EFFECTS OF FLOODS ON ECONOMIC VALUE OF CROPS, LIVESTOCK PRODUCTION AND LAND AMONG COMMUNITIES OF NYANDO AND BUDALANGI IN THE LAKE VICTORIA BASIN, KENYA

BY

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ABSTRACT

Increasing frequency and intensity of extreme climatic events such as floods are likely to increase the vulnerability of poor households and communities in developing countries. The Lake Victoria basin of Kenya, specifically Budalangi and Nyando sub-counties are characterized by frequent floods which often affect economic activities of communities residing in the region thus increasing their vulnerability to subsequent flood events. However, the combined effect of floods on economic value of crops, livestock and land are little understood. This hampers appropriate adaptation strategies, resilience, climate smart agriculture and other related intervention measures by the locals. This study sought to model the relationship between economic value of crops, livestock and land as influenced by floods using the Ricardian Model. Specific objectives were to estimate the effects of floods on crop yield among households living within Nyando and Budalangi, Kenya; to model the economic effects of floods on animal production among households living within Nyando and Budalangi, Kenya and to model the effects of floods on the economic value of land among households living within Nyando and Budalangi, Kenya. Across-sectional research design was adopted for this study. Data was collected from 424 randomly selected households from the two flood prone regions using questionnaires. The findings showed that most (59.3%) respondents were male, with 51.9% of household members aged between 26-55 years. Most (91.4%) respondents inherited the land on which they lived, while crop farming was the main (67.7%) source of livelihood, though most (83.7%) households did not generate enough income for their use. Over half (59.9%) the respondent were agro-pastoralists, while 39.2% practiced agriculture. All respondents grew food crops on their farms, with majority (41%) growing maize. However, the food harvested in the previous season lasted less than 3 months for most (38.5%) households. Livestock (especially cattle) keeping was practiced by most (87.1%) households, predominantly for food. Floods affected 57.7% of the respondents, with livestock rearing being affected according to 95.5% of the respondents. Upto85.2% reported losing some livestock over the last 20 years. The Ricardian Model explained 38.6% of crops and livestock variations with respect to floods. The effect of floods was higher in Nyando than Budalangi. Upon simulating floods effects on crops and animal losses, the negative impacts on crops tended to be of a higher magnitude than on animals. A tendency was observed for increased floods to be beneficial to rice and potatoes as opposed to other crops. The Ricardian model further indicated that among the households surveyed, production was more important in their decision-making than the flood event. Decreased flood intensity generated a moderately positive effect on the land value, with a simulated scenario showing a decrease in floods with an increase in land value of6% the usual price. Findings from this study will improve scientific knowledge of the impact of floods on specific livelihood sources of the LVB inhabitants and therefore inform specific strategies of adaptation and mitigation.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Floods, unpredictable rainfall and other extreme weather conditions are a few examples of climate change impacts. There is considerable historical evidence showing that extreme climatic conditions, such as floods, have increased considerably and this has severely affected crop and animal production globally (James, 2002; Ouedraogo *et al.,* 2006; Barbier *et al.,*2009; Zorom*et al.,* 2012; Traore *et al.,* 2013). The seriousness of global climate change and climate variability has led to a growing interest in assessing the vulnerability of households, communities and regions to the rapidly changing environmental and economic conditions (Fazey *et al.,* 2010). However, despite the worldwide coverage of extreme climatic events such as floods, there exists inter and intra-sectoral variation in vulnerability to their effects depending on location, adaptive capacity, socio-economic factors, as well as household characteristics (Senbeta, 2009).

The impact of extreme climatic events such as floods is believed to be enhanced in Africa; a continent that has contributed the least to the factors that lead to the accelerated climate change (Hulme *et al.,* 2005). This situation has been attributed to the continent's low adaptive capacity, overdependence on rain-fed agriculture, high poverty levels, habitation of flood prone regions and existence of many other stressors at the community and household levels (Collier *et al.,* 2008).

In sub-Saharan Africa, droughts and floods are two extreme climatic events that adversely affect the agricultural sector, and by extension the households. These climatic events often have severe socio-economic impacts such as shortages of food, water, energy and other essential basic commodities, as well as long-term food insecurity (IPPC, 2001). Past studies (Jones *et al.,* 1997), suggest that the direct and indirect effects of floods on crop yields and crop management, livestock production and livestock yield as well as many other livelihood sources are normally massive and they impact more on the most vulnerable populations. The negative consequences of flooding in Africa is already being felt most by communities living in flood prone regions across the continent especially the poor who rely heavily on rain fed agriculture. This in essence affects crop and livestock production which then undermines both the short and long-term efforts aimed at improving the living standards of communities living in the LVB while achieving sustainable development within the region. Despite this, information on the magnitude and extent of floods on the economic value of crops and animals among the LVB inhabitants is still lacking.

Floods are a common phenomenon in Kenya, with the country ranked among the 16 worst affected tropical countries during the 1997/98 *El Niño* event which resulted in severe floods after major rivers in the country attained record peaks causing havoc and destroying livelihoods (Gadain *et al.,* 2006). In recent times, floods have increased in frequency and magnitude leading to crop damage and livestock losses. The high population within the Lake Victoria basin has worsened the impacts of climatic events such as floods owing to the immense pressure that they have exerted on land resources through land fragmentation and poor cultivation methods (Barbier *et al.,* 2009).

Whereas a general observation has been made and detailed spatial information on flood extent given, the related socio-economic impacts of flooding coupled with household characteristics on economic wellbeing of communities living within flood prone regions is largely lacking, yet this level of data is very useful in any comprehensive analysis of flooding effect on vulnerable communities.

In the Lake Victoria Basin (LVB) floods are likely to worsen the already existing poverty levels, given their direct impacts on critical sources of livelihood such as agriculture and food security, water resources as well as human and livestock health (Mogaka *et al.,* 2006; Mugisha *et al.,*2007). Studies by ISDR (2004) showed that recurrent floods have high economic implications on the affected households and can easily trigger food insecurity, thus impact negatively on the economic wellbeing of the affected communities. This can restrict or hamper long term growth in the affected regions (ISDR, 2004). The studies by Mogaka *et al.* (2006) and Mugisha *et al.* (2007) on the LVB did not however clearly establish how household characteristics combine with flooding events to influence livestock production and crop yield among communities residing within the basin.

Given that 98% of Kenya's agricultural crops are rain fed and only 19% of Kenya's potential agricultural area is equipped for irrigation, the high rainfall variability coupled with frequent floods pose a significant economic and livelihood risk of loss to the affected households. The high population growth rate within the Lake Victoria basin of Kenya is likely to worsen the situation by a projected doubling of the demand for land, food, water and livestock forage within the next 30 years, further impacting on poor households (Davidson *et al.,* 2003). Upon simulating the number of occurrence of floods, the negative impacts on land value could be higher or lower in magnitude than in other unaffected regions. This is clearly missing and thus needs to be modeled and their repercussions evaluated within the Lake Victoria basin; the outputs of which would guide specific strategies of adaptation and mitigation.

The major food crops grown within the Lake Victoria basin of Kenya are maize, beans, rice and bananas, while sorghum, millet, and root crops, such as cassava and sweet potato are considered important food security crops (Kairu, 2001). Among these, maize is regarded as the most important cereal crop accounting for over 80% of the national production of cereals, yet it is also one of the most sensitive to climatic variability (Ouma *et al.,* 2002). However, while floods may affect some crops negatively, others such as rice tend to record higher yields during flooding, hence the need to establish the exact effects of floods on crop farming. The major livestock types that are kept in the LVB include cattle, sheep, goats, chicken, pigs and donkeys. However, unlike in the arid regions of Kenya where large herds of livestock are kept by single households, most households in the LVB are agro-pastoralists who keep a small number of livestock, while others practice zero grazing for subsistence purposes (Gichere *et al.,* 2013).

In an attempt to estimate property values in the affected areas, some researchers focused on earthquakes(Palm, 1982; Scawththorn *et al.,* 1982; Brookshire *et al.,*1985; Beron *et al.,* 1997; and Yamaga *et al.,* 2002), others have concentrated on flooding and floodplain locations (Okayo *et al.,*2015; Gichrere *et al.,* 2013; UN, OCHA, 2006; Babcock and Mitchell, 1980; Burby and French, 1981; Muckleston *et al.,* 1981; Sheaffer and Greenberg, 1981; Changnon *et al.,* 1983; MacDonald; Tamai and Ishihara, 1999). A few of these studies attempted to determine the effect of a disastrous event on land prices, but the methods used differ and findings on whether a disastrous event affects land prices are sometimes contradictory. In any attempt to ascertain the effect of flood damage on land prices in Kenya or other African countries, an important consideration is that the price of a piece of land greatly exceeds the value of any buildings or agricultural practice on it. Land prices, agriculture and building values therefore should be evaluated separately, and property values as the sum of them. This study therefore sought to determine the effect of flood damage on land prices and agriculture in flood prone regions of Budalangi and Nyando within the Lake Victoria basin of Kenya.

The overall economic implications of floods effect on households include, destruction of crops, lowering in value of land, death, loss of livestock from flood waters and increased health care expenditure; all of which can push more people below the poverty line by consuming the affected household's savings during treatment thus undermining the livelihoods and contributing to further impoverishment of the already vulnerable households (IPCC, 2012).

Future rainfall projections for Kenya up to the year 2030 broadly indicate that there will be increases in annual rainfall, with highest amounts expected in western parts of Kenya around Mount Elgon, Elgeyo Escarpment and Cherangani Hills (the catchment of River Nzoia which drains through Budalangi sub-county). If these projections are accurate, there are likely to be far-reaching effects on the intensity and frequency of floods in the region (Mango *et al.,* 2007). As a result of increased frequency and intensity of floods, thousands of people living in the lowlands could be forced to move to higher ground and adopt various coping measures to survive. While these coping measures may be successful in the short term, they often have severe implications for longer-term livelihood sustainability. Many of the measures people adopt allow them to survive the impact of floods but not to recover from it. The resulting 'loss and damage' and inadequacy of coping mechanisms occasioned by floods therefore suck people into an ever-more vicious cycle of poverty.

Budalangi and Nyando are two regions in the Lake Victoria basin of Kenya that have always experienced severe flooding events over the past decade (Odada *et al.,* 2009). In Budalangi for instance, households experience about 60% annual reduction in food production and about 76% of the households become food insecure every year (Gichere *et al.,* 2013). Households suffer from shortfalls in food production because of prolonged and recurrent floods and disease and other related factors. However, information on the repercussion of floods on crops and as well as households characteristics that determine adaptation strategies still remains undocumented.There are practically no studies in the Lake Victoria basin that provide data or quantifiable relationships among climatic factors, households characteristics and economic values of crops and animals, that would allow for development or application of models to orient strategies of response to flooding events for these two regions.

Despite the high sensitivity of the LVB region to climatic events, little focus has been given to understanding the close relationship between household characteristics and flooding events and how a combination of the two influence the socio-economic status of communities residing within flood prone regions of the Lake Victoria basin of Kenya. This gave the impetus to carry out investigations within the Lake Victoria basin region in a bid to understand the extent of loss and damages caused by floods and their economic implications to the affected households.

While the economic theory postulates that non floodplain regions are likely to have high crop production yields, higher income and reduced poverty levels, the opposite is true for floodplains within the Lake Victoria Basin of Kenya where poverty levels have remained high raising doubts as to whether the changing climate and its associated floods have any positive significant contribution to the livelihoods of the people residing within this region. Despite the acknowledgement of floods as a disaster with negative impacts on vulnerable communities, most of the studies in the LVB have remained mainly descriptive without any economic or statistical modeling, hence the need for this study. This paradoxical situation thus informed the investigation of the effects of floods and household characteristics on economic activities of the communities residing in the two regions within the LVB.

Lack of information on the impacts of floods on livelihood sources among communities and the lack of advance flood warning mechanisms means that the population is often caught unawares, every time floods occur, leaving no lead time to take preventative measures. In the absence of effective response to disasters, flood risk management in Kenya has remained largely inconsistent, uncoordinated and reactive as opposed to being proactive (ROK, 2007; Karanja *et al.*, 2002). Therefore, coping with flood hazards can only be developed by first evaluating the vulnerabilities of individual households and reporting the effects of such climatic events on individual households appropriately, as was done in this study.

1.2. Statement of the Problem

Nyando and Budalangi regions are often faced with floods whenever heavy rains are experienced in the western parts of Kenya. Recurrent floods have often caused havoc among people leading to destruction of crops, animal deaths among other losses; all of which exacerbate the poverty levels that are already prevalent among the LVB region inhabitants. Floods are a therefore a threat to food security among inhabitants residing within Nyando and Budalangi regions in the LVB owing to their overdependence on rain-fed agriculture, limited resources and weak response mechanisms.

While many studies have focused on the effect of floods on vulnerable communities, hardly has any study attempted to establish the exact effects of floods combined with household characteristics on the livelihood sources (mainly crop and animal production) of households residing within the Lake Victoria Basin of Kenya. In addition, there is no empirical or statistical evidence on the magnitude and direction of influence of the household characteristics on the existing relationship between floods and livelihood sources at household level. This study therefore sought to establish the combined effect of floods and household characteristics on the livelihood sources; with specific focus on crop and animal production among residents of Budalangi and Nyando in the Lake Victoria basin of Kenya.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of this study was to determine the effect of floods on economic value of crops, livestock production and land among communities of Nyando and Budalangi, Kenya.

1.3.2 Specific Objectives

The study was guided by the following specific objectives:

a) To estimate the effects of floods on crop yield among households living within Nyando and Budalangi, Kenya.
b) To model the economic effects of floods on animal production among households living within Nyando and Budalangi, Kenya.
c) To model the effects of floods on the economic value of land among households living within Nyando and Budalangi, Kenya.

1.4. Hypotheses

a) Floods have no effects on crop yield among households living within Nyando and Budalangi, Kenya.
b) Floods have no effect on livestock production among household living within Nyando and Budalangi, Kenya.
c) Floods have no effect on economic value of land among households living within Nyando and Budalangi, Kenya.

1.5 Study Justification

The entire LVB covers a surface area of 194,000 Km^2, with an approximate human population of 12.5 million people on the Kenyan part of the LVB alone (Odada *et al.,* 2009). Presently, food productivity does not meet the food demand due to, in part; high population growth and declining animal production, declining crop yields resulting from deteriorating soil productivity due to soil erosion that has been enhanced by extreme climatic events like flooding (GoK, 2008). Heavy precipitation and flooding in over-cultivated land is likely to induce soil erosion which in turn leads to loss of fertile soils and subsequent reduction in food crops and fodder.

In Kenya, it is widely acknowledged that improved food productivity is key to the country's socioeconomic development. As such, the government has developed a number of programs to help households improve on food security via crop farming and animal keeping (GoK, 2008).Agriculture sector, of which 70% is dominated by subsistence farming, forms the foundation of the national economy and constitutes the primary source of livelihood for the overwhelming majority of the population. According to World Bank (2010), the agricultural sector employs 85% of the labour force and contributes about 35% to gross domestic product and 73% to total export revenues. In addition, approximately 85% of household food and nutritional security is derived from the agricultural sector.

Extreme climatic events such as drought and floods have worsened food production and food security scenarios in Kenya. This has been worsened by the fact that the local communities are exclusively dependent on rain-fed agriculture. For instance, Kenya experienced a reduction in agricultural production by 3.1% in 1997/1998 that was again followed by a 3.5% drop in 2000 and 2001 and another 10% decline in mid 2004 (Gitu, 2004). In 2008, about 1.1 million people;

on average 242,000 households, were food insecure due to extreme climatic events such as droughts and floods.

Nationally, the impacts of extreme climatic events and the strategies used by household to counter the effects are widely recognized. However, little is known about the economic impact of such events vis a vis household characteristics with regards to crop yield, animal production and land value in specific regions such as Nyando and Budalangi. This study therefore sought to explore the economic impact of floods on the value of household livelihoods to inform decision makers on better design or implementation of climatic and weather variability adaptation programmes. The information is also important for the design of effective climatic and food security related projects in Nyando and Budalangi regions of western Kenya where the frequency and magnitude of floods has increased and become unpredictable.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This chapter reviews empirical and theoretical literature related to the study. The chapter encompasses the following sub themes: The influence of floods on crop yield among households living within the LVB of Kenya; The effects of household characteristics on the relationship between floods and crop production among households living within the LVB of Kenya; The influence of floods on livestock production among households living within the LVB of Kenya; The effects of household characteristics on the relationship between floods and livestock production among households living within the LVB of Kenya; effects of floods on land value, description of the Lake Victoria Basin, flooding events and their effects on households; community-wide economic effects of climate vulnerability and climate change; and mitigation strategies for climate variability and change impacts among households. The theoretical review of factors influencing communities' response to climate change and variability is also given.

2.2. Influence of Floods on Crop Yield among Households Living in Flood Prone Areas

Evidence from the Intergovernmental Panel on Climate Change (IPCC, 2007) is now overwhelmingly convincing that climate change is real, and that its' extreme climatic events among them floods will worsen, with the poorest and most vulnerable people likely to bear the greatest brunt. The IPCC (2007) acknowledges that climate change is a long term global problem that has been unfolding over many decades. The Food and Agricultural Organization (FAO, 2008a) reported that as a result of climate change, the wet regions are expected to become wetter while dry regions could become drier. A world Development Report by World Bank (2010) on climate change reported that unpredictable weather patterns are likely to reduce agricultural productivity especially in the tropical regions, with extreme climatic events such as floods likely to directly affect poor people's livelihood assets, including crops, livestock, access to clean water, destruction of homes and infrastructure. The report further observed that increasing frequency of floods followed almost immediately by devastating droughts will likely increase the poor households' vulnerability, by impacting negatively on their livelihood sources, key among them food crop production. This would exacerbate the incidence, severity and persistence of famines, which would then trigger food insecurity in affected areas.

This World Bank Report (2010) was based on a wider area; comparing the low, mid and high-income countries without showing the magnitude of the effects of climate change on the various household livelihood assets such as crops and livestock production. In addition, while the World Bank (2010) report was based on studies conducted at a large scale and comparing different countries based on income levels, its findings cannot be applied to gauge the effect of floods on economic activities of households living in specific flood prone regions at the local scale and with different household characteristics, as was done in this study. The World Bank Report (2010) also failed to establish the critical role played by household characteristics on increasing or reducing the severity of the impacts of extreme climatic events including flooding on livelihood sources.

Studies by AfDB *et al.,* (2003) showed that many sectors including the agricultural sector that provides basic livelihood sources to the poor in developing countries are not able to cope with today's climate variability and stresses. This same report (AfDB *et al.,* 2003) cited a significant reduction in water availability and accessibility, poor crop yield, low animal produce as well as increased human and animal diseases as some of the sectors that are already being impacted directly by climate change, and thus pose a real threat to food security in many African countries.

Climate variability is especially important to Kenya's agricultural sector, which, like most African countries, is entirely dependent on bimodal rainfall (GOK, 2010). Like many other studies across the globe, the impact of floods tends to be generalized often at a larger scale thus ignoring the impacts of the same at the lowest (household) level; a gap that this study sought to fill.

Agriculture which forms the basic livelihood source for a large proportion of the rural poor is also the most climate-sensitive sector (IPCC, 2007). In regions where livelihood sources are limited to rain-fed agriculture; as is the case in most parts of the Lake Victoria basin, a decrease in crop yield resulting from climate variability would trigger famines among the affected communities (Skoufias *et al.,* 2012). In areas where livelihood sources are limited, decreasing crop yields and water scarcity threaten families, forcing communities to seek alternative options such as migration to other areas (AfDB, 2003).

The actual economic losses among households resulting from destruction of livelihood sources such as crops and livestock that are normally triggered by extreme climatic events like flooding for instance are usually massive and in most cases accompanied by psychological stress to the affected communities (Olago, 2005). Climate variability therefore undermines attempts to reduce poverty and food insecurity especially among the poor. Reports project that food production, including access to food, in many African countries will be severely compromised by climate variability and change (IPCC, 2007; Thompson *et al.,* 2010).

It is projected that unpredictable rainfall patterns and increased frequency and magnitude of floods will add to the stress on agriculture across many regions of developing countries, including Kenya by reducing crop yields. Although there is concurrence that increasing frequency and magnitude of floods and its effect on agricultural productivity, including value of land, there is little quantified information on the potential economic impact. Furthermore, the monetary value of land often depreciates based on the position and the condition of the piece of land in question.

