available at:

http://www.nationalacademies.org/includes/malaria.pdf accessed on 10th May 2011

United Nations (2000) The Millennium Development Goals report, New York

United Nations (2007) The Millennium Development Goals report, New York

UNDP (2007) Uganda's progress report on Millennium Development Goals, available at: www.undp.or.mdgs accessed 1st September 2011

United Nations Foundation (2010) Preventing Malaria: http://www.unfoundation.org/global-issues/children's-health/preventing-malaria-deaths.html, accessed April 2010

USAID (2006) Kabale district IRS project report. Available at http://pdf.usaid.gov/pdf_docs/PDACI230.pdf accessed on 19th April 2011

Walker R (2009) Climate change and primary health care intervention framework. Aust J Prim Health 15: 276-284

Weidong G, Regens JL, Beier JC et al (2006) Source reduction of mosquito larval habitats has unexpected consequences on malaria transmission. 17560-17563: PNAS: Volume 103: No 6: Doi_10.1073_pnas.0608452103

World Health Organisation (2009) Malaria report Available at: http://www.who.int/malaria/publications/country-profiles/profile_uga_en.pdf accessed on 5th December 2010

World Health Organisation (2010) Text by Hollyman S. In: WHO facts on malaria: Available at: http://www.who.int/features/factfiles/malaria/malaria_facts/en/index1.html accessed on 3rd September 2010

Yin RK (2009) Case Study Research: Case Study Research: Design and Methods. Fourth Edition. SAGE Publications. California, ISBN 978-1-4129-6099-1

Zhou G, Minakawa N, Githeko AK et al. (2004) Association between climate variability and malaria epidemics in the East African highlands PNAS 2004 101 (8) 2375-2380; Doi:10.1073/pnas.0308714100

8.0 Appendix

Appendix 1: Questionnaire

Questionnaire for Land use change impacts on people's health in a mountainous terrain: A case of aquaculture on malaria incidence in Kabale district, Uganda

Farmer's Name ……..……..…….. Village ……..……

Parish …….. Sub county ……..

District ……..
Country……..

GPS coordinates

(North=1 South=2) NS…….. HH1……-…… dd

(East=1 West=2) EW…… HH2…… - …….. dd
Altitude (meters above sea level) MASL ……

Date of interview
(dd/mm/yy)……

Pond site characterization
……
……

Section A: Household Characteristics.

1	Farmer's age in Number of years	1= 18 years and below 2= 18 - 36 years 3= 36- 54 years 4= 54 and above 45
2	Sex	1= Male 2=Female
3	Farmers using treated mosquito nets and reason	1= yes, reason 2=No, reason
4	Farmers using untreated mosquito nets	1= yes, reason 2= no, reason
5	How many fish ponds do you own?	
6	Distance range of homestead from	1= 0 - 0.5km

	fish ponds	2= 0.5 - 1.0km 3= 1.0 - 1.5km
7	Number of household members	1= 1-2 2= 2-4 3= 5-7 4 = above 7
8	Household type	1=Male headed one wife 2=Male headed more than one wife 3=Female headed no husband 4=Single man with children, no wife
9	How often do you come to your family from your place of work? If applicable	
10	Other forms of income?	
11	What is your level of education?	

Section B: Perceptions about Malaria and aquaculture

12	Why or Why not practice fish farming? If yes, when did you start?	
13	If yes, When did you start?	
14	How much money do you get from selling fish?	
15	When did you first hear of malaria in Kabale	
16	Has it increased or decreased?	
17	Give reason for the above	
18	How do you deal with malaria	
19	Where do you seek health care when you fall sick?	
20	How far is the health centre from your home?	
21	Effectiveness of the current methods of dealing with malaria 1 = Very effective 2= effective 3= moderate 4= poor	Mosquito nets Insect repellents Insecticide spays Tablets Mosquito coils Mosquito traps
22	Receptiveness to new methods of dealing with malaria	
23	Are there other problems associated with fish farming?	
24	What land use practices would be linked to malaria?	

25	Who takes care of the fish ponds	
26	Do you think fish farming is associated with an increase in malaria?	
27	What do you feed the fish on?	
28	Where do you grow it or buy it from	

Section C: Socio-economic burdens of malaria in the study area

29	How many times a month do family members fall sick of malaria?	
30	How much money do you spend on in a month if someone suffered from malaria?	
31	How many days do your family members miss school due to malaria over the last six months?	
32	How many days do your family members miss work due to malaria over the last six months?	
33	How much money do they lose when they miss work?	
34	Is malaria a serious killer disease in your family?	
35	Breeds kept in your fish pond	
36	Challenges of fish farming	