According to FAO (2008a), the greater impact of increased climatic variability in the short term on food security could come from the projected increases and severity of extreme weather events such as floods rather than from gradual changes in the climate. Already, food production is not keeping pace with the ever growing population in most developing countries in Africa, with some researchers picking out climate change as one of the potential causes of the recent upsurge in food prices (Ringler *et al.,* 2010).All in all, while floods have been reported as having direct and indirect effects on crop production, it is still not clear how floods impact on livelihood sources of households with different socio-economic characteristics but residing within the same region.

2.3. Effects of Household Characteristics on the Relationship between Floods and Crop Production

The macroeconomic costs of the impacts of floods on households are highly uncertain, but very likely have the potential to threaten development in many countries. Studies show that natural hazards when occurring on their own are not harmful. However, when they interact with people, they are likely to cause damage of varying magnitudes with some resulting in disasters (Smith and Ward, 1998). It would, however, be important to establish which specific household characteristics would sufficiently cushion a household or community from the devastating effects of floods in the LVB. Senbeta (2009) reported that disasters occur when natural hazards interact with vulnerable communities, property and livelihoods such as crops and livestock causing varying degrees of loses depending on the level of vulnerability of the individual, group or households affected. Separate studies by Mendelsohn *et al.* (2007) and McMahon *et al.* (2011) both concluded that the overall income of most rural households is affected by climate, with the mechanism of transmission being specifically agricultural income through crop and livestock losses. These two studies, however, assume that most or all rural households rely on the same livelihood sources or have similar household characteristics which may not always be the case.

It is thus important to emphasize that the extent to which climatic events impact on households depends not only on the magnitude of the climatic event itself but also on the household characteristics including level of adaptation as well as the financial ability of the affected household to respond to the effects of such adverse climatic events (Jacoby *et al.,* 2011). Household's vulnerability to food insecurity triggered by destruction of crops due to adverse climatic events such as floods is exacerbated by a range of factors that weaken the household's ability to cope with or manage such climatic events. The factors include low levels of human and physical capital, insufficient access to assets and services (public or private), weak institutional structures, inexistent or inefficient social protection programmes and greater exposure to uncertainty in the physical and economic environment (Skoufias *et al.,* 2011). These factors reflect households' lower adaptive capacity and higher susceptibility to the impacts of extreme climatic events.

Kabubo-Mariara and Karanja (2007) observed that the livelihoods of most rural households in Kenya are closely linked to the general climatic conditions of their regions. Agriculture is by far the mainstay of the LVB inhabitants with good fertile land available for farming (Oyugi *et al.,* 2003). Almost three quarters of the Kenyan labor force still depends on the agricultural sector for their livelihoods, while most of the farmers depend entirely on timely and adequate rainfall for crop production (FAOSTAT, 2010). However, unfavourable climatic conditions and frequent occurence of extreme climatic events have hampered production and affected the economic status of those dependent on it (Otiende, 2009). This is worsened by the high poverty levels among most households who also happen to be the majority living in high risk areas such as flood plains. A report by the Government of Kenya (GOK 2005) showed that fifty-two percent of the population in Kenya live below the poverty line, mostly in rural areas, while the poorest of the poor are more vulnerable and mostly found in the northern arid zones of the country (Save the Children, 2007). Other studies have also shown that more than 80 percent of the rural poor are located in the high potential areas of Lake Victoria and Mount Kenya (GOK, 2005).

A study by Otiende (2009) on economic impacts of climate change in Kenya focusing on riparian flood impacts and cost adaptations in the Lake Victoria and Lower Tana River basins reported that during floods, homes are destroyed, livestock is affected, crops are destroyed, both human and livestock health is compromised, traditional family systems are completely broken down and there is often no security as homes are deserted, roads become impassable, children are cut off from schools, latrines and buildings collapse, while families are forced to squeeze in makeshift camps without adequate shelter, food, privacy or sanitation and are therefore literally reduced to beggars who depend on relief rations for survival (Otiende, 2009). Otiende's study however, gave a general overview of the effects of floods on Lake Victoria and Tana River basin inhabitants but did not give impacts on individual households as these are bound to be different based on the different vulnerabilities driven by the varying adaptation mechanisms and household characteristics.

In addition, while Otiende (2009) focused on riparian floods on two different basins (i.e. Lake Victoria Basin and Tana River Basin) the current study explored the impact of floods on livelihoods of households living within two known flood prone regions taking into consideration their household characteristics and their possible link to agriculture and livestock production. The study was further informed by the fact that food security and family wellbeing are threatened when the resource base on which household heads especially women rely on to carry out their critical roles and obtain supplementary incomes is undermined.

Some of the socio-economic factors that increase vulnerability to floods at the community level include: poverty and low income levels which prevent long term planning at the household level; high illiteracy levels; inadequate or lack of appropriate and empowered institutions; poor settlement patterns; high population densities and other factors that inhibit population mobility (Smith and Ward, 1998). Other socio-economic characteristics such as age, income level, level of education and gender can also influence the nature of response of a household to natural disasters (AfDB *et al.*, 2003).

Vulnerability may differ seasonally or at different times within people's lives. It also differs across groups within communities or households, owing to their livelihood activities or social standing as well as the geographical location of their homes. The poor are often the most exposed to extreme climatic events such as floods owing to their limited choice of place of residence or their limited and non-diversified sources of livelihood (AfDB *et al.*, 2003).

Households draw on a range of coping strategies in times of stress; although those available to the very poor are often more restricted and less resilient. A study by AfDB *et al.* (2003) however, showed that even in situations where certain communities or households are adapted to a particular climatic stress, an increase in intensity of the stress, frequent climatic extremes such as flooding, or abrupt changes in climate can cause severe shocks that ultimately affect the communities or households.

Studies also show that the unpredictability and increased frequency of climate extremes such as floods reduces the recovery time for poor households to adjust from one climatic shock to another. Traditional coping strategies may not be appropriate in this context because in most cases they only lead the poor to rely on ad-hoc and unsustainable responses. Beckam *et al.* (2002) while conducting a study on coping and adaptation strategies of households and local institutions in Central Vietnam noted that while people often use a number of strategies to move out of poverty, increased frequency of the climatic events and high vulnerability makes them slip back easily into poverty at a later date indicating a close linkage between climate variability and community or household safety nets. It would however be imperative to establish how households living in flood prone regions but with different socio-economic characteristics are able to cope with recurring flood events especially within the Lake Victoria basin of Kenya.

Settlement patterns within the LVB are partly influenced by population pressure, with a tendency for slums to develop in areas designated as flood-prone (Odada *et al.*,2006). Settlement on steep slopes as well as cultivation on such lands is also common thus increasing vulnerability to natural calamities such as floods and landslides which are likely to impact on agriculture (Afifi and Warner, 2007). Encroachment and settlement on floodplains, overstocking far in excess of the carrying capacity of the land, and destruction of riverine forests for settlement and farming purposes have all been identified as some of the factors contributing to increased flood hazards (EPA, 2006). A study by Otiende (2009) showed that the geographical location of residence plays a critical role in determining exposure to flooding among households.

Apart from the highly unpredictable and frequent climatic events, other characteristics that increase household's vulnerability to climate change effects include: household assets (physical, social and human capital), income source characteristics, exposure to climate-change risks and the financial capacity to cope with weather shocks or other climate events (Davies and Leavy, 2009). Schmidhuber and Tubiello (2007) stated that extreme climatic events are not a new phenomenon in the agricultural sector, but are generally expected to increase in frequency and magnitude, while areas subject to extreme events are likely to expand. This is becoming worrisome due to the high dependency on rain-fed agriculture by many households including those living in the LVB of Kenya. Therefore, establishing the extent of flood impacts on crop production among households with different household characteristics is of utmost importance, especially within the Lake Victoria basin of Kenya where such information is clearly missing.

2.4. Relationship between Floods and Livestock Production in Flood Prone Areas

Livestock is an invaluable asset for rural families in term of milk, meat, drought power and as a source of household's income. Flooding of areas meant for livestock production results in a variety of negative impacts. The magnitude of impacts depends on the vulnerability of the affected population, as well as the frequency, intensity and extent of flooding. In vulnerable places, important livestock diseases are likely to increase in severity as well as spread to new regions. The effect of recurrent floods on agriculture is not therefore limited to crop production but also has far-reaching consequences on livestock rearing either directly or indirectly via impacts on pasture, water and exacerbated livestock diseases as demonstrated by Niaber and Hahn (2007) in their study of livestock production system management and response to climatic factors.

Floods may affect animal production indirectly by threatening the availability of feed and shelter. Like agricultural crops, pasture fields can be completely destroyed and stocks of hay and other animal feeds washed away. Feed deprived and shelter less animals can become stressed so severely that there immune system is reduced increasing the risk of contracting contagious diseases or reducing their production. Experts predict that climate change will likely hurt the small livestock keepers who in most cases form the majority within East and Central Africa region (van de Steeg *et al.,* 2009). The impact that climate change brings about often exacerbates the vulnerability of livestock systems and reinforces existing factors that simultaneously affect livestock production systems. For rural communities, losing livestock assets to floods might lead to their eventual collapse into chronic poverty with long-term effects on their livelihoods. However, a study by Jacoby *et al.* (2011) showed that the impacts of flooding on the various sectors of agriculture can be heterogeneous even within a single region.

What most of these studies fail to bring out clearly is the level to which household characteristics influence the impact of floods on animal production among households operating under different socio-economic status, but residing within the same high risk area. This implies that different households could be affected to varying degrees by floods owing to their household characteristics and the type and number of livestock kept.

2.5. Effects of Household Characteristics on the Relationship between Floods and Livestock Production among Households

High food prices result in a deterioration of real income for the affected households and since most households in the LVB region do not have good asset base, increased food prices would exacerbate their sensitivity and limit their access to food (Cooper *et al.,* 2008). A rise in food prices, fall in livestock prices, depletion of food reserves without replacement, deterioration of human and animal health due to floods and contamination of clean water are some of the direct and indirect economic consequences that result from the severity of extreme climatic events such as floods on livestock keeping among the poor and susceptible communities (UN-OCHA, 2006). Due to increased frequency and unpredictability of floods in the LVB region, every little effort made by communities in the area to improve their economic situation; such as divesrifying their livelihood sources by keeping different types of livestock is always eroded through extreme climatic events like floods (IPCC, 2001). The dependency syndrome emanating from regular food relief and recurrent flood have hampered the communities' capacity to rid themselves of food insecurity (UNDP, 2008).

Mogaka *et al.* (2006) in their study on climate variability and water resources degradation in Kenya reported that the 1997/98 *El Niño* floods caused serious damages to water supply infrastructure including dams, water pans and pipelines as well as the transport network across the country, which made access to water for livestock a nightmare for the small scale farmers who own livestock in the affected regions, thus contributing to increased cost of animal production in the affected communities. However, the study by Mogaka *et al.* (2006) only focused on the effects of floods on major public infrastructure such as roads, telecommunication lines among others, and how they affect communities countrywide and therefore could not establish the specific effects of floods on communities' livelihoods such as livestock production and agriculture at a local scale. This study thus sought to establish how floods affect crops and livestock production in communities living in flood prone areas within Lake Victoria basin of Kenya.

2.6 Effect of Flooding on the Value of Land

Most studies have focussed on the effects of natural disasters on property values in the affected areas. Some have focused on earthquakes (Okayo *et al.,* 2015, Gichere *et al.,* 2013; Palm, 1982; Scawththorn *et al.,* 1982; Brookshire *et al.,* 1985; Beron *et al.,* 1997; and Yamaga *et al.,* 2002), others have concentrated on flooding and floodplain locations (Babcock and Mitchell, 1980; Burby and French, 1981; Muckleston *et al.,* 1981; Sheaffer and Greenberg, 1981; Changnon *et al.,* 1983; MacDonald; Tamai and Ishihara, 1999; Yabe and Murayama, 2000). All these studies attempted to determine the effect of a disastrous event on land prices, but the methods used differ and findings on whether a disastrous event affects land prices are sometimes contradictory.

For example, in the case of flooding, most studies have attempted to detect a discount for a floodplain location (i.e., the net effect of all attributes that affect property values), rather than focus primarily on flood damage. Furthermore, most of the data available is insufficient to conclude whether flood damage resulting from floodplain activities is reflected in the fair market value of floodplain property (Chao *et al.,* 1998). After the Tokai flood of 2000, civil engineers, disaster scientists, and hydrologists conducted many surveys and studies in an attempt to clarify the characteristics of the flood and the direct damage done, but no one looked into the indirect damage, such as the falling off of property values such as land.

In any attempt to ascertain the effect of primary flood damage on land prices in Japan, Korea, or other Asian countries, an important consideration is that the price of a piece of land greatly exceeds the value of any buildings on it. Land prices and building values should therefore be evaluated separately, and property values as the sum of them. This study therefore sought to determine the effect of flood damage on land value, rather than building values; in particular, the value of land in the flood prone regions of Budalangi and Nyando within the Lake Victoria basin of Kenya.

2.7. Mitigation Strategies against the Impacts of Climate Variability and Change Impacts among Households

People often develop coping strategies to deal with climate variability and change just as they do with other shocks or stresses. These include building social networks as forms of insurance, traditional forecasting in order to be better prepared for climate variability and changes and developing ingenious means of protecting assets such as constructing raised granaries to keep away flood waters (IPCC, 2007; Otiende, 2009). However, the poor households' range of coping strategies are naturally more restricted owing to their low financial capabilities, lack of assets and by other stresses on their livelihoods. It must, however, be remembered that there is no single specific coping strategies that can be applied across the board and that each household would require specific intervention measures depending on their household characteristics. Since climate extremes are 'covariant risks' (*i.e.* simultaneously affecting a wide range of people), current safety nets are likely to be overwhelmed. This includes both formal systems (e.g. social assistance), and informal systems (e.g. social networks).

Establishment of accurate and early warning systems with linkages up to the household levels is therefore an ideal first priority option in flood management which can only be achieved given enough information of the economic impact on individual households in relation to reccuring flood events. Equally important is the preparation of contingency plans for evacuation and relief measures during the event itself (Twigg, 2003). However, financial, human, and technical resources for sustainable flood management measures have always been scarce in developing countries like Kenya, and lack of these resources limits the country's responsiveness to natural disasters (Gullet *et al.,* 2006). Many institutions handling natural disasters in the country are often faced with inadequate budgetary allocations and in most cases depend on unpredictable donor support (UNEP, 2009).

The Government of Kenya and other stakeholders have always undertaken several measures to control floods, especially in flood prone areas by constructing dykes along major rivers (Gullet *et al.,* 2006). However, construction of dykes has not been very successful in the country due to their inability to sustainably control the floods (Karanja *et al.,* 2002). As such, the vulnerable people within the community continue to bear the greatest impact of extreme climatic events like floods.

2.8. Theoretical Review of Factors Influencing Communities' Response to Climate Change and Variability

The existence and extent of climate change is a topic of great importance to climate scientists as well as individuals, groups, and organizations (Weber, 2010). Despite its environmental, social and economic importance, climate change is a phenomenon that is not easily and accurately identified by the lay public, using their normal tools of observation and inference (Weber, 2010).

However, literature on public understanding of climate change indicates widespread awareness of the issue and a general concern, but limited behavioral response towards its mitigation (Palm, 1998). Unlike, climate change effects, most elements of climate variability (floods, droughts, high rainfall among others), which are also driven by climate change, are well known to communities, probably due to their frequency and recognizable effects on the affected households.

The disparity between public awareness and concern about climate variability and change on the one hand, and the limited behavioral response on the other is consistent with the widely-reported 'value-action' or 'attitude-behavior' gap (Blake, 2001; Kollmuss and Agyeman, 2002). The public understanding of climate change and climate variability literature indicates that individuals perceive a wide variety of barriers to engaging with climate change, while the perceptions literature also suggests that there are other barriers, including social and institutional (Blake, 2001). However, there are only a few examples in the literature which explicitly address some of these barriers. Stoll-Kleemann *et al.* (2001) for instance highlighted the psychological barriers to climate change mitigation strategies.

There is a general consensus among the scientific community in recent years that major anthropogenically - induced climate variability and change can have cumulative and fundamental effects on the earth's natural systems over the next several decades, with studies already showing that concern over climate variability and change has increased over the past two decades (DEFRA, 2002) and especially since 2003 (GlobeScan, 2006). However, while people associate climate variability and change with negative feelings and maintain that they are very concerned, the issue is not one of the public's main environmental concerns (Poortinga and Pidgeon, 2003;

OST and MORI, 2004). Whilst it is considered socially relevant, most individuals do not feel that it poses a prominent personal threat (Lorenzoni and Pidgeon, 2006). It has been observed that health, security, and other social issues are often considered more important than environmental issues by the public (Norton and Leaman, 2004; Poortinga and Pidgeon, 2003). A number of social and cultural factors, such as the general way in which climate variability and extreme climatic events such as floods are treated in the mass media, may help perpetuate the lack of urgency that the public perceives regarding climate related risks (Michael *et al.*, 2006).

The level to which individuals understand the causes and consequences of climate variability and change, and the extent to which they regard either of them, as harmful to their well-being, may correspond to their personal lifestyle decisions and willingness to support climate change policy initiatives (Bostrom *et al.*, 1994). These perceptions may mediate human interaction with the environment (Saarinen *et al.*, 1984). Attempts have been made to model the various factors that influence decisions and perceptions in dealing with climate variability and change (Stamm*et al.*, 2000). The Theory of Planned Behavior, for example, which postulates that beliefs (about the behavior in question, subjective norms and perceived behavioral control) determine intention to act and consequent behavior has been used to predict environmental behavior (Hines *et al.*, 1987). However, this theory has been critiqued on the grounds that it presents an overly individualistic and rational perspective of behavior, and as such, more contextual models have been proposed (Guagnano *et al.*, 1995).

Virtually all current theories of choice under risk or uncertainty are cognitive and consequentialist (Loewenstein *et al.*, 2001). These rational choice models typically assume that people analytically assess the desirability and likelihood of possible outcomes to arrive at a calculated decision. Thus, most theorists assume that decision making about risk is essentially a cognitive activity (Leiserowitz, 2006). Mental model approaches, however, are still primarily cognitive, which focus on the role of scientific information and knowledge in the formation of public's environmental beliefs and misconceptions (Leiserowitz, 2006).

Environmental scientists, decision makers and risk communicators are increasingly becoming aware, that simply providing more detailed and accurate information, while important, is not sufficient to generate appropriate public concern for some risks or to allay public fears about others (Leiserowitz, 2006). Critiquing the cognitive paradigm underlying most risk perception and mental models research, Zajonc (1980) argued that affective reactions to stimuli are evoked automatically and subsequently guide rational information processing and judgment. Cultural theorists on the other hand are also of the opinion that social values and worldviews also play an important role in risk perception and behavior (Douglas *et al.,* 1998). Cultural theory focuses on how different individuals and groups interpret the world in different, yet patterned ways (Douglas *et al.,* 1998). Cultural theorists argue that hierarchists, individualists, egalitarians and fatalists each identify and define different risks that threaten their own preferred way of life. Each world view thus represents a different 'rationality;' a set of presuppositions about the ideal nature of society which leads each group to perceive different risks and prefer different policy responses (Leiserowitz, 2006).

Summarizing the convergent findings of numerous theoretical studies, Epstein (1994) stated that "experientially derived knowledge is often more compelling and more likely to influence behavior than is abstract knowledge". Likewise, Nisbett and Ross (1980) argued that vivid, concrete information has a greater influence on perceptions and inferences than 'pallid' (e.g., abstract and technical) information. Action that follows from climate change perceptions can be informed by different processes. For instance, affect-based decisions about climate change are unlikely to motivate significant action, as politicians and the general public are not particularly worried about climate risks, and because attempts to scare people into greater action may have unintended negative consequences (Leiserowitz, 2006).

Likewise, analysis based decisions are also unlikely to result in significant action, because of large discounting of uncertain future costs of climate risks compared to the certain and immediate costs of climate change mitigation. Rule-based decisions that determine behavior based on moral or social responsibility may hold out the best prospects for sustainable action. Moreover, fostering actions that would mitigate or help adapt to climate change is only possible if those actions are consistent with personal values (Leiserowitz, 2006). Such values themselves may vary among people and communities, depending on local context factors such as community well-being, occupations, poverty levels, and key resident characteristics (Leiserowitz, 2006).

Nevertheless, societal perspectives of climate change need to be integrated within the policy process on an on-going basis, to explore the understanding of climate change by heterogeneous publics through time and shape policies accordingly. Framing is one important process by which communicators can enhance their impact on the public by linking messages and recommendations to their audience members' deeply held values and beliefs (Leiserowitz, 2006). This can be done by defining or "framing" the relevance of climate change in ways that connects to the core values of specific audience segments, and repeatedly reinforcing that information through a variety of trusted sources and networks of recruitment. Purposive communication can for instance foster enhanced public engagement on the issue. The public health frame that climate change is a major threat to people's health and well-being has considerable potential to motivate individuals to reduce greenhouse gas emissions and take adaptive actions to reduce their health risks from expected impacts (Leiserowitz, 2006). The health frame for instance is thought to be one of the most effective ways since it connects a complex and poorly understood topic (such as climate change) to the risks that the public already understands and accepts as important (e.g., asthma, respiratory problems, vulnerability to extreme heat, food-borne illness and infectious disease) (Haines *et al.,* 2009).

CHAPTER THREE: STUDY DESIGN AND METHODOLOGY

3.1. Introduction

This chapter introduces the study methodology that was used in achieving the objectives of the present study. It particularly outlines the study design, the study area, population of the study area, sampling technique and sample size; sampling procedure, study instruments, study validity and reliability. The data analyses and the softwares used are also highlighted.

3.2. Study Area Description

This study was conducted in two flood prone regions (Nyando and Budalangi) within the LVB of Kenya which lies between latitude 0° 20'- 3^0 00'S and longitude 31^0 39'- 34^0 53'E, with an approximate human population of 12.5 million people (Odada *et al.,* 2006). The climate of the basin is largely influenced by the lake with parts of the basin experiencing periodic floods while others experience arid conditions. The region's continued population growth accelarates the depletion of natural resources exacerbating the effects of climate change and variability on the LVB inhabitants. Up to 70% of this population live in rural areas and practice small-scale agriculture and fishing as the predominant economic activities(KNBS, 2007). However, despite its great importance, Otiende (2009) observed that some parts of the LVB region are seriously impacted by adverse climatic events mostly floods. Indeed a study by Olago (2004) on climate and hydrological variability and extremes in the Lake Victoria basin showed that the economic performance of the Lake Victoria basin region of Kenya is heavily influenced by climate variability. Olago (2004) further noted that substantial declines in economic growth are often registered during extreme climatic events among them floods. Riverine floods are the most dominant in Kenya and often occur along floodplains including Budalangi and Nyando regions as a result of exceeded stream flow capacity, leading to spillover of the natural banks or artificial embankments (Smith and Ward, 1998).

Figure 3.1. Map of the Lake Victoria basin of Kenya showing the location of the two study areas (1) Budalangi and (2) Nyando regions

Since the two study areas for instance Budalangi and Nyando regions are both highly prone to floods and were selected to enable the study to establish the influence that household characteristics have on the relationship between floods and livelihood sources (crop farming, livestock production and economic value of land) among households residing in the two areas. Each of the two different study sites is briefly described in the paragraphs that follow.

The Nyando area covers 1,168.4 km^2 and is found within the Lake Victoria basin of Kenya, much of it being in the Kano Plains, and lies between an altitude of 1120m and 1150m a.s.l. The region receives an annual average rainfall of about 1835mm, though the frequency of heavy precipitation events especially in the lower areas is higher (Otiende, 2009). The area is characterized by periodic floods with some of the major flood events in the area documented to have occurred in 1937, 1947, 1951, 1957-1958, 1961, 1964, 1985, 1997-98, 2002, 2003, 2007 and 2009 (Ogallo *et al.,* 2000). Of these floods, the *El Nino* related floods of 1997/98 constituted one of the greatest flood episodes experienced not only in the Nyando region, but also in other parts of Kenya including Budalangi region.

The Budalangi area covers approximately 188.3 km^2 in surface area and lies within the Western part of Kenya near the shores of Lake Victoria. Budalangi division has a population of about 66,723, and a population density of 354 persons per square kilometer (KNBS, 2010). It is one of the major flood prone areas in Western Kenya (Mango, 2003; ROK, 2004). Major flood disasters in the region were reported in 1945, 1948, 1951, 1961 – 1962, 1975, 1977, 1978, 1997 –1998 (El Nino rains), 2001, 2002 and 2003 (Mango, 2003). The latest flood disaster was experienced in December 2011. Floods have often left a history of destruction in Budalangi and in the recent times, floods have been reported to displace not less than 25,000 people every time they strike (Otiende, 2009). These disasters have direct, indirect and secondary effects on the economy and development of the region. However, the region also experiences dry spells most times of the year.

3.3. Study Design

This study adopted a cross-sectional research design which entailed collection of quantitative data from study respondents using questionnaires.

3.4. Study Population

The study respondents were derived from a target population of adults aged between 18 and 80+ years living within the two selected regions of the Lake Victoria Basin, Kenya, as determined by the 2009 Kenya Population and Housing Census. The target population was 66,723 for Budalangi, and 350,353 for Nyando region (KNBS, 2010) bringing the total target population for the study to 417,076.

3.4.1. Sample Size Determination

The sample size was determined from the target population of adults living within Nyando and Budalangi counties of Kenya. The formula as described by Fisher *et al.* (1998) for sample populations exceeding 10,000 was used in calculating the sample size as shown below. A confidence level of 95% was assumed.

$$n = \frac{Z^2pq}{d^2}$$

n= minimum sample size

Z= Standard normal deviate at the required confidence level (error 5% Z = 1.96)

P= Proportion of subjects in the sample population estimated to be affected by floods. [Flood conditions affect majority of community members (over 95% of the population), therefore, 95% was taken as the proportion of subjects in the sample population affected by floods].

q=1-p

d= Absolute precision expressed as a fraction of 100 (accuracy level of 5 % chosen = 0.05).

$$n = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384$$

An additional 10% was added to cover for the anticipated non-responses and spoilt questionnaires and to increase the power of the study.

10% of 384 = 38.4≈ **38**

The minimum sample size was therefore 212 respondents from each study site, making a total of 424 respondents in the study. A total of 418 respondents responded to the questionnaires.

3.4.1.1. Inclusion criteria

All adults aged between 18 and 80+ years living within the two selected regions of the Lake Victoria Basin, Kenya, and who gave their informed consent to participate in the study were included.

3.4.1.2. Exclusion criteria

Individuals below the age of 18, those living outside the two selected study regions and those living in the study regions but did not give their informed consent to participate in the study were excluded.

3.5. Sampling Design, Instruments and Data Sources

A multi-stage sampling method was used to randomly select 418 households from the sample frame list. Sample frame list was collected from Nyando and Budalangi sub-counties Agricultural Offices respectively. Firstly, the study purposively selected 26 villages from which it randomly sampled out 418 households. From 418 households, the study collected data using a household questionnaire. Primary data included household characteristics, crop and animal production. Addition, information on the population characteristics was obtained from the Kenya National Population and Housing Census report (KNBS, 2010). The interview schedule was tested within the sample population and the results of the pretest discussed with the interviewers and necessary adjustment made to the schedules.

3.6. Estimating Economic Losses on Households from Various Sectors

Households are often faced with huge losses in different sectors ranging from their source of livelihoods e.g. crop and animal farming to their health as well as the local economy. Various methods were used to estimate the economic losses resulting from floods on the most critical sectors among the LVB inhabitants as given in sections that follow.

3.6.1. Estimating Economic Losses Arising from Livestock Loss As A Result Of Climate Change Markers

The number of livestock lost due to flooding events was estimated based on the responses obtained from the study questionnaires among households in the two study regions. This was done to establish the approximate amount of monetary loss incurred per household resulting from death of livestock. The livestock studied included: cattle, sheep, goats, chicken, pigs and donkeys. However, several assumptions were made, such as: the current market price of a particular livestock type was deemed the same in the two study areas, that the losses in livestock were spread over a twenty year period (1991-2011), and that the average number of livestock owned by each household was the same for a particular study area.

3.6.2. Estimation of Economic Losses Arising From Crop Failure

In estimating the economic losses arising from crop failure during the previous growing season, data on actual yield as well as the expected yield was collected from the respondents in the two study areas by use of a structured questionnaire. The economic losses resulting from crop failure due to inability by households to reach their target yield (expected yield) in the previous growing season was computed for the two regions by calculating the difference between the expected and the actual yield attained. In the estimation, the price of a 90kg bag of a given food crop was obtained from the current market prices (as at April, 2012) and was assumed constant in the two regions. It was also assumed that the average expected yields per household were the benchmark upon which the yields from previous growing seasons were measured.

3.7. The Ricardian Model

The Ricardian model approach is based on statistical relationships between climatic variables and economic indicators. An advantage of this approach is that producer adaptation to local climate conditions is implicitly considered. Ricardian model has gained popularity among economists and is based on the idea that land value, derived from efficient land use and the existence of competitive markets, represents the present value of expected net revenue. This model calculates the effects of variations in climatic, economic and non-economic variables on the value of arable land using disaggregated information. The essential building blocks in the Ricardian risk analysis are hazard, exposure, vulnerability, and loss. Hazard represents the occurrence and severity of adverse events. Exposure characterizes the asset(s) at risk. Vulnerability describes the potential damage to the exposure, corresponding to varying degrees of hazard severity. Risk is expressed in terms of the probability of exceeding specific levels of direct losses (in physical and monetary terms).

The Ricardian Model postulates the relationship between productivity and climate (Mendelsohn *et al.,* 1994), by numerically estimating the impacts of climatic variables on crops and animals variables. The RM incorporates livelihoods, using economic proxy variables, such as rural incomes, or, as in this study, the education levels of the household heads. The fundamental supposition of the Ricardian Model (RM) is that the agricultural producer seeks to maximize economic utility, making decisions based on the market prices and other factors, such as climatic variables. The fundamental development of the RM was by Mendelson et al. (1994) and it has been applied in the United States (Mendelsohn *et al.,* 1994; Mendelsohn, 1996; 1999; 2001), Brazil (Mendelsohn *et al.,* 2001), India (Dinar *et al.,* 1998 Kumar and Parikh, 2001), Great Britain (Maddison, 2000) and Canada (Reinsborough, 2003).The indicated principle is described in equation (1) (Mendelson *et al.,* 1994), which constitutes the fundamental expression of the RM:

$$V = PLE\, e\Phi tdt = f\, [\Sigma\, Pi\, Qi\, (X, F, Z, G) - \Sigma\, RX]\, e\Phi tdt \quad (1)$$

Where V is the basic or intrinsic value of agricultural activity, represented by productivity; PLE is the quantifiable economic proxy variable; Pi is the market price of production i; Qi is the quantity of produce; X is a vector of non-agricultural economic income; F is a vector of the climatic variables considered (floods); Z is a set of land variables; G is a set of other economic variables, such as access to markets and transportation; R is a vector of the prices of inputs and expenses x; t is time; and Φ is the rate of discount. The RM integrates and examines how a set of independent exogenous variables (F, Z and G) affect the dependent variable productivity, using; as was indicated, an economic proxy variable. Given the practical and conceptual difficulty of objectively measuring productivity (V), in equation (1), the RM is expressed in simplified form (2), and in function of a proxy variable (Mendelson *et al.,* 1994):

$$PLE\, e\Phi tdt = f\, [\Sigma\, Pi\, Qi\, (X, F, Z, G) - \Sigma\, RX] \quad (2)$$

Describing the fundamental conceptualization of RM in the specific terms of this study, the dependent proxy variable land value responds to the marginal influence of flood and of other agricultural and market variables that are further expressed in the following quadratic regression (3) (Mendelson *et al.,* 1994):

$$PLE = B0 + B1F + B2\, F2 + B3\, Z + B4\, G + u \quad (3)$$

Where: B0 is the intercept; B1 is coefficients of the climatic variable vector (flood) in its lineal (F) and quadratic (F2) expressions; B3 is the coefficient of the vector of variables of land (Z) and B4 of the vector (G) of variables of the related market value, and "u" is the term of perturbation or regression error. The quadratic expression (3) reflects the non-lineal form that the value of the land acquires as a response to the incidence of the variable flood. When the coefficient B2 of the quadratic term F2 is positive, the function of the response of the value of the land is a convex-shaped curve, and when B2 is negative, the function has a concave-shaped curve (Mendelson *et al.,* 1994). The RM postulates, based on agronomic information, that land value takes a concave shape in response to flood; that is, that there is a given flood where the value of the land is maximum, which changes with every farm (Mendelson *et al.,* 1994).

3.7.1. The Concepts behind Ricardian Model

The RM does not explain the mechanisms of adaptation of agricultural producers to flood, nor does it establish or verify the decisions and/or perceptions of the future of the producer; it only reflects the behavior of a dependent variable, the land value, in response to the effect of independent variables. To do this, the RM requires information from farmers with regard to the scenario of flood event and their decisions that that enable them to adapt to the flood events (Mendelsohn *et al.,* 1994).

It is expected that: (i) to maximize benefits of crop and animal production, the farmer should take decisions that add value to those that reduce it, or increase costs of the products, and (ii) that this behavior can be expressed in the same terms that applies to the equation of the RM (1), as is expressed in (4) (Mendelson *et al.,* 1994):

Max= PiQi (X, F, Z, G) - RX (4)

The present study of the application of the RM (Mendelson *et al.,* 1994) is based on obtaining economic and productive information, by means of surveys, from small and medium/large-scale farmers in Budalangi and Nyando, and the integration of information, fundamentally on land and flood event, obtained by means that will be indicated further on.

3.8. Data Analysis

The data collected from 418 household heads was entered and cleaned in Microsoft Excel for subsequent analysis using SPSS software. Differences between variables (flood prone regions and economic impacts based on livestock produce and crop yields) were analyzed using R software. The study defined variables considered to estimate the econometric modeling of this study as follows (Table 3.1).

Table 3.1: Variables used in the Ricardian Model

Variables	Measurements
Gender	1= Male; 0 = Male
Education	Years
Labour	Man-day
Land size	Acres
Income	Kshs/US$
Age	Years
Floods	1 = Yes; 0 = No
Crop diversification	1 = Yes; 0 = No
Crop yields	Kg/sack
Animal diversification	1 = Yes; 0 = No
Animal production	Cost per unit

3.8.1 Applications of the Ricardian Model

First, important relevant variables were calculated, such as the number of flood occurrence in the past 20 years, with the goal of describing and understanding the productive and social-economic context of the agricultural producers who were surveyed, and who also constitute the direct inputs for the application of the RM. Secondly, two groups of adjustment regressions were carried out, in accordance with the inclusion or not of the independent flooding event variable, versus the dependent variable crops, animals and land value.

Each group of adjusted regressions were evaluated and scenarios considered included: (i) the totality of the surveyed producers; (ii) those producers who declared having lost their productivity due to flooding event; (iii) those who experience reduced frequency of flooding events (iv) small-scale producers; (v) medium/ large scale producers; (vi).Up to eight (8) mentioned flood scenarios, which have a certain possibility of occurring, were simulated of the effect of flood on estimated land value.

3.9. Validity and Reliability Tests

Instrument Validity is the extent to which an instrument measures what it is supposed to measure and performs as it is designed to perform. It is rare, if not nearly impossible, that an instrument be 100% valid, so validity is generally measured in degrees. As a process, validation involves collecting and analyzing data to assess the accuracy of an instrument. To ensure instrument validity with a high degree of accuracy, the content selected and included in the data collection tools were all relevant to the variables under study and answered the study objectives accordingly. In addition, no defects in research instruments were allowed to curb biases or systematic errors that could lower the validity of the findings. According to Kombo and Tromp

(2006), respondents may give incorrect answers to impress the interviewer, a situation known as respondents' effect. This type of error was surmounted by supplementing the responses with secondary data on crop harvests and livestock costs obtained from market reports, while the Kenya Integrated Household Survey report of 2005-2006 (KNBS, 2006) was used to help estimate the economic impacts of climatic variations, based on the frequencies of the affected respondents. This also helped in avoiding recall bias from respondents who may not have been able to remember exact climatic related events and their impacts on economic status. Secondary data from population census was also used to estimate economic losses due to flood related disease prevalence.

The sampling tools were pre-tested in a pilot study on a few respondents who were, however, not included in the final study. Necessary changes were made to the sampling tools before final administration. Content validity, sometimes called logical or rational validity, is the estimate of how much a measure represents every single element of a construct. It was determined by evaluating test items against the test specifications drawn up through a thorough examination of the subject domain so as to ensure that it covered a representative sample of the items to be measured. Questionnaires were carefully drafted to ensure that each question covered a specific area or objective of the study. Construct validity was upheld by ensuring that the variable relationships were specified and by examining the empirical relationships between the measures of the concepts.

3.10. Ethical Considerations

Verbal consent was obtained from all the study respondents before their participation in the study, and after the participants had received detailed information about the study. To help assure anonymity, the respondent's names were left optional. Clearance for the collection of health and medical data was sought from the relevant authorities in the Ministry of Health offices, located in the different study regions, before obtaining any health records. Authorization to carry out the research was sought from the Director, School of Graduate Studies (SGS), Maseno University. Prior authority to conduct the study was also obtained from the County Commissioner's offices in the two counties (districts by then) that were studied. District officers, area chiefs, and other stakeholders were consulted.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

4.1. Introduction

This chapter presents the detailed analysis of the data collected during the study and interpretation of the results. A summary of the findings is presented based on the questions asked as informed by the study objectives and hypotheses that the study sought to answer as stated in section 1.4. In the study, a total of 422respondents were targeted out of whom 418 responded.

4.2 Diagnostic Analysis and Regression Model

Associations between crops, animals were correlated among factors using Pearson correlation. For analysis of effects of flood crops and animals were entered into a regression model. There were no strong correlations among factors, thus it was possible to identify which explanatory variables were most important to be included in the model. Thus, all the dependent variables were included in the model as shown below (Table 4.1 and 4.2). R software, version 3.1.0 was used for both correlation analysis and the regression models.

Table 4.1: Descriptive Statistics of crops grown by households

	Floods	Maize	Sorghum	Millet	Green grams	Groundnuts	Rice	Potatoes
Mean	1.58	1.54	1.98	1.55	1.87	1.93	1.95	1.93
Std. Deviation	.495	.499	.137	.498	.333	.254	.209	.258
Skewness	0.311	0.144	7.045	0.203	2.251	3.402	4.380	3.330
Std. Error of Skewness	.119	.119	.119	.119	.119	.119	.119	.119
Kurtosis	1.912	1.989	47.854	1.968	3.083	9.617	17.268	9.134
Std. Error of Kurtosis	.238	.238	.238	.238	.238	.238	.238	.238
Minimum	1	1	1	1	1	1	1	1
Maximum	2	2	2	2	2	2	2	2

Source: Survey Data (2014)

Table 4.2: Descriptive Statistics of floods against livestock

	Floods	Cattles	Goats	Sheep	Chicken
Mean	1.05	1.70	1.81	1.74	2.99
Std. Deviation	.209	.998	.309	.158	.689
Skewness	4.378	3.342	.883	1.567	-.562
Std. Error of Skewness	.119	.119	.119	.119	.119
Kurtosis	17.259	12.126	8.122	37.072	.767
Std. Error of Kurtosis	.238	.238	.238	.238	.238
Minimum	1	1	1	1	1
Maximum	2	6	3	3	4

Source: Survey Data (2014)

4.3. Demographic Characteristics of Respondents' Households

Figure 4.1 depicts the responses pertaining to the relationships of household members to the household head. From the findings, it was clear that most (47.6%) of the household members were heads, followed by children (24.6%), then spouses (23.7%) and lastly relatives, at 4.1% (Figure 4.1).

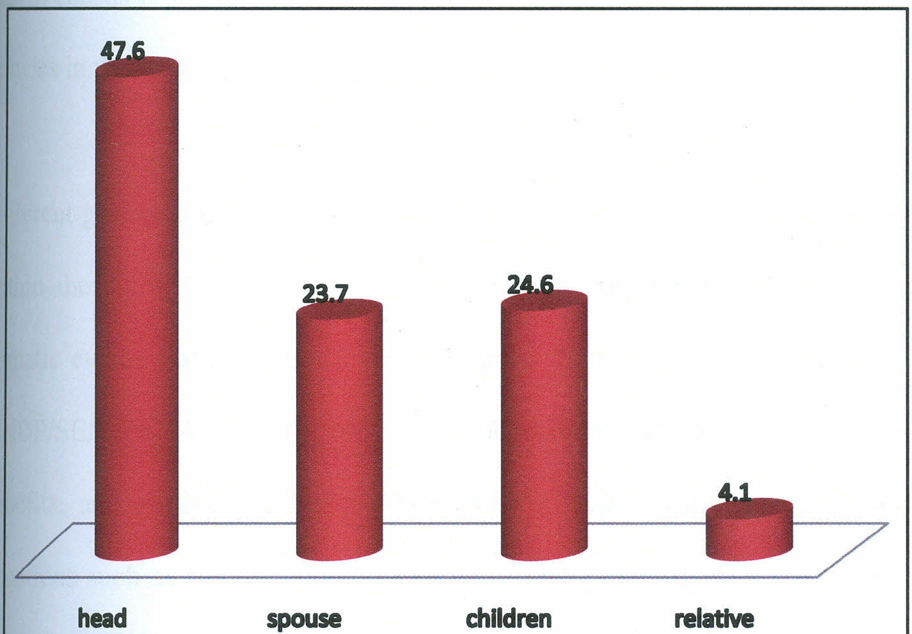

Figure 4.1: Relationship of household member to head of the house

Source: Survey Data (2014)

4.3.1. Gender and age of respondents

Out of the 418 respondents interviewed, 59.3% were male while 40.7% were female (Table 4.3).

Table 4.3: Respondents' Gender

		Frequency	Percent
	Male	248	59.3
Valid	Female	170	40.7
	Total	418	100.0

Source: Survey Data (2014)

The gender dimension is important in climate change and variability dialogues, as many studies including those of UNDP/SEMARNAT (2006) have shown that men and women are affected differently by flood events based on the means at their disposal; with the females being particularly more vulnerable to adverse climatic events than men. Consistent with the KNBS

(2010) census report, the current study also established that there were slightly more males than females in the two study regions.

Different groups (male, female, children and the elderly) and sectors (agriculture, livestock etc) within the same locality are often affected to varying degrees and magnitudes by adverse climatic events such as floods, depending on their vulnerability (Ng'ang'a, 2006). Reports by UNDP/SEMARNAT (2006), indicated that women's limited economic resources, limited social benefits, and general lack of political power lessen their capacity to respond in emergency situations such as floods, compared to men. Their inability to act is often aggravated by factors such as scant dissemination of emergency information and high illiteracy levels among most of them; particularly those living in poverty stricken households (UNDP/SEMARNAT, 2006). Women's increased vulnerability is also exacerbated by lack of rights to land ownership, inaccessibility to critical information, limited access to credit facilities and other financial services, lack of opportunity to voice their grievances among others (Andolan, 2008).

The impacts of climate variability and change are already having significant effects on social and cultural ways of life in many societies (IPCC, 2007), and adjustments will therefore be required to cope with the most direct impacts such as changes in availability of water, poor crop yield, low animal produce and increased human and livestock diseases (FAO, 2008b). Resource-dependent communities are particularly vulnerable to adverse climate change and variability, whose influence on the natural systems on which they heavily depend is already evident (Boko, 2007). Some of the demographic characteristics that result in varying levels of exposure of households to certain types of extreme climatic events include location of the home, sensitivity of the affected people to hazards (age, gender, health condition, occupation, economic status, or dependency on impacted resources), and their adaptive capacities (knowledge and attitudes, skills, economic status, social affiliation, and willingness and ability to change) (UNFCCC, 2006). Vulnerable groups exist in a society, because of disparities in education and income levels, among other socio-economic characteristics that influence the action taken by households, when faced with extreme climatic events (Ng'ang'a, 2006).

Punitive laws and community beliefs also increase women's vulnerability to climate change markers. In Bangladesh, for instance, restrictions placed on women's movements hamper their access to shelter or medical attention when cyclones or floods strike (Rowshan, 1992). Since majority of the LVB household population is comprised of females, the effect of climate change and variability may be severe on most households, especially the female-headed ones. Given that climate change is likely to further intensify the existing inequalities and influence/affect the capacity of women and men to cope with additional stresses differently, more attention is needed to ensure that adaptation and mitigations strategies developed take into account these differences and focus more on the needs of women in view of their roles as the most significant suppliers of family labour and efficient managers of household food security (IFAD, 2009). Adaptation strategies should therefore be geared towards separately addressing the different impacts of climate change and variability on women, men and children and must ensure that each group is given the necessary support and empowerment as part of building the community's resilience to climate change and variability (IFAD, 2009).

In terms of age differences among household members, the findings showed that the largest proportion (51.9%) of the respondents were aged between 26-55 years, followed by those aged between 6–25 years old (28.0%) then 56-85 years (15.5%). Those aged below 5 years accounted for 5.0% of the population (Figure 4.2).

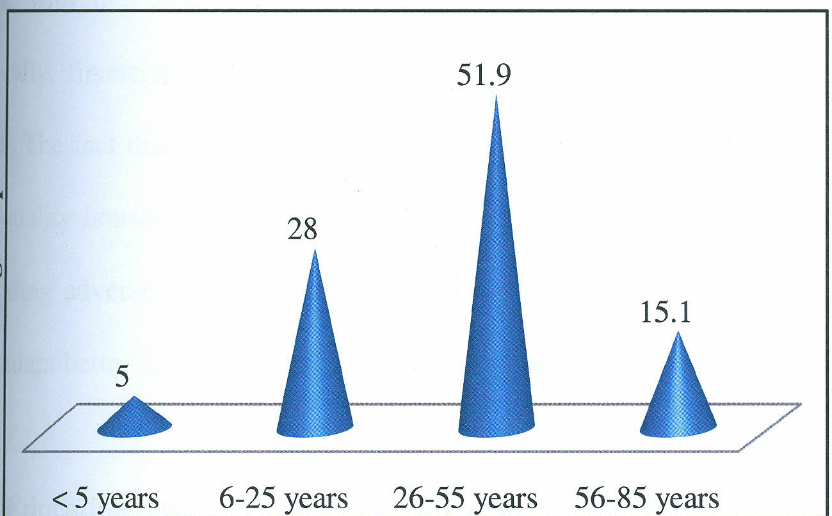

Figure 4.2: Age differences among household members

Source: Survey Data (2014)

The age structure of a population is very important as far as climate change and variability is concerned. This is because the people's socio-economic needs and their vulnerability to extreme climatic events differ with age (NACPD, 2011). The current study established that there were more persons in the middle age groups (between 22 and 55 years old), than in the older or younger age groups. The age distribution across the two studied regions was however slightly different with that of the Kenya National Population and Housing Census (KNBS, 2010), which showed that young people below the age of 24 years accounted for more than half the population in each of the two study areas. Reports by NCAPD (2011) show that Kenya's population is predominantly youthful, with over 60% of the population being overly dependent on about 40% of those who are productive, for survival thus reducing the quality of life for many households and further increasing the household's vulnerability to adverse climatic events.

The skewed population is therefore a source of concern as was also reported by Haq *et al.* (2008), in which they noted that certain age groups in society were often impacted more than others, with the older people for instance being particularly vulnerable because they are physically, financially and emotionally less resilient to deal with extreme climatic events like floods. The fact that most older people are already socially deprived due to poor health, live in poor quality houses, have a restricted mobility due to old age, often lack prior information on impending adverse climatic events and do not have social support networks that could enable them adapt better to change, makes them particularly vulnerable (SNIFFER, 2009).

4.3.2. Education levels among household heads

Regarding the highest level of education completed by household members, the results showed that majority (59.3%) of the dependents (at 248) had cleared nursery school, while the proportion of those who had finished primary, secondary and university education was 37.1%, 2.2% and 1.4%, respectively. From the findings, the proportion of household members who had attained secondary school level of education and above was relatively small (Table 4.4).

Table 4.4: Highest level of education completed by household members

	Frequency	Percent
Nursery	248	59.3
Primary	155	37.1
Secondary	9	2.2
University	6	1.4
Total	**418**	**100.0**

Source: Survey Data (2014)

According to UNESCO (2000), education is an indispensable means of unlocking the potential of inhabitants living in vulnerable areas through provision of knowledge and skills that are required to secure economic well-being, health, liberty and security hence its inclusion into this study. The findings showed that among the household members, only 25.6% representing 107 dependants were currently enrolled in school. The current study also established that there were a considerable number of people in the two flood prone areas of the study who never had secondary school education having dropped out after primary school education.

These findings are a clear attestation to a possible link between frequent flooding in an area and interruption of schooling. Studies have shown that climate change markers may exacerbate factors that cause children to drop out of school, while qualified teachers may find it difficult to take up teaching jobs in disaster prone regions, thus causing perennial shortage of qualified staff in such areas (Achoka and Maiyo, 2008). Such difficulties are bound to affect enrollment, quality of education and the overall performance of the students and the school (Achoka and Maiyo, 2008).

The current study findings also suggest that residents of disaster prone/hardship areas, who get a chance to attend school, go on to complete their secondary education with some advancing past secondary education level. It was also evident in this study that despite these areas being flood prone, they also had a good proportion of respondents who had completed secondary school education, with some advancing to post-secondary education. This could be regarded as one of the coping strategies since education is considered a form of empowerment that is also likely to reduce household vulnerability to climatic events such as floods and thus safeguard against adverse climatic events (ISDR, 2004).

Studies by NCAPD (2011) show that youth who complete secondary school are more likely to have a smaller family and earn much more income when they become adults (ISDR, 2004). More earnings by family members will empower households and cushion them against negative impacts of adverse climatic conditions. Education, especially up to secondary level, is therefore a critical investment and a first step towards stability for the household (UNESCO, 2000). The World Bank acknowledges in its World Bank (2007) report that young people need to acquire the right knowledge and skills to better handle extreme climatic events in their locality.

4.4. Livelihood Sources at the Household Level

Regarding livelihood sources, findings showed that crop farming was the main source of livelihood according to most respondents (67.7%). Other livelihood sources mentioned include fishing (13.4%), farming (13.4%), casual employment (4.3%) and salaried employment (1.2%). There was no response on livestock production (Figure 4.3).

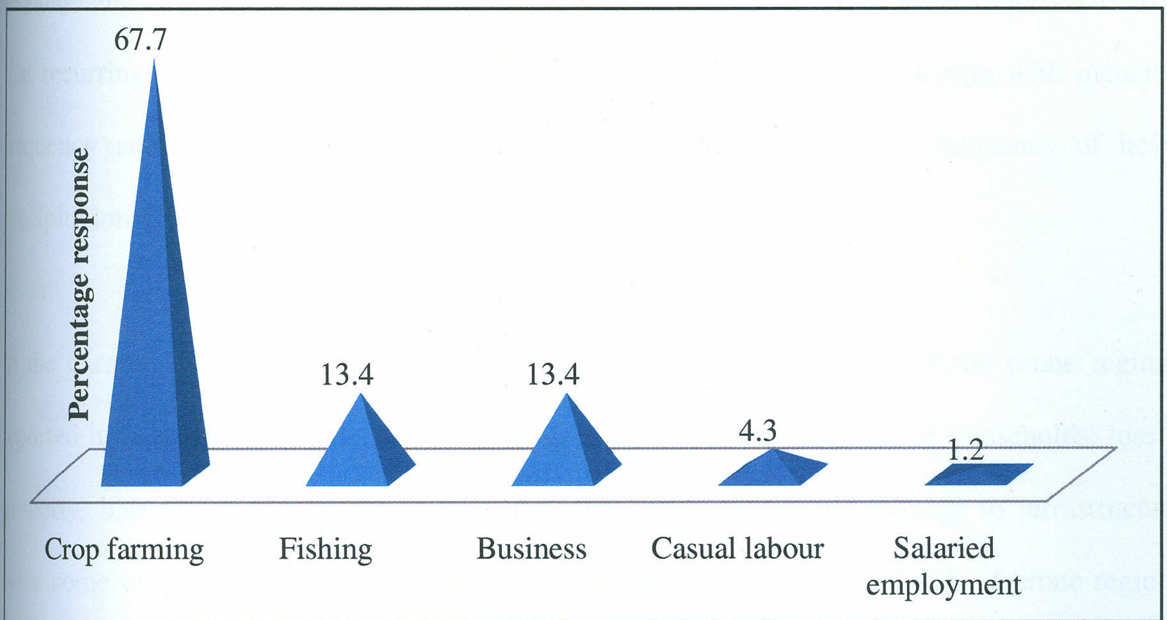

Figure 4.3: Main source of livelihood

Source: Survey Data (2014)

Floods are complex natural events caused by climate variability and have the ability to negatively or in some few instances positively affect livelihood sources(ADPC and UNDP, 2005). Reports indicate that over the past decades, the pattern of floods across all continents has been changing, becoming more unpredictable, frequent and intense thus increasing the local communities' vulnerability to adverse effects (IPCC, 2007). Similar observations were made in the current study, in which most respondents in the two flood prone regions reported having noticed changes in the frequency and magnitude of floods in their regions. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007) predicted an increase in frequency and magnitude of heavy precipitation which was likely to augment flood risk in many regions through effects such as loss of lives and livelihoods, destruction of supportive structures among other household assets. Like the case of the flood prone regions

(Nyando and Budalangi), in the current study, previous studies by Gullet *et al.* (2006) also noted that recurring floods are often experienced in most low lying plains of Kenya with increased frequency and magnitude. The IPCC (2007) predicted an increase in frequency of heavy precipitation events which were likely to augment flood risk in many areas.

In the current study, a higher proportion (over 90% for those living in flood prone regions) reported having been affected by floods. Crop destruction, displacement of households, loss of property, loss of lives and livelihood sources, loss of livestock and damage to infrastructure, were some of the effects of floods mentioned by study respondents in the flood prone regions. However, other studies have reported that the magnitude of a flooding disaster is not determined by flood waters alone but also by the resources available to the locals and also their vulnerability levels, with the poor being the hardest hit (UNDP, 2008).

The poor people, often already vulnerable to other stresses, such as illnesses, food insecurity, water shortage and conflicts, are in most cases forced to live in high risk areas, build their homes and grow their food on floodplains or other inappropriate risky areas thus further exposing themselves to impacts of adverse climatic events (Ng'ang'a, 2006). This was the case for most inhabitants from Budalangi region, who despite experiencing recurrent floods were still reluctant to relocate to safer locations, instead preferring to stay put, in the high risk areas. This could have been due to the often perceived benefits of living in flood plains such as fertile soils, availability of pasture, abundant water and fish resources among others, which to them outweigh the risks.

4.5. Crop Production and Losses arising from Crop Failure due to Floods

There was the need to establish whether the respondents grew any crops on their farms. There was an overwhelming response on this as 100.0% of the respondents reported growing one type of crop or the other (Table 4.5).

Table 4.5: Crops grown by households

		Frequency	Percent
Valid	Yes	418	100.0

Source: Survey Data (2014)

On the type of crop grown by households, 41% of the respondents reported growing maize on their farms, 34% grew millet, 10% grew green grams, 1% grew sorghum, 5% grew groundnuts, 3% grew rice and 5% grew potatoes on their farms (Figure 4.4).

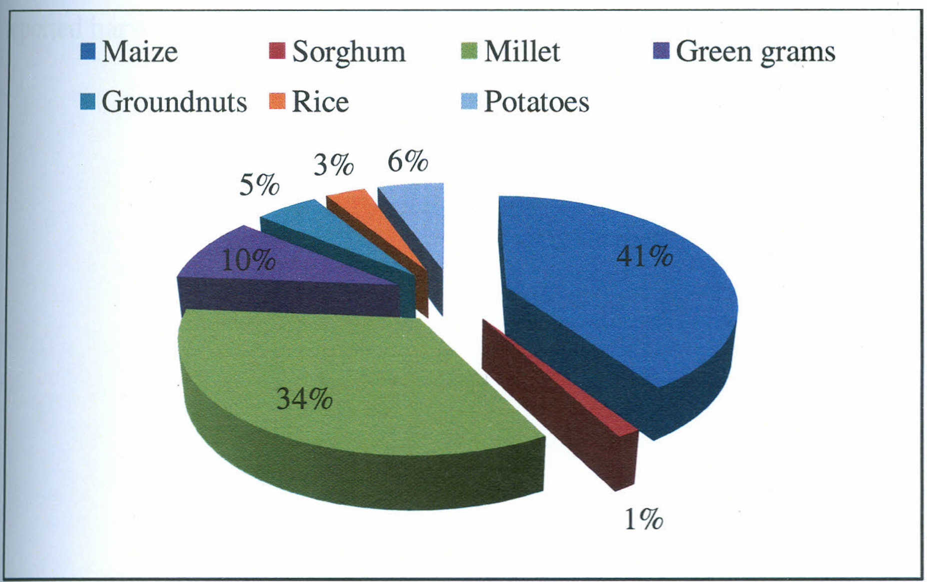

Figure 4.4: Type of crops grown

Source: Survey Data (2014)

Among the respondents who reported planting maize, only 8.9% reported harvesting 0.1 to 5 sacks of maize, while a large majority (91.1%) reported harvesting between 6 and 10 sacks during the previous harvesting season (Table 4.6).

Table 4.6: Last season's maize harvest

		Frequency	Percent
Valid	0.1-5 sacks	37	8.9
	6-10 sacks	381	91.1
	Total	418	100.0

Source: Survey Data (2014)

Of those who reported planting sorghum in the previous season, 2.2% reported harvesting nothing. 30.9% harvested between 0.1 and 5 sacks, 59.6% harvested between 1 and 10 sacks, 6.5% harvested between 11 and 20 sacks, 0.2% harvested between 21 and 30 sacks while 0.7% reported harvesting more than 30 sacks in the previous growing season (Table 4.7).

Table 4.7: Last season's sorghum harvest per household

		Frequency	Percent
Valid	0	9	2.2
	0.1- 5 sacks	129	30.9
	1-10 sacks	249	59.6
	11-20 sacks	27	6.5
	21-30 sacks	1	.2
	more than 30 sacks	3	.7
	Total	418	100.0

Source: Survey Data (2014)

Only a small proportion (0.1%) of those respondents who reported planting millet in the previous season did not get any harvest. A large proportion (86.8%) however reported harvesting between 1 and 10 sacks of millet, 10.0% harvested between 0.1 to 5 sacks, 1.4% harvested between 11 and 20 sacks and 0.7% reported harvesting more than 30 sacks of millet in the previous season (Table 4.8).

Table 4.8: Previous season's millet harvest among household

		Frequency	Percent
Valid	0	4	1.0
	0.1 -5 sacks	42	10.0
	1-10 sacks	363	86.8
	11-20 sacks	6	1.4
	More than 30 sacks	3	.7
	Total	418	100.0

Source: Survey Data (2014)

Green grams were also grown in parts of the study area. Of those who reported growing green grams, slightly over half (51%) reported harvesting between 0.1 and 5 sacks, 34.2% harvested between 6 and 10 sacks while 10.3% harvested between 11 and 20 sacks. Only 0.7% harvested more than 30 sacks (Table 4.9).

Table 4.9: Previous season's green grams' harvest among households

		Frequency	Percent
Valid	0.1 -5 sacks	213	51.0
	6-10 sacks	143	34.2
	11-20 sacks	43	10.3
	21-30 sacks	16	3.8
	more than 30 sacks	3	.7
	Total	418	100.0

Source: Survey Data (2014)

Groundnuts were also grown by some households in the two study areas, with 94.5% of the respondents reported harvesting between 0.1 and 5 sacks while the remaining 5.5% of the respondents reported harvesting between 6 to 10 sacks (Table 4.10).

Table 4.10: Last season's groundnut harvest

		Frequency	Percent
Valid	0.1-5 sacks	395	94.5
	6-10 sacks	23	5.5
	Total	418	100.0

Source: Survey Data (2014)

As the findings suggest, most households in the present study did not attain their targeted crop yield, translating to huge economic losses due to presumed lost crop productivity. Maize which is the main staple food among households recorded particularly low actual yields compared to the expected yields. This could be attributed to unpredictable weather patterns in the respective regions, since maize cultivation is highly dependent on favorable weather patterns (Ouma *et al.*, 2002). However, it is important to note that different households had different expectations, in terms of number of bags (90 kg) of crop yield; some of which may have been unrealistic. Nevertheless, the differences in expected yields among households could probably be attributed to factors like the size of land under cultivation, type of crop grown, amount of fertilizer used, location of land and more critically, the climatic conditions of the region.

Based on the current study findings, it was clear that households residing in disaster prone regions had diversified their agricultural produce by introducing a wide range of food crops probably to increase their security against total loss in case one type of crop fails. However, high diversification of crops especially in disaster prone regions can also be counteractive as witnessed among households from Nyando region who despite planting a wide variety of crops also recorded high crop failure attributed to poor yields, probably due to unfavorable climate. The high presumed losses could also have been due to unrealistic expectations placed on these crops by the households. For instance, the expected yield of groundnuts, green grams and rice could have been too unrealistic resulting in presumed high cost as a result of failure to meet the targeted yield.

4.5.1. Sufficiency of the crop yields harvested

The crop yield from the previous growing season according to most (67.4%) respondents was fair. However, 18.2% thought the harvest was poor while 10.0% thought the harvest was good. Those who thought that the harvests were excellent as well as those who thought that their harvests were very good were 1.9% and 2.4%, respectively (Figure 4.5).

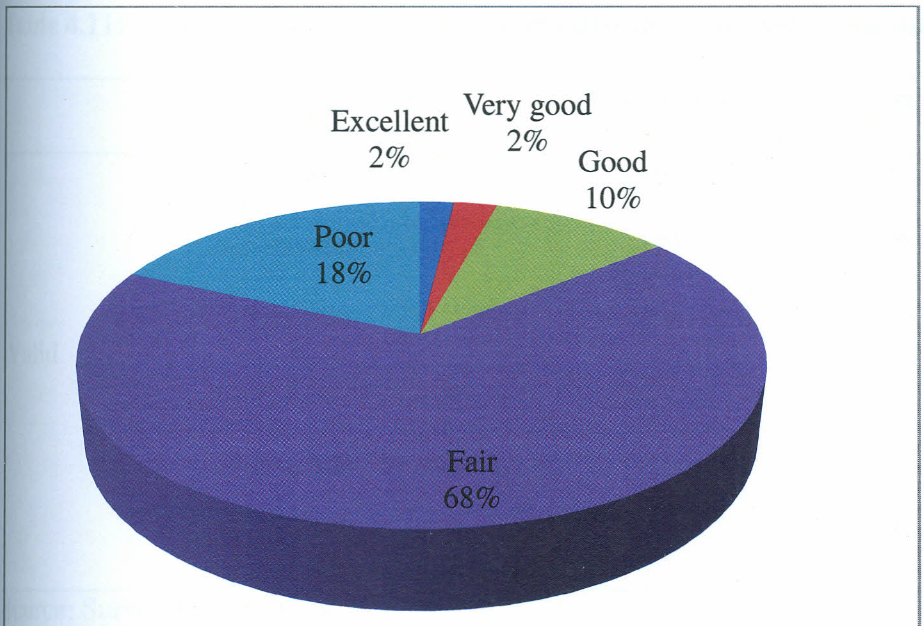

Figure 4.5: Ranking the harvest by households

Source: Survey Data (2014)

Food sufficiency was an important aspect in this study. The respondents were asked how long the previous harvest lasted. Most (38.5%) of the respondents indicated that the last harvest lasted for less than 3 months, 28.9% between 4 and 5 months, 16.5% between 5 and 8 months, 5.5% between 8 and 10 months, while 10.5% reported that the harvest lasted throughout the year (Table 4.11).

Table 4.11: **Duration over which food harvested in the previous season lasted**

		Frequency	Percent
Valid	Less than 3 months	161	38.5
	4-5 months	121	28.9
	5-8 months	69	16.5
	Over 8 to 10 months	23	5.5
	Throughout the year	44	10.5
	Total	418	100.0

Source: Survey Data (2014)

Current findings showed that food harvested over the previous year lasted less than three months for most households living in the flood prone areas; a further indication of the increased impact of climate variability on food security. Unfortunately, climate variability has seriously affected food production and availability, making many poor households in developing countries unable to get access to food which is a basic need (IPCC, 2001; Mwandosya *et al.,* 1998). Consistent with current study findings, IPCC (2001) also highlighted the close link that exists between global climate variation and food insecurity among the poor households especially in developing countries.

Floods and heavy rainfall were among the major climate change markers that were linked directly to food insecurity by study respondents in the two flood prone regions within the Lake Victoria basin of Kenya. Most study respondents from the two regions reported that the amount of food crop harvested during the previous growing season was far below the expected yield; a factor they attributed mainly to floods, unpredictable weather patterns, reduced soil fertility, increased pests and diseases among other factors. Studies by URT (2003), carried out in Tanzania reported that interference with food security was probably the worst impact of climate variability. In many low-lying areas, the inundation lasts for weeks, leading to total loss of crops. The worst affected are the poor who inhabit the flood plains and riverine lands to eke out a meager living from agriculture, livestock farming and fisheries. Because of poverty, lack of education and poor rural infrastructure, the rural poor are the most vulnerable groups to floods and post-flood consequences. The floods severely limit and hamper the developmental process, further increasing the vulnerability of the rural society and thereby perpetuating and increasing the incidence of poverty.

The LVB climate shows spatial and temporal variability with flood prone regions particularly in the lowlands including the Nyando and Budalangi regions bearing the full brunt of increased flood frequency and magnitude while the highland areas are only affected to a lesser extent or not affected at all, yet they fall within the same region (Oyugi *et al.,* 2003). Since most of the residents in the Lake Victoria Basin are largely poor and depend on rain-fed agriculture, the changing weather pattern is likely to interfere with their livelihood sources like farming and animal production further increasing their vulnerability and augment their poverty levels.

The wide fluctuations in agricultural output that have occurred in relation to climate variability attest to the fact that agriculture is an economic activity that is heavily dependent on the prevailing weather conditions (Kabubo-Mariara, 2007). Consistent with the current study findings, research shows that whenever floods occur, they are often accompanied by huge losses through general crop failure, crop damage, livestock deaths, pests and disease outbreaks, displacement of people among other negative factors, all of which impact negatively on the socio-economic status of the affected households (Kabubo-Mariara, 2007).Studies by DipECHO (2004) showed that loss of assets due to flood waters, which act as a buffer for most poor households, can increase the household's vulnerability to the next natural hazard, while prolonged flooding period can limit a household's ability to replant quickly after flood waters recede. This is because either the cropping season is often almost over or the necessary agricultural support is unavailable, thus augmenting the food crisis (ALNAP and Pro Vention, 2007).

The current study findings showed that for most households, food harvested during the previous season lasted less than three months, implying that climatic events particularly floods could be playing a crucial role in food insecurity as most of the households in the LVB and Kenya in general rely on the natural environment for their livelihoods.

4.5.2. Crop failure and resulting mortalities among households

As regards crop failure related mortalities among members of the household, most (94.3%) respondents indicated that they had not experienced any deaths occasioned by lack of food due to crop failure. However, 5.7% of the respondents indicated that they had experienced death occasioned by the lack of food due to crop failure (Table 4.12).

Table 4.12: Mortality related to crop failure

		Frequency	Percent
Valid	Yes	24	5.7
	No	394	94.3
	Total	418	100.0

Source: Survey Data (2014)

Natural disasters such as floods have significant humanitarian, social, political, and economic implication that undermines human livelihoods and security (Human Impact Report, 2009). Disasters leave large numbers of people ill, disabled, widowed, orphaned, displaced or suffering from post-traumatic stress disorder or death, thus affecting human development (Basu, 2005). Clearly, the impact of climate variability on socio-economic status of the LVB inhabitants will continue to rise.

4.6. Livestock Keeping and Production

Most (87.1%) study respondents indicated that they kept livestock, while a small proportion (12.9%) did not keep any livestock (Table 4.13).

Table 4.13: Livestock keeping by households

		Frequency	Percent
Valid	Yes	364	87.1
	No	54	12.9
	Total	418	100.0

Source: Survey Data (2014)

The most common livestock kept according to majority (46.7%) of respondents was cattle. Other livestock kept included: goats as reported by (25.35%) of the respondents, sheep (9.6%), pigs (1.4%) chicken (4.2%), donkeys (4.2%), ducks (4.3%) and bees (4.3%) (Figure 4.6).

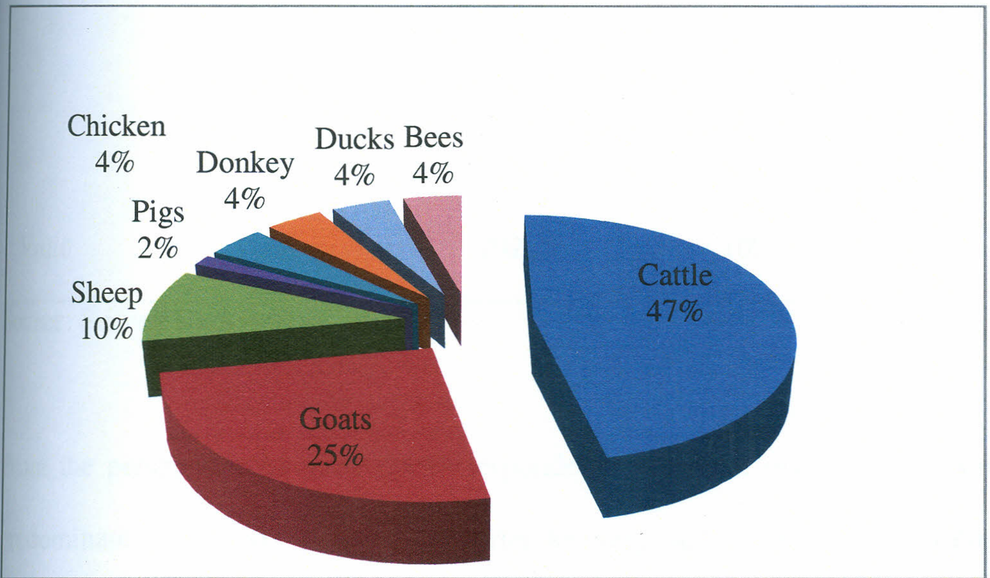

Figure 4.6: Types of livestock kept

Source: Survey Data (2014)

Cattle were the most preferred livestock among households in the two study regions, though they also registered the highest losses through deaths compared to all other livestock. Goats, sheep, donkeys, poultry and pigs were also affected by climate variability markers over the last 20 years. The number of livestock or bee colonies kept by respondents is summarized in Table 4.12. Based on the responses, most (83.7%) respondents kept between 1 and 5 animals/colonies. Those who reported keeping between 6 and 10 animals were 12.9% whereas those who kept between 11 and 15 and over 20 livestock /bee colonies were 3.1% and 0.2%, respectively.

Table 4.14: **Number of livestock/bee colonies kept by households**

		Frequency	Percent
	1-5	245	83.7
	6-10	38	12.9
	11-15	9	3.1
	over 20	1	0.2
Valid	Total	292	100

Source: Survey Data (2014)

From the perspective of most (74%) respondents, the main reason for livestock keeping was predominantly for food. Those who reported keeping the livestock for sale were 6% while those who kept the animals for farm power were only 3%. However, 18% of the respondents reported keeping the livestock for consumption as well as for sale (Figure 4.7).

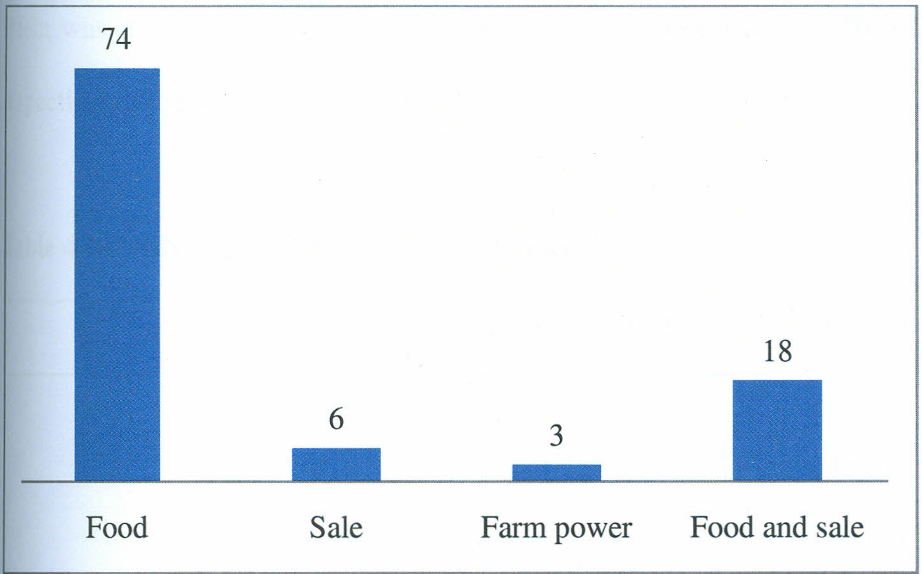

Figure 4.7: Reason for keeping livestock

Source: Survey Data (2014)

The majority of the respondents (95.5%) admitted that floods affected livestock rearing. Those who denied this claim were only 4.5% of the respondents (Table 4.15).

Table 4.15: Effect of floods on livestock rearing

		Frequency	Percent
	Yes	279	95.5
	No	13	4.5
Valid	Total	292	100

Source: Survey Data (2014)

The study examined how seriously livestock had been affected by floods. Out of those who indicated that floods had an effect on livestock, 71.8% acknowledged that the effect was severe while those who thought that the effect was moderate were 18.4%. Those who thought that the effect was mild as well as those who thought that there was no effect were 8.1% and 1.7%, respectively (Table 4.16).

Table 4.16: Adverse effect of floods on livestock

		Frequency	Percent
	Severely	210	71.8
	Moderately	54	18.4
	Mildly	24	8.1
	Not affected	5	1.7
Valid	Total	292	100

Source: Survey Data (2014)

Most (85.2%) respondents reported losing livestock in the last 20 years (Table 4.17).

Table 4.17: Livestock lost in the last 20 years

		Frequency	Percent
	Yes	249	85.2
	No	43	14.8
Valid	Total	292	100

Source: Survey Data (2014)

Most livestock losses resulting from diseases; some of which are triggered by floods occurred during the rainy season according to the respondents, implying that heavy rainfall or floods could be linked to livestock diseases and loss. The current findings were consistent with those by

KFSSG (2008), which reported that climate change markers affect the nature and distribution of pests and diseases, with resultant impacts on livestock production and human health and in turn, on livelihoods, food security, and the economy. Apart from exacerbating diseases, floods can also sweep away livestock thus contribute directly to their death. According to UN OCHA (2006), those who are unable to move their livestock to safety during floods or droughts often incur full (100%) losses.

As regards the year that the respondents experienced the loss of livestock, over half (52.4%) of the respondents reported losing most of their livestock between the years 2006 and 2010. Those who indicated loss of their livestock between 2010 and 2011 were 36.8%. Those who lost their livestock between the year 2001 and 2005 were 7.1% whereas those who lost their livestock between 1996 and 2000 were 3.6% (Table 4.18).

Table 4.18: Years during which loss of livestock occurred among households

		Frequency	Percent
	1996-2000	11	3.6
	2001-2005	21	7.1
	2006-2010	153	52.4
	2010-2011	108	36.8
Valid	Total	292	100

Source: Survey Data (2014)

Table 4.19 shows the number of livestock lost through flooding. Most respondents lost between 6 and 10 livestock, with 97, 90 and 59.8% reported losing between 6 and 10 sheep, goats and cattle, respectively. Over 20% of the respondents also reported losing more than 10 chicken due to floods.

Table 4.19: Number of livestock lost due to floods

		Cattle (%)	Goats (%)	Sheep (%)	Chicken (%)
	0-5	35.9	6.5	2.2	3.1
	6-10	59.8	90.0	97.5	76.8
	More than 10	4.3	3.6	0.7	20.1
Valid	Total	100	100	100	100

Source: Survey Data (2014)

Table 4.20 gives the results on the approximate cost of losses from livestock by the respondents. Most (55.9%) respondents reported losing between Kshs. 10, 001 and 20,000 in monetary terms due to livestock loss. 36.5% lost between Kshs. 1,000 and 10,000, 7.2% lost between Kshs. 20,001 and 30,000 while 0.4% of the respondents reported losing between Kshs. 30,001 and Kshs.40,000.

Table 4.20: **Approximate cost of losses from livestock per household**

Cost (in Kshs)	Frequency	Percent
1000-10000	107	36.5
10001-20000	163	55.9
20001-30000	21	7.2
30001-40000	1	0.4
Total	292	100

Source: Survey Data (2014)

In as much as some households within the LVB reported having lost some livestock, the actual number of livestock that were reported to have died over the last 20 years (1991-2011) and whose death was directly attributed to extreme climatic events like floods was relatively low (probably due to the fact that most households kept only a small number of livestock) translating to equally low monetary loss per household per annum, which if compared to crop losses among households within the same region may pass as negligible. The current study findings therefore show an advantage of livestock keeping in the LVB region over crop cultivation with regards to climatic variability in the region.

It is however possible that the climatic condition in the LVB region was somewhat more favorable for livestock keeping than crop farming. In addition, households may have opted for other mitigation or coping strategies such as selling off their livestock during flooding to avert any losses that were likely to be incurred as a result of livestock deaths or transferring the livestock to safer grounds during adverse climatic events thus preventing them from being swept away with flood waters. All these factors may have contributed to the overall reduced livestock deaths, thus keeping the actual losses minimal or inconceivable for the LVB household. Since livestock diseases are also difficult to associate with adverse climatic conditions, the respondents may not have included other livestock losses resulting from diseases, when indeed climatic variability could have been the cause behind those illnesses as well.

Natural vegetation is important for the success of livestock keeping. Table 4.21 shows that 96.4% of the respondents indicated having noticed changes in natural vegetation cover over the last 20 years. Only 3.6% of the respondents had not noticed any changes in natural vegetation cover.

Table 4.21: Changes observed in natural vegetation cover over the last 20 years

		Frequency	Percent
	Yes	403	96.4
Valid	No	15	3.6
	Total	418	100.0

Source: Survey Data (2014)

Figure 4.8 gives an account of the kind of changes observed in vegetation cover as reported by those who claimed noticing changes in vegetation cover over the last 20 years. From the results, most (37.6%) respondents indicated that they noticed changes in natural vegetation cover through diminishing tree cover, diminishing grass land (26%), increased tree cover (12.2%) increased grassland pasture (21.1%) and increased weed infestation (3.1%), respectively.

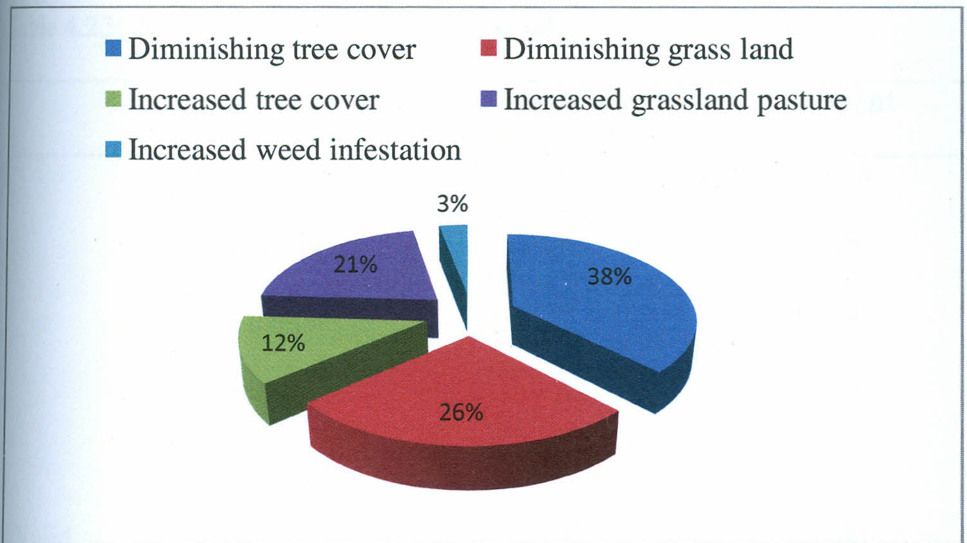

Figure 4.8: Kind of changes observed in the natural vegetation cover

Source: Survey Data (2014)

Most (75.6%) respondents reported that natural vegetation cover resulted in increase in cost of animal production. However, 24.4% of the respondents disagreed (Table 4.22).

Table 4.22: Effect of vegetation cover on cost of animal production

	Frequency	Percent
Yes	316	75.6
No	102	24.4
Total	418	100.0

Source: Survey Data (2014)

With regards to assistance with care of livestock, most (49.8%) respondents reported having nobody to assist them in taking care of the livestock. Those who reported having one person, two, three and four people giving a hand were: 39%, 9.1%, 1.7% and 0.5%, respectively (Table 4.23).

Table 4.23: Assistance with care of livestock

		Frequency	Percent
	None	145	49.8
	one person	114	39
	two people	27	9.1
	three people	5	1.7
	four people	1	0.5
Valid	Total	292	100

Source: Survey Data (2014)

Seemingly, people in disaster prone regions (and probably elsewhere) tend to prefer crop farming because it is convenient (labour saving) and does not require daily attention compared to livestock which have to be attended to at all times; a factor which could have made it less appealing to most LVB residents.

Livestock rearing could even be more difficult in the LVB regions (including the current study regions) considering the relatively small open (communal) land for livestock pasture. This could have influenced the household's decision to stick to crop farming which probably gives them more time to relax and avoid quarrels with neighbors, as commonly occurs with livestock farming when livestock stray to other people's farms and destroy crops. However, in as much as people in the LVB region prefer the easier option of crop farming, the climatic conditions in most part of the region do not seem to favor it, thus necessitating awareness creation among households on various diversification options to enable them make informed decisions. The current findings are an indication that livestock keeping could be better adapted to withstand climate variability such as floods compared to crop farming because of their mobility which facilitates their transfer to safer grounds during adverse climatic events or in search of food as opposed to crops which cannot be relocated and instead absorb the full impact of adverse climatic events.

4.7. Duration of Residency, Land Ownership and Land Size

Most (37.3%) respondents reported having lived in their respective areas for between 0 to 10 years. Those who had lived in their respective areas for between 11-20 years were 24.7%. Those who had lived in their areas for between 21-30 years were 20.8% while those who had lived in their areas for between 31-40 years were 17.2% (Table 4.24).

Table 4.24: Period of residence on land by household

		Frequency	Percent
Valid	0-10 years	156	37.3
	11-20	103	24.7
	21-30 years	87	20.8
	31-40 years	72	17.2
	Total	418	100.0

Source: Survey Data (2014)

4.7.1. Land ownership

On the method of land acquisition, most (91.4%) of the respondents reported having inherited their land from their ancestors, while 6.9% reported having bought their land and 1.7% got their land as a gift (Table 4.25).

Table 4.25: **Method of land acquisition**

		Frequency	Percent
Valid	Inherited	382	91.4
	Bought	29	6.9
	Gift	7	1.7
	Total	418	100.0

Source: Survey Data (2014)

Land is regarded as one of the most important natural resource for agricultural production in Kenya (Musambayi, 2013). Most (91.4%) of the respondents reported having inherited the land on which they lived from their parents. This implied that a large majority of households had lived in the same area for a considerable duration of time and were therefore, in a better position to give accurate responses with regards to any climate variability induced changes that had occurred in the region over the last couple of years.

4.7.2. Land size owned by the households

As regards size of land owned by households, majority of the respondents reported owning between 1 and 5 ha representing 65.8%. Those who owned between 6 and 10 ha were 4.0%, while those with more than 10 ha were 10.8%. Those with less than 1 ha were 19.4% (Table 4.26).

Table 4.26: **Size of land owned by households**

		Frequency	Percent
Valid	less than 1	81	19.4
	1-5 ha	275	65.8
	6-10 ha	17	4.0
	more than 10 ha	45	10.8
	Total	418	100.0

Source: Survey Data (2014)

The average area of the farms surveyed was 39.1 ha, with a range of 0.21 to 694 ha, and a mode of 12 ha. In the Budalangi region, a meager 10% of the area was cultivated, while in the Nyando region, only 24% was cultivated, owing to the frequency of flooding events.

Land fragmentation was common in the highly populated and fertile regions such as the flood prone region of Budalangi. Based on the findings, it was thus evident, that the highly potential agricultural land is increasingly facing fragmentation making it less viable economically. High population growth coupled with land inheritance system among most households living within the Lake Victoria Basin could have been the driving force behind land fragmentation practices, especially in highly fertile region of Budalangi. Consistent with the current study findings, Gitu (2004) also reported that land fragmentation was attributed to high population density, and was most common in fertile areas with favorable weather patterns. The effect of land fragmentation on livestock keeping has also been highlighted by a number of researchers. For instance, studies by ILRI (2010) also showed that land fragmentation has serious impacts on livestock keeping particularly among large-scale livestock ranchers.

4.7.3. Land use among households

As regards land use among households, most (59.9%) respondent reported agro-pastoralism as the most common land use, while 39.2% of the respondents reported agriculture, while 1.2% cited pure pastoral activity as the main land use activity on their land (Table 4.27).

Table 4.27:Main land use among households

		Frequency	Percent
Valid	Pastoral	5	1.2
	Agro-pastoral	249	59.5
	Agriculture	164	39.2
	Total	418	100.0

Source: Survey Data (2014)

The current study findings indicating that most respondents within the LVB of Kenya are agro-pastoralist is consistent with previous studies by Maitima and Gumbo (2007) who also reported that agricultural production has been practiced in the basin of Lake Victoria for many generations with the most common mode of agricultural production being subsistence farming.

4.7.4. Changes observed in land use over the last 20 years

As regards changes in land use over the last 20 years, a large proportion (72.2%) of respondents reported that they had not witnessed any changes in land use over the last 20 years, while 27.8% indicated that they had witnessed some changes in land use (Table 4.28).

Table 4.28: Changes Observed in Land Use

		Frequency	Percent
Valid	Yes	116	27.8
	No	302	72.2
	Total	418	100.0

Source: Survey Data (2014)

Soil fertility was cited as the main reason for the change in land use according to most (44%) of the respondents who reported noticing changes in soil fertility. Other causes of change in land use were inadequate rainfall as reported by 30% of the respondents. Too much rain, increase in pest, reduced income and increased production cost were also cited by 14%, 4%, and 6% of the respondents, respectively (Figure 4.9).

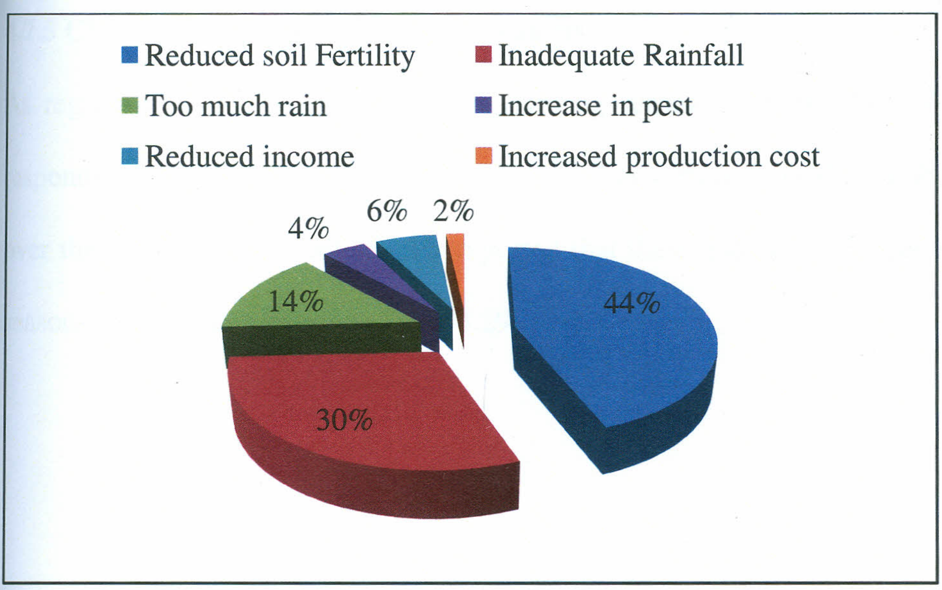

Figure 4.9: Main reason for the change in land use

Source: Survey Data (2014)

Land use change has been cited as one of the main drivers of environmental change, which influences the basic resources of land including soil. Studies show that land use in the LVB like other parts of East Africa is changing fast. While some areas are undergoing expansion of cultivation and grazing, others are intensifying. Like was the case in this study, other researchers have also shown that the patterns of land use in the Lake Victoria basin are highly determined by rainfall amounts and soil characteristics (Maitima *et al.,* 2010).

Poor soil productivity is common in the LVB where nutrient levels (SOC, P and K) have sunk to very low levels since the 1980's. The reasons for the depletion are related to land use and management changes, with rates of nutrient depletion reported to vary according to soil properties, with the sandy soils in the LVB of Kenya reported to sustain higher losses than the predominantly clayey soils in other sites within the basin (Maitima *et al.,* 2004).

4.7.5 Changes in number of growing seasons

As regards changes in the number of growing seasons over the last 20 years, most (62.7%) respondents reported that they had not observed any changes in the number of growing seasons over the last 20 years, while 37.3% reported that there had been changes in number of growing seasons over the same period (Table 4.29).

Table 4.29: Change in the number of growing season

		Frequency	Percent
	Yes	156	37.3
Valid	No	262	62.7
	Total	418	100.0

Source: Survey Data (2014)

Over half (51.2%) of those respondents who reported having noticed changes in number of growing seasons attributed this to unpredictable weather patterns, 22.4% to decreased rainfall, 14,7% to increased rainfall, 0.6% to lack of funds, 4.1% to decreased soil fertility, and 7.1% to other unmentioned things (Figure 4.10).

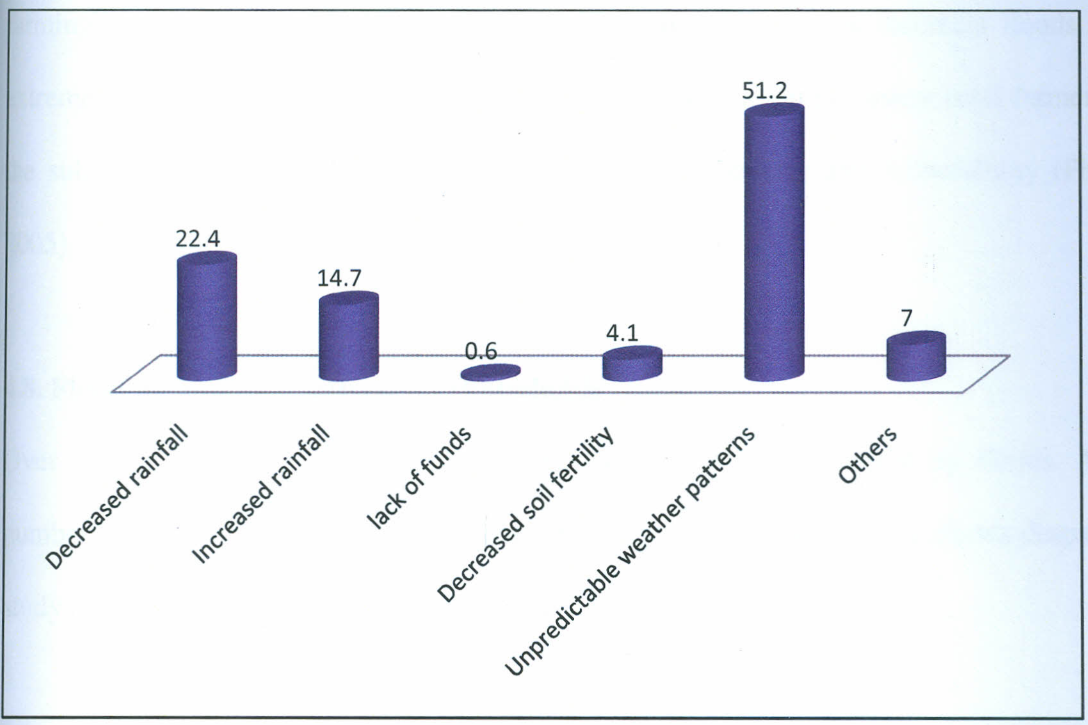

Figure 4.10: Reasons for the changes in growing seasons

Source: Survey Data (2014)

Consistent with the current study findings showing unpredictable rainfall as the main reasons for change in land use, studies by Mugalavai *et al.* (2008) on rainfall and length of growing season in Western Kenya also reported that rainfall characteristics in terms of length of growing season has been uncertain due to high variability of onset and cessation of the rainy season. Studies show that in the next decade, it is expected that there will be a haphazard shift in crop growing seasons, poor crop productivity and abrupt outbreaks of diseases and vectors. Kenya's human population will therefore be at greater health and life risks than before. The immediate major development problem already facing the country is persistent and the increasing level of food insecurity linked to increasing poverty and changing climate. Almost 18 million Kenyans live below the poverty line (WRI, 2007), the majority of whom reside in the rural areas and marginalized lands, with more than 90 percent relying on rain-fed subsistence or smallholder farming to survive (KARI, 2008). Evidence strongly suggests that recurrent floods and other extreme climatic events may exacerbate the poverty level, leaving many rural farmers, mainly the subsistence or smallholders, trapped in a cycle of poverty and vulnerability (Phiri *et al.*, 2005).

4.8. Flooding and their Effects on Households

Over half (57.7%) of the respondents reported having been affected by floods. A sizeable number of households, at 42.3%, however, had not been affected by the floods despite the two study regions being flood prone areas (Table 4.30).

Table 4.30: Flooding on households

		Frequency	Percent
	Yes	241	57.7
Valid	No	177	42.3
	Total	418	100.0

Source: Survey Data (2014)

Floods, associated with extreme climate events, have very devastating effects on almost all socio-economic activities and are very common in many parts of Africa including the Lake Victoria Basin region of Kenya. Flooding in its most immediate form can inundate farms and villages and disrupt transportation networks, ultimately affecting food security and market distribution systems. Studies show that some parts of Kenya experience a number of natural hazards, most common ones being floods, droughts, landslides, and strong winds, which have increased significantly, in frequency, magnitude and complexity (UNDP, 2008). Floods were cited as among the most common hazards related to climate variability in the two study regions. Comprehensive, up-to-date information describing hydrologic conditions is therefore needed to anticipate and mitigate flood impacts on populations targeted for assistance.

Information gathered from the respondents and as shown in Table 4.31 shows that floods affected the community in different ways. Based on the responses obtained, famine and poverty was the main effect of flooding reported by most (47.6%), respondents. Damage to property/homes, crop failure, increase in human/animal diseases, interruption of power supply, migration to other areas, landslides, drowning, injuries and accidents were also mentioned by 37.1%, 5.7%, 2.2%, 6.3%, 0.2%,0.5%, 0.2% and 0.2%, respectively.

Table 4.31: Severity of Floods on Households

		Frequency	Percent
Valid	Crop failure	24	5.7
	Famine and poverty	199	47.6
	Damage to property / homes	155	37.1
	Increase in human /animal diseases	9	2.2
	Interruption of power supply	26	6.3
	Migration to other areas	1	0.2
	Causing landslides	2	0.5
	Drowning	1	0.2
	Injuries and accidents	1	0.2
	Total	418	100.0

Source: Survey Data (2014)

The severity of floods in the two study areas within the Lake Victoria basin was clearly visible among the households. From the results on Table 4.31, where 47.6% of the respondents cited famine and poverty as a major consequence of flooding, 37.1% indicated that floods caused a greater damage to property and homes, 6.3% cited interruption of power supply while 5.7% complained of crop failure. According to a report by USAID (2008), flood events increase the vulnerability of the affected households further impoverishing them economically.

4.8.1. Flood effects, challenges and adaptation strategies by the Nyando and Budalangi communities

In order to assess and compare the effect of floods in the two regions, this study sought to establish the number of times that floods have occurred in the last 20 years and the effects faced by households. The first question was later used in simulating the severity of floods in the study areas. For the second question, 88% of Nyando and 91% of Budalangi households had their crops destroyed by floods (Table 4.32).

Table 4.32: Effects Encountered by households

	Nyando			Budalangi			Pooled			t test
Variables	**%**	**SD**	**SE**	**%**	**SD**	**SE**	**%**	**SD**	**SE**	
Crop destruction	88%	0.41	0.04	94%	0.42	0.03	91%	0.40	0.03	-1.54
Crop failure	68%	0.36	0.03	72%	0.45	0.02	70%	0.40	0.03	-1.31
Reduced production	78%	0.41	0.04	92%	0.44	0.03	80%	0.42	0.03	1.37
Livestock death	16%	0.46	0.04	20%	0.41	0.03	19%	0.41	0.03	1.21
Soil erosion	70%	0.45	0.03	90%	0.42	0.04	89%	0.40	0.03	-1.69

Source: Survey Data (2014)

Up to 78% of Nyando and 92% of Budalangi respondents experienced reduction in production due to floods. Nevertheless, the student *t* tests showed no substantial disparities between Nyando and Budalangi households over the effects of flood on livestock production and crop yields. The study shows that 70% of Nyando and 90% of the highland households experienced soil erosion.

In contrast, the results show that 16% of the Nyando and 19% of the Budalangi households experienced livestock death. Overall, results showed that crops farming had more climate related losses compared to livestock rearing which in this case recorded very minimal losses. Most study respondents reported that the quantity of food harvested during the previous growing season was far below the expected yield; a factor they attributed to reduced soil fertility, unpredictable weather patterns, increased pests and diseases among other factors.A study by Walker and Ever (2010) in Gunnedah Australia observed that all livestock are susceptible to foot problems after long periods of immersion in water. Thus flood conditions can expose cases of dormant footrot which eventually can lead to animal's death. In both Budalangi and Nyando, the household heads reported death of animal due to floods, suggesting that as found elsewhere floods have detrimental effects on animal's production in the area.

Studies by URT (2003), carried out in Tanzania reported that interference with food security was probably the worst impact of climate variability. Studies by DipECHO (2004) showed that loss of assets, which act as a buffer for most households, can make such households more vulnerable to the next flood episode, while prolonged flooding often limits people's ability to replant quickly after flood waters recede. This is because either the cropping season is often almost over or the necessary agricultural support is unavailable (ALNAP and ProVention, 2007). This is a clear pointer that climate change markers such as flood could be playing a critical role in food insecurity as most of the households in the LVB and Kenya in general rely on nature for their livelihoods.

Based on the current study, most households did not attain their targeted yield, translating to huge economic losses due to lost productivity. Maize which is the main staple food among households recorded particularly low actual yields compared to the expected yields. This could be attributed to unpredictable weather patterns in the respective regions, since maize cultivation is highly dependent on favourable weather patterns. Different households had different expectations, in terms of number of bags (90 kg) of crop yield. The differences in expected yields among households could probably be attributed to factors like the size of land under cultivation, type of crop grown, amount of fertilizer used, location of land and more critically, the climatic conditions of the region. Most respondents reported low actual crop yields from their farms as they did not reach their targeted yield. This translated to huge economic losses, resulting from lost productivity on the affected households.

Maize which forms the main staple food among the LVB inhabitants recorded particularly low actual yields compared to the expected yields. Most households in Nyando region recorded highest losses in rice yield averaging Kshs 52,626 in the last growing season and lowest losses in peas (Kshs. 2,358). Maize recorded an average loss of Kshs. 12,441 per household in the two regions as a result of crop failure.

4.9. Economic Losses Resulting from Crop Failure

Most households in Nyando region recorded highest losses in rice yield (Kshs 52,626), groundnuts (Kshs. 48,222), green grams (Kshs. 44,882) and millet (Kshs. 29,308), due to crop failure based on the inability to meet the set target. Maize (a staple food) recorded a loss of Kshs. 9,599 per household in the previous planting seasons as a result of crop failure (Table 4.33).

Table 4.33: Estimated economic loss resulting from crop failure in Nyando region per household

	Maize	Beans	Peas	Sorghum	Millet	Green grams	Groundnuts	Rice	Vegetables	Potatoes
Expected amount usually harvested (90kg bag)	6	1.84	0.43	4.28	6.56	7.42	5.00	16.61	4.71	2.00
Amount harvested in last season (90kg bag)	2.69	0.40	0.07	0.70	0.97	1.33	0.25	11.24	1.64	0.50
Estimated loss of crop failure (90kg bag)	3.31	1.44	0.36	3.58	5.59	6.09	4.75	5.37	3.07	1.50
Market price of crop grown (90kg bag)	2,900	6,100	6,550	3,742	5,243	7,360	10,152	9,800	2350	3586
Estimated cost of crops lost in the previous growing season (Kshs)	9,599	8,784	2,358	13,396	29,308	44,822	48,222	52,626	7,215	5,379

Source: Survey Data (2014)

In Budalangi, the most important food crops were maize, sorghum, vegetables, millet and beans based on their expected yield. However, only maize and potatoes yielded more than half (> 50%), the expected harvest during the previous growing season. Despite this, greatest economic losses from crop failure during the previous growing season were recorded in maize (Kshs. 15,283) and sorghum (Kshs. 13,134) yields (Table 4.34).

Table 4.34: Estimated economic loss resulting from crop failure in Budalangi region per household

	Maize	Beans	Peas	Sorghum	Millet	Groundnuts	Vegetables	Potatoes
Expected amount usually harvested (90kg bag)	13.27	2.18	1.0	4.69	2.32	3.0	4.0	1.75
Amount harvested in last season (90 kg bag)	8.00	0.53	0.16	1.18	0.33	2.0	1.2	1.0
Estimated amount lost (90 kg bag)	5.27	1.65	0.84	3.51	1.99	1.0	2.8	0.75
Market price of crop grown (90kg bag)	2900	6100	6550	3742	5243	10,152	2350	3586
Estimated cost of crops lost in the previous growing season (Kshs)	**15,283**	**10,065**	**5,502**	**13,134**	**10,434**	**10,152**	**6,580**	**2,690**

The losses presumed to have been incurred by households due to failure to reach the target crop yield was up to three times higher (Kshs. 221,709) in Nyando, compared to Budalangi (Kshs. 73,804) region, during the previous growing season. The pooled average presumed losses for the two regions was Kshs. 147,774 with groundnuts registering the highest losses, while peas recorded the least losses (Table 4.35).

Table 4.35: Total economic losses per food crop in the two study areas (Amount in Kshs)

	Maize	Beans	Peas	Sorghum	Millet	Green grams	Ground nuts	Rice	Vegetables	Potatoes	Total
Nyando	9,599	8,784	2,358	13,396	29,308	44,822	48,222	52,626	7,215	5,379	**221,709**
Budalangi	15,283	10,065	5,502	13,134	10,434	-	10,152	-	6,580	2,690	**73,840**
Total	**24,882**	**18,849**	**7,860**	**26,530**	**39,742**	**44,822**	**58,374**	**52,626**	**13,795**	**8,069**	**295,549**
Mean	**12,441**	**9,425**	**3,930**	**13,265**	**19,871**	**22,411**	**29,187**	**26,313**	**6,898**	**4,035**	**147,775**

Source: Survey Data (2014)

4.9.1 Relating floods with food crops grown in the region

Table 4.34 shows the correlation between flood and the various crops that were grown by the respondent in the two study areas. From the correlation results, there was a significant negative correlation between floods and maize, millet, green grams and potatoes. However, the correlation between floods and sorghum was negative but not significant whereas that between floods, rice and groundnuts was positive but insignificant. The correlation between floods and maize was -0.157 (p =0.001) meaning that as floods increased by 1 unit, maize production decreased by 15.7%. Regarding sorghum and floods, the correlation coefficient was -0.092 (p = 0.059), implying that an increase in floods by 1 unit resulted in a decline in sorghum production by 9.2%. On millet production, the correlation coefficient was -0.150 (p =0.002) meaning that an increase in floods by 1 unit resulted in a decline in millet production by 15% (Table 4.36).

Table 4.36: Correlation between crops grown in the region and floods

		Flood	Maize	Sorghum	Millet	Green grams	Groundnuts	Rice	Potatoes
Flood	Pear Correlation								
	Sig. (2-tailed)	1							
Maize	Pear Correlation	-.157**							
	Sig. (2-tailed)	.001	1						
Sorghum	Pear Correlation	-.092	.010						
	Sig. (2-tailed)	.059	.838	1					
Millet	Pear Correlation	-.150**	-.166**	.084	1				
	Sig. (2-tailed)	.002	.001	.085					
Green grams	Pear Correlation	-.183**	-.124*	-.053	-.316**	1			
	Sig. (2-tailed)	.000	.011	.278	.000				
Groundnuts	Pear Correlation	-.024	.123*	.099*	.113*	.094	1		
	Sig. (2-tailed)	.619	.012	.042	.021	.055			
Rice	Pear Correlation	.094	.142**	-.030	.057	-.014	.257**	1	
	Sig. (2-tailed)	.055	.004	.534	.248	.773	.000		
Potatoes	Pear Correlation	-.287**	-.184**	.096*	-.102*	.173**	.143**	-.061	1
	Sig. (2-tailed)	.000	.000	.049	.036	.000	.003	.216	

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

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

Source: Survey Data (2014)

On green grams, the correlation coefficient was -0.183 (p = 0.000) meaning that an increase in floods by 1 unit resulted in a decline in green gram by 18.3%. On groundnuts (p =0.619), rice (p =0.055), and potatoes (p =0.000), production, an increase in floods increased groundnuts and rice production by 2.4% and 9.4% respectively but lowered that of potatoes by 2.87%. The study findings show that different crops are affected differently by floods, with those favored by flood waters such as rice recording high yields while others such as sorghum recording negative yields.

According to Amikuzuno and Donkoh (2012), climate variability, affects the agro-ecological and growing conditions of crops and is recently believed to be the greatest impediment to the realization of the Sustainable Development Goals (SMDG) of reducing poverty and food insecurity through increased agricultural production in developing countries.

4.10. Economic losses resulting from livestock lost as a result of flooding

The most common livestock kept by respondents of Nyando region included cattle, goats, sheep and poultry. Study findings showed that losses arising from cattle were highest (Kshs. 535), followed by poultry (Kshs. 428), sheep (Kshs. 300) and goats (Kshs 270), in the Nyando region, Table 4.37. Unlike other regions studied, households in Nyando did not keep any donkeys and pigs.

Table 4.37: Costing the average livestock losses in Kshs/household/yr in Nyando region

	Cattle	Goats	Sheep	Poultry
Total no. of livestock lost among the households in the last 20 years	290	35	15	1026
To number of households who lost livestock	41	11	4	36
Average no. of livestock lost per household	7.07	3.18	3.75	28.5
Total household population in the region	78,225	78,225	78,225	78,225
Percentage of household population that lost livestock	79%	21%	8%	67%
Actual household population that lost livestock	61,798	16,434	6,258	52,411
Actual number of livestock lost in the previous year	436,912	52,260	23,468	1,493,714
Current market prices per livestock type	10,000	1,700	1,600	300
Total cost of livestock lost per region in the last 20 years	4,369,120,000	88,842,000	37,548,800	448,114,200
Annual cost of livestock lost in the region	218,456,000	4,442,100	1,877,440	22,405,710
Annual average loss per household (in Kshs)	**3,535**	**270**	**300**	**428**

Notes on table 4.36
the total population of livestock types are obtained from Kenya population census report of 2009
the percentage of livestock type likely to be lost is obtained from people interviewed from study areas
the population of livestock likely to be lost is the product of total population of livestock types and percentage of livestock types likely to be lost
cost of livestock type is obtained from *Kenya Livestock Markets Report 2011*
cost of livestock type lost is the product of population of livestock type likely to be lost and the price of livestock type
household population is obtained from Kenya census 2009
the percentage of house population keeping livestock is obtained from people interviewed in the study areas
the household population likely to keep livestock is the product of total household population to the percentage of people keeping livestock
the cost of livestock type lost is the average cost of livestock type lost and the household population keeping livestock
The same model is applied for all the other regions

Cattle, goats, pigs and poultry were the main livestock kept by residents from Budalangi region. Losses arising from cattle loss were the highest (Kshs. 1,706), among livestock kept by households in Budalangi followed by goats (Kshs. 275), sheep (Kshs. 583) and poultry (Kshs. 179), Table 4.38. Households from Budalangi did not however keep sheep and donkeys.

Table 4.38: Average livestock losses in Kshs/household/yr in Budalangi region

	Cattle	Goats	Pig	Poultry
Total no. of livestock lost among the households in the last 20 years	24	11	7	143
To number of households who lost livestock	8	4	3	10
Average no. of livestock lost per household	3	2.75	2.33	14.3
Total household population in the region	15,245	15,245	15,245	15,245
Percentage of household population that lost livestock	36%	18%	14%	45%
Actual household population that lost livestock	5,488	2,744	2,134	6,860
Actual number of livestock lost in the last 20 years	16,464	7,546	4,972	98,098
Current market prices per livestock type	11,375	2,000	5,000	250
Total cost of livestock type lost in the region in the last 20 years	187,278,000	15,092,000	24,861,100	24,524,500
Annual cost of livestock lost in the region	9,363,900	754,600	1,243,055	1,226,225
Annual average loss per household (Kshs)	**1,706**	**275**	**583**	**179**

4.10.1. Relating floods with livestock kept against floods

From Table 4.39 below, there was a positive correlation between floods and the livestock kept except goats. The findings showed that as the rain water increased by one unit, cattle also increased by 2.8% although the association was insignificant (p= 0.563). As rainfall increased by one unit, goats decreased by 2.3%. The association was also not significant (p = 0.635). With regards to sheep, the results found that there was no association between floods and sheep at all but considering chicken, the association was negative but not significant and a unit increase in rainfall led to a decrease in chicken by 3.6%.

Table 4.39: Correlations of floods and livestock kept

		Floods	Cattle	Goats	Sheep	Chicken
Floods	Pearson Correlation	1	.028	-.023	.000	.036
	Sig. (2-tailed)		.563	.635	1.000	.458
Cattle	Pearson Correlation	.028	1	-.044	.061	-.034
	Sig. (2-tailed)	.563		.365	.213	.492
Goats	Pearson Correlation	-.023	-.044	1	.065	.077
	Sig. (2-tailed)	.635	.365		.182	.117
Sheep	Pearson Correlation	.000	.061	.065	1	.007
	Sig. (2-tailed)	1.000	.213	.182		.891
Chicken	Pearson Correlation	-.036	-.034	.077	.007	1
	Sig. (2-tailed)	.458	.492	.117	.891	

Source: Survey Data (2014)

4.10.2. Application of the Ricardian Model on Effects of Floods on Crops and Livestock

In theRicardian model analysis , the estimated values of some of the parameters are significant with a probability (t test) $Pr < 0.05$, which is acceptable according to Gujarati (1996). The independent variables estimated coefficients values are all negative indicating that the land value dencreases when flood increases.In the US, (Federal Emergency Management Agency (FEMA), 2002), the total amount of flood on land value was estimated to be about $6 billion on average. The land in eastern North Carolina is relatively flat and low-lying, and most of the area is prone to flooding. Prior to Hurricane Floyd many people in eastern North Carolina did not have flood insurance and many homeowners in floodplains were not aware that they lived in a floodplain (FEMA, 2002). This study is similar to the current study, although the terrain of both Nyando and Budalangi are quite difference, suggesting that land value in two regions would be even much more affected as observed in the current study.

The average number of households who lost livestock , average amount of maize harvested and market price of maize were all negatively affected by frequent flood events as shown in Table 4.40..

Table 4.40:Regression output of the Ricardian Model based household heads' responses on effects of Floods on Crop and Livestock

<table>
<tr><td></td><td>Model DF: 412</td><td>DF: 344</td><td></td><td>Total DF: 415</td><td></td></tr>
<tr><td></td><td>Value F: 9.11</td><td>Pr> F < 0.0001</td><td></td><td></td><td></td></tr>
<tr><td>Variable</td><td>DF</td><td>Estimated coefficient</td><td>Error</td><td>Valor T</td><td>Pr> |t|</td></tr>
<tr><td>Intercept</td><td>1</td><td>61452</td><td>31532</td><td>1.07</td><td>0.32</td></tr>
<tr><td>Knowledge of the household head of floods</td><td>1</td><td>-51.81</td><td>11.34</td><td>-2.33</td><td>0.02</td></tr>
<tr><td>Average number of households who lost livestock</td><td>1</td><td>-4385.74</td><td>86.53</td><td>-1.32</td><td>0.401</td></tr>
<tr><td>Average amount of maize harvested in Kg (stable food)</td><td>1</td><td>-1635.683</td><td>936.86</td><td>-1.04</td><td><0.01</td></tr>
<tr><td>Market price of maize (Kg) staple food</td><td>1</td><td>-965.83</td><td>867.71</td><td>-4.27</td><td>0.03</td></tr>
<tr><td>Average market price of maize in short rainy season</td><td>1</td><td>-33.78</td><td>1807.17</td><td>-0.18</td><td>0.51</td></tr>
<tr><td>Average market price of maize in long rainy season</td><td>1</td><td>-6172.03</td><td>1374.18</td><td>-2.21</td><td>0.02</td></tr>
<tr><td>(Average market price of maize short rainy season)^2</td><td>1</td><td>10.81</td><td>77.17</td><td>-0.25</td><td>0.61</td></tr>
<tr><td>(Average market price of maize in long rainy season)^2</td><td>1</td><td>231.21</td><td>98.16</td><td>1.27</td><td>0.02</td></tr>
</table>

Statistical significance according to t test with Pr (∝) ≤ 5%.
DF: degree of freedom; T: calculated T value; Pr> |t|: probability on T statistic; ( )^2: variable in quadratic expression.

The typical Ricardian Model residual curve generated with respect to the average household food production against flood events, where the highest production can be achieved when there is less or no flood is presented in Figure 4.11. As flood events increases, the value of land decreased due to its destructive effects.

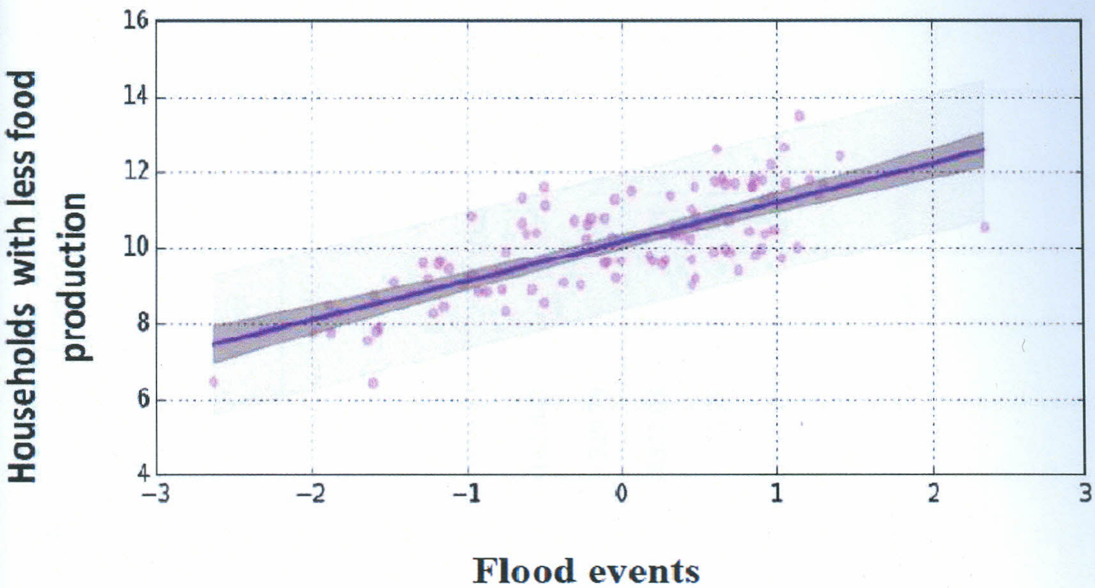

Figure 4.11: Flood events against households with less food production

4.10.3. Application of the Ricardian Model on Effects of Floods on Land Value

In the Ricardian model, both combined dataset for Budangi and Nyando showed remarkable effects of floods on land value (Table 4.41). The below output show that the independent variables that support greater explanatory power (estimated value) are: (i) with a negative sign: flood, that is to say, land value decreases when floods increased; and (ii) with a positive sign: with less or no flood, the slope of the land, short rainy season or no rain, that is, when these increase land value increases, which is a reasonable result. Background variable considered, that have little relation to land value is: knowledge of the household head of floods, in which with increased some activates would be applied to rejuvenate the land.

Table 4.41:Ricardian Model, including all household head interviewed on floods effects on land value

<table>
<tr><td></td><td colspan="2">Model DF: 410</td><td>DF: 8</td><td colspan="3">Total DF: 412</td></tr>
<tr><td></td><td colspan="2">Value F: 9.11</td><td colspan="4">Pr> F < 0.0001</td></tr>
<tr><td>Variable</td><td>DF</td><td colspan="2">Estimated coefficient</td><td>Error</td><td>Valor T</td><td>Pr> |t|</td></tr>
<tr><td>Intercept</td><td>1</td><td colspan="2">38442</td><td>52351</td><td>1.07</td><td>0.222</td></tr>
<tr><td>Knowledge of the household head of floods</td><td>1</td><td colspan="2">-51.81</td><td>30.26</td><td>-2.33</td><td>0.01</td></tr>
<tr><td>Average acres of land</td><td>1</td><td colspan="2">-4385.74</td><td>1096.53</td><td>-4</td><td><0.001</td></tr>
<tr><td>Average vegetation cover</td><td>1</td><td colspan="2">-182.683</td><td>936.86</td><td>-2.04</td><td>0.04</td></tr>
<tr><td>Short rainy season</td><td>1</td><td colspan="2">329.78</td><td>1008.14</td><td>-0.19</td><td>0.35</td></tr>
<tr><td>Long rainy season</td><td>1</td><td colspan="2">-4322.03</td><td>1524.18</td><td>-3.11</td><td>0.003</td></tr>
<tr><td>(Short rainy season)^2</td><td>1</td><td colspan="2">-10.71</td><td>87.19</td><td>-0.14</td><td>0.59</td></tr>
<tr><td>(Long rainy season)^2</td><td>1</td><td colspan="2">-1111.21</td><td>68.16</td><td>2.36</td><td>0.04</td></tr>
</table>

Statistical significance according to t test with Pr (∝) ≤ 5%.

DF: degree of freedom; T: calculated T value; Pr> |t|: probability on T statistic; ( )^2: variable in quadratic expression.

Figure 4.12 below, further presents the best adjustment between the variables flooding events versus land value (regression output; R^2 = 45%), as provided by the respondents in the study regions. As it stood out, about 45% of land value was between US$2,000 and US$10, 000, and values over US$ 10, 000 were uncommon. The national average was US$5 910, ranging from US$400 to US$ 40, 000. In Kisumu City of the Lake Victoria basin which is relatively a large city with a greater population density, a higher average estimated value of the same piece of land is approximately US$11000 per hectare. The opposite was observed in the Nyando region, where the average piece of land was US$3 914 per hectare. When the estimated value of infrastructure (houses, storage facilities, fences and others) were included, the value was US$11, 335 per hectare. The exchange rate value of the dollar considered as at August 2010 was 85 Kenya shillings per dollar.

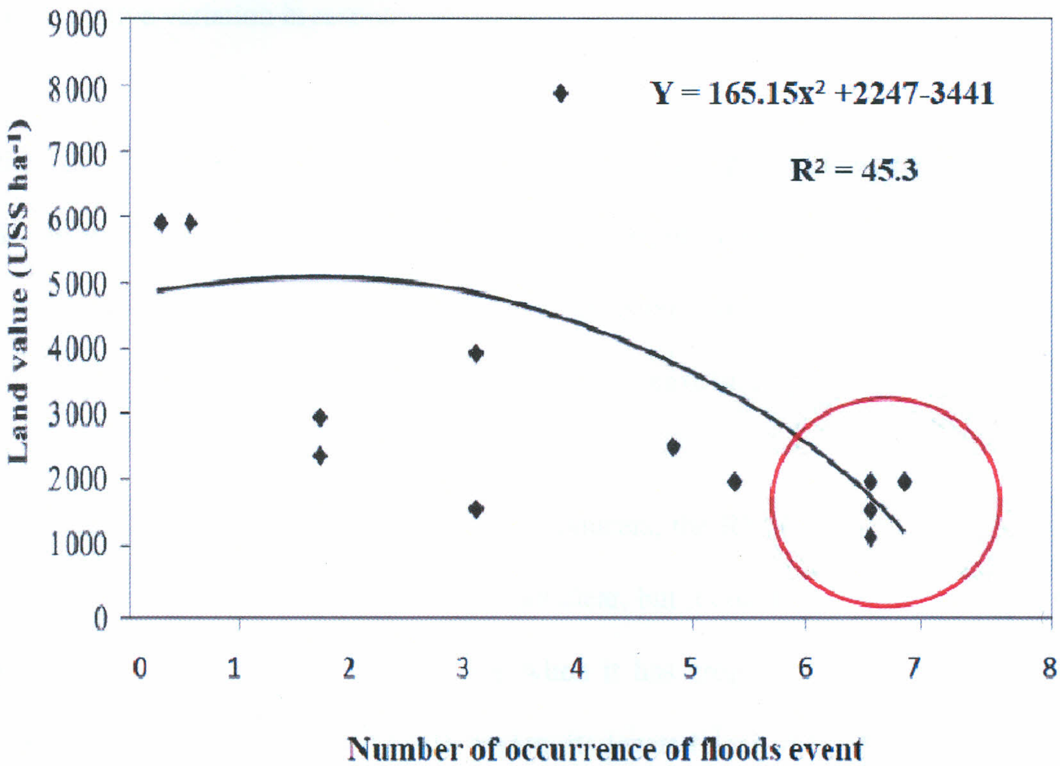

Figure 4.12: The relationship of flood events and land value in Nyando and Budalangi regions in Lake Victoria basin of Kenya

Thirteen regressions were calculated (denoted as x1 to x13) that relate the independent climatic variable flood events to the estimated land value (Table 4.41).The model (x1) explains 23% (R^2) of the variation of the land value when the total of farms surveyed is analyzed. In general, there was more adjustment than in the analysis with the variable flood. Nevertheless, in contrast to what was obtained with the flood variable, among small-scale producers (x2) a lower R^2 was detected (8%) than among medium/large scale-producers (x3; R^2 = 17%). This could be related to a greater average productivity of the medium/large-scale producers, but with greater sensitivity to flood, given a greater spatial variability among their farms. As well, it could be related to the greater marginality of the small-scale producers, so the lower the expected yields, the less relative variation in response to changes in flood event.

In the case of output in terms of production, the model explains between 11-14% (R^2) of the variation of the land value (x5, x6 and x7). The results indicated that among the producers surveyed, production is more important in their decision-making than the flood event. Thus, the application of adaptation strategies related flood could have an important impact on productivity.

On the other hand, with medium/large scale producers, the RM explained more the variation in the land value. The causes of this result are not clear, but it could be that the owner of the land is expected to rate his/her land value higher when it has crops or when it is next to town, for example, Nyando although flood prone region, its located next to Kisumu City when compared to Budalangi, which could generate sensitivity to variation flooding events. Higher $R^2$was observed in the regressions of medium/large-scale producers, tending to be lower during long rainy seasons; so that this would suggest that with long rainy season land owners are likely to charge less to a new buyer as compared to dry season.

The agricultural systems with lower land value, and probably less productivity and greater dependence on the factor of flood, are in zones with more extreme average levels of climate change. In general in Budalangi and Nyando, the effects of simulated climatic change could affect some scenarios, strata of producers and zones of the country; the effects are seen as having less magnitude than is predicted in other parts of the continent. For example, Mendelsohn (1996) has estimated a negative impact on important agricultural sectors in Brazil, with strong economic implications, owing to the predominance of some of extreme climatic factor such as floods. The effects of the simulated scenarios are presented in Table 4.42 and 4.43below. Considering the totality of farmers, the scenarios that only decreased flood intensity generate a moderately positive effect on the land value and livelihoods.

Table 4.42: Regressions output of the Ricardian Model on flood effect on small and medium/large scale producers in Nyando and Budalangi

Identifier#	Estimated land size/production	Regression	R^2 value
X1	Total land	Y = 28. 19X-1028X-5423	0.23
X2	Total land* Small size land owner	Y = 132. 20X-4515X-3267	0.08
X3	Total land* medium size land owner	Y = 84. 35X-1539X-2118	0.13
X4	Total land* large size land owner	Y = 341. 67X2-2713X-3152	0.11
X5	Total land* small size small producer	Y = 26. 44X2-3162X-4271	0.07
X6	Total land* small size medium producer	Y = 68. 87X2-3974X-6973	0.14
X7	Total land* small size large producer	Y = 456. 34X2-6421X-5429	0.15
X8	Total land* medium size small producer	Y = 74. 28X2-2117X-2630	0.17
X9	Total land* medium size medium producer	Y = 84. 35X2-1539X-2118	0.22
X10	Total land* medium size large producer	Y = 471. 63X2-2740X-3316	0.28
X11	Total land* large size small producer	Y = 79. 46X2-1820X-2144	0.18
X12	Total land* large size medium producer	Y = 378. 54X2-3750X-4781	0.26
X13	Total land* large size large producer	Y = 142. 96X2-2742X-3720	0.11

Table 4.43: Relative change (%) of land value under different simulated scenarios in Nyando and Budalangi

Respondent's response to flood event	Total production	Small scale producers	Medium to large scale producers
Decreasing floods on livelihoods	1.73	1.88	8.21
Increasing floods on livelihoods	-0.353	-0.74	-6.53
Decreasing floods + animal production	0.46	3.23	3.47
Decreasing floods + crop production	2.84	0.71	1.23
Increasing floods + animal production	3.54	4.4	3.79
Increasing floods + crop production	-0.43	-6.74	-4.53
Decreasing floods + animal and crop production	1.5	0.45	8.77
Increasing floods + animal and crop production	0.31	0.33	2.11

The impact according to the producer stratum is also shown above in Tables 4.42,4.43 and Figure 4.13 below. Among small-scale producers, land value follows a similar pattern to effects of floods on livelihoods. The greatest impact is in simulated scenarios that decrease in floods, with a 6% increase in land value. In other scenarios, the relative increase in land value is on the order of 3% when floods decrease. Land value goes down when floods increase. The predicted result in this stratum could respond to the presence of small-scale producers with marginal lands of lower productivity, consequently flooding can have a relatively minor impact. As well, this could indicate that small farms have more stable land values because of scale, with fewer profitable alternatives in the use of the land. Among the medium and large scale producers, land value also increases moderately in the scenarios that decrease with floods. Parallel to this, in Budalangi, as opposed to Nyando regions, cattle production predominates under conditions of flood, so that a scenario of flooding could have a positive perspective in terms of future profitability, causing greater complications and costs in the management of cattle, pastures, and soil adaptation and drainage. The scenarios that increase floods also show a reduction in the land value, although more attenuated (-5%), possibly because of the partially beneficial effects of floods.

In Nigeria, floods removed significant amount of topsoil large area of farm land. While some parts of the landscape have, lost significant amounts of topsoil both from the sheet erosion as rain falls wet soils. However, the removal of topsoil is always a loss to agricultural productivity as topsoil is the part of the soil horizon with higher level of organic matter and nutrients and generally better structure (USDA, 1993). The current study concur with the above study indicating that flood effects in Budalangi and Nyando had considerable effect of land degradation in terms of soil erosion.

In general, the behavior of the totality of households in the study showed tendencies and magnitudes more similar to the stratum of small-scale producers than those of medium/large scale producers. This is probably because the majority of the surveyed producers belong to this stratum. The tendencies, compared in the columns of Tables 4.40 and 4.41, while in some scenarios seem contradictory, can or are reflecting dissimilar contexts among types or stratum of producers (Figure 4.13).

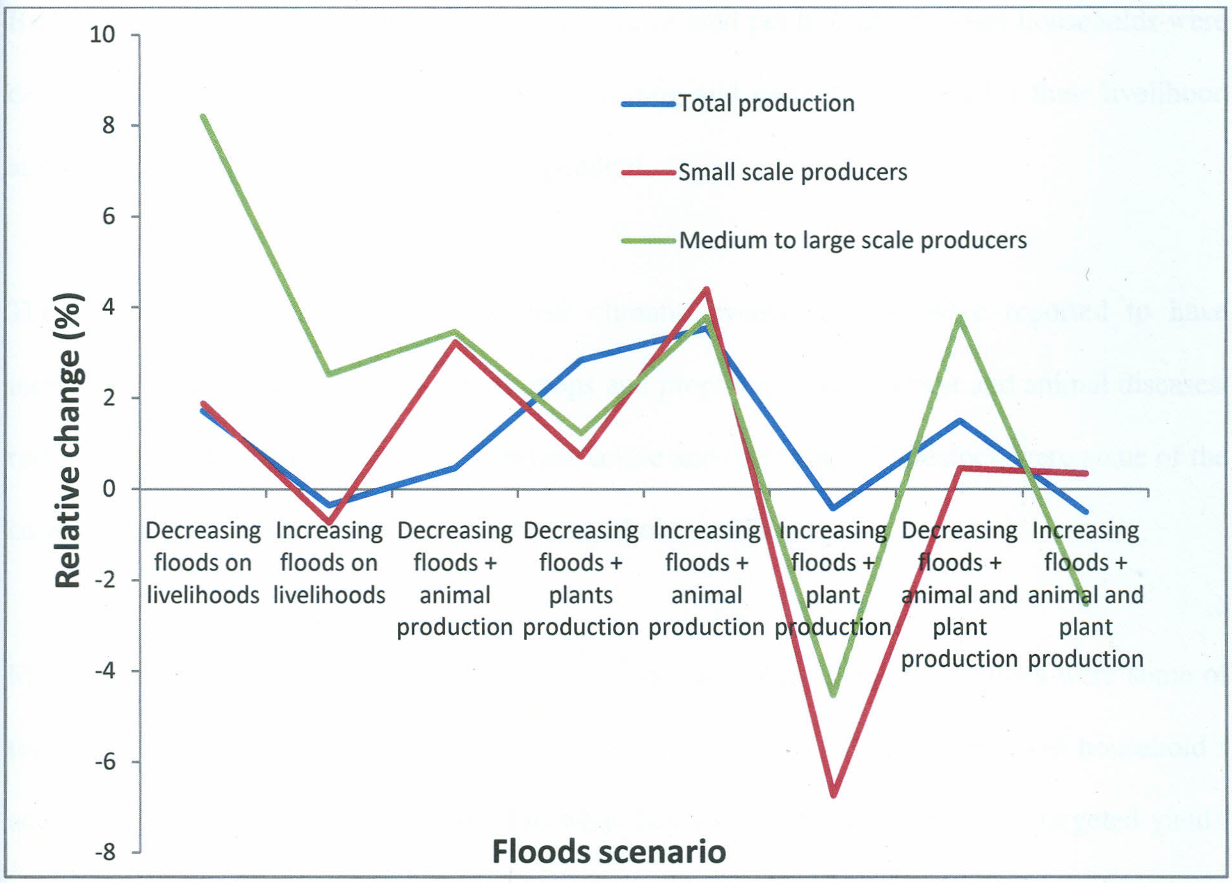

Figure 4.13: Flood scenario under different scales of production

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary of the Findings

Most of the household population was aged below 20 years, while only a small proportion of household members had attained more than secondary school level of education, most of who were from Nyando region. Most (92%) respondents had inherited the land on which they lived, while land fragmentation was most common among households living in fertile regions of Budalangi as exhibited by the small mean acreage of land per household. Most households were dependent on rain-fed agriculture, livestock keeping and natural resources for their livelihood and sustenance, all of which are climate dependent.

The frequency and magnitude of adverse climatic events (floods) were reported to have increased in the two regions. Damage to crops and property, increased pest and animal diseases, rotting of mature crops, destruction of infrastructure and drowning of livestock were some of the consequences of heavy rains and floods on household livelihoods.

Maize, beans, sorghum, millet, green grams, groundnuts, vegetables and potatoes were some of the main food crops grown in the two study regions of the LVB. However, most household's actual crop yields were lower compared to what they had anticipated to harvest (targeted yield), translating to huge monetary losses. In addition, food harvested in the previous season lasted less than 3 months for most households.

Most households kept a small number of livestock which included cattle, chicken, goats, sheep, donkeys, ducks and pigs. Some of the respondents reported losing livestock directly as a result floods.

Coping strategies against climate change markers included, diversification of agriculture and livelihood sources, setting aside savings for any eventuality, though most respondents were of the opinion that coping strategies aimed at lessening the impacts of climate change were not practical enough.

5.2. Conclusions

There is in Budalangi and Nyando, a relationship between flood variables and the agricultural production systems. I therefore conclude that,

1. The results demonstrated that most households in the lake Victoria Basin were dependent on rain-fed agriculture and other natural resources making them highly vulnerable to climate variability. The findings revealed losses in both crop yields and livestock production attributed to floods and other climatic events. This therefore implied that the food harvested by most households within the Lake Victoria basin of Kenya was insufficient to meet the needs of the household members. However, other factors besides adverse climatic events such as land fragmentation, high population growth, poor agricultural practices, and high poverty levels among others also contributed to the high food deficits recorded among many households in the two flood prone regions.
2. The Ricardian Model could explain satisfactorily (R^2 = 38%) the total national variation of the variable agricultural land value in response to climatic change. The independent

variable; flood presented a lower relationship to land value than the independent variable precipitation. With additional restrictions, such as the presence or absence of irrigation or agricultural extension, diverse relationships were detected that require more specific analysis.

3. The scenarios of change in floods show high impact on the land value than has been reported for less flood prone regions. Predictions at the national level reflect neutral impacts with a slight tendency to be beneficial when temperature increases. With an increase in precipitation, the impact is of greater magnitude, from neutral to slightly favourable in small scale agricultural producers and negative in medium and large-scale producers.

5.3. Recommendations

Following the huge losses recorded in crop farming compared to livestock rearing, this study recommends;

1. The adoption of cheaper and affordable alternatives to crop cultivation such as small holder dairy goats or/and sheep rearing, poultry farming, bee keeping among others within LVB.
2. It is also necessary to invest in research and development aimed at innovating technologies that will modify the properties of crops, increase their tolerance to extreme weather conditions in order to cope with declining yields and poor animal production.
3. There is need to expand the scope of the study to other parts of the Lake Victoria Basin and the entire country and also incorporate other climate change markers such as drought so as to get a more clearer picture of climate change effect on households to better inform national and regional policy.

4. Income generated by most households in the study regions was not adequate, therefore necessitating the need to encourage diversification of sources of income and adoption of alternative strategies such as operating small businesses which can withstand the effect of climatic variations.
5. There is need to educate and create public awareness among community members on mitigation and coping strategies against flooding and also empower them economically so that they are able to cope with changes in climate.

5.4. Contribution of this Study

This study findings highlighted the often unseen or ignored subtle effects of floods on economically vulnerable communities in the Lake Victoria basin, and based on the findings recommends effective flood mitigation and coping strategies as well as awareness creation among LVB households on importance of livelihood source diversification.

5.5. Suggestions for Future Research

There is need to carry out more focused studies on the suitability of crop over livestock keeping or vice-versa among households, probably focusing on the entire LVB to establish with certainty which among them (crop farming or livestock rearing) does better than the other and why, so as to inform policy with the aim of addressing the perennial food insecurity problems within the LVB.

In view of the potential of climate change to intensify and hence alter the magnitude and intensity of major climatic events, means that climate induced losses on livelihood sources are likely to intensify thus increase the vulnerability of the basin's inhabitants. This therefore necessitates the need for more studies aimed at establishing ways of improving the incomes and general living standards of households to enable them better deal with emerging climate related issues.

Results from this study bring into sharp focus the adamancy of people in disaster prone regions to relocate from these regions despite them being aware of the dangers they face, hence the need for studies to establish the most appropriate solution for these communities so as to avert further losses of life.

REFERENCES

Achoka, J. S. K. and Maiyo, J. (2008).Horrifying disasters in western Kenya; Impact on education and national development, Masinde Muliro University of Science and Technology, Kenya. *Academic Journals, Educational Research and Review* ***3***(3): 154 - 161.

ADPC and UNDP (2005).*Integrated flood risk management in Asia.* Bangkok: Asian Disaster.

AfDB, ADB, DFID, DGIS, EC, BMZ, OECD, UNDP and UNEP (2003). Poverty and climate change: reducing the vulnerability of the poor through adaptation, VARG multi development agency paper, United Nations Development Project (UNDP) United Nations, New York. *www.undp.org/energy/povcc.htm.*

Afifi and Warner (2007). The Impact of Environmental Degradation on Migration Flows across Countries UNU-EHS working paper no. 3. Bonn.

ALNAP and ProVention (2007). *Slow-onset disasters: drought and food and livelihoods insecurity. Learning from previous relief and recovery responses.* www.alnap.org/publications/pdfs/ALNAPProVention_lessons_on_slow-onset_disasters.pdf.

Andolan, M. J. (2008). *The Gender issues in Pastoralism Trends and Capacity Building.* Presented by Pastoral People's Movement of India. MARAG.

Babcock, M. and Mitchell, B. (1980).Impact of flood hazard on residential property values in Galt (Cambridge), Ontario. *Water Resources Bulletin*, 16(2), 532-537.

Barbier, B., Yacouba, H., Karambiri, H., Zorome, M. and Some, B. (2009).'Human vulnerability to climate variability in the Sahel: farmers' adaptation strategies in northern Burkina Faso', Environmental Management, Vol. 43, No. 5, pp.790–803.

Basu, P. (2005). A financial system for India's poor. *Economic and Political Weekly* ***40*** (37): 4008–4012.

Beckam, M., van An, L. and QuangBao, L. (2002). Coping and Adaptation Strategies of Households and Local Institutions in Central Vietnam. Stockholm Environmental Institute SEI/REPSI Report Series No. 5.

Beron, K. J., J. C. Murdoch, M. A. Thayer and W. P. M. Vijverberg, (1997).An analysis of the housing market before and after the 1989 Loma Earthquake.*Land Economics*, 73(1),101-113.

Blake, D. E. (2001). Contextual effects on environmental attitudes and behavior, *Environment and Behavior*, ***33***:708-725.

Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo R. and Yanda, P. (2007). Africa. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M. L. Parry, O. F., Canziani, J. P., Palutikof, P. J. van der Linden and C. E. Hanson, Eds., Cambridge University Press, Cambridge UK, 433-467.

Bostrom, A., Morgan, M. G., Fischhoff, B. and Read, D. (1994). What do people know about global climate change? 1. Mental models, *Risk Analysis*, ***14***(6): 959-970.

Brookshire, D. S., Thayer, M. A., Tschihart, J. and Schulze, W. D. (1985). A test of the expected utility model: evidence from earthquake risks. Journal of Political Economy, 93, 369-389.

Burby, R. J. and French, S. P. (1981).Coping with floods: the land use management paradox.*Journal of the American Planning Association*, 47, 289-389.

Changnon, S. A., Schicht,R. T. and Semonin, R. G.(1983).A plan for research on floods and their mitigation in the United States. In: *Final Report to National Science Foundation* (NSF-PAG-81-17027).Illinois State Water Survey Division, Department of Energy and Natural Resources.

Collier, P., Conway, G. and Venables, T. (2008).Climate Change and Africa. Oxford Review of Economic Policy.

Cooper, P. J. M., Dimes, J., Rao, K., Shapiro, B. and Twomlow, S. (2008). Coping better with current climatic variability in the rain-fedfarming systems of Sub-Saharan Africa: An essential first step in adapting to future climate change? *Agriculture, Ecosystems&Environment**14**:* 843-852.

Davidson, O. K., Halsnaes, S., Huq, M., Kok, B., Metz, Y., Sokona, G. and Verhagen, J. (2003). The development and climate nexus: the case of sub-Saharan Africa. Climate Policy 3S1: S97-S113.

Davies, M. and Leavy, J. (2009). *Connecting Social Protection and Climate Change Adaptation, In Focus Issue* 2, Institute of Development Studies (IDS), University of Sussex, Brighton.

DEFRA(2002). Survey of public attitudes to quality of life and to the environment: 2001. Department for Environment, Food and Rural Affairs, London.

DipECHO (2004).*The Evaluation of DIPECHO Action Plans in the Caribbean Region.* Brussels: Directorate-General for Humanitarian Aid Disaster Preparedness Programme. apps.odi.org.uk/erd/ReportDetail.aspx? reportID=3276.

Douglas, M., Gasper, D., Ney, S. and Thompson M. (1998). Human Needs and Wants', in Rayner, S. and Malone, E. L. (eds.), *Human Choice and Climate Change*, Battelle Press, Columbus, pp. 195–264.

Environmental Protection Agency (EPA) (2006).Excessive Heat Events Guidebook. Report from the United States Environmental Protection Agency, Washington, DC. EPA 430-B-06-005, 52 pp.

Epstein, S. (1994). Integration of the cognitive and the psychodynamic unconscious, *Am. Psychol.* **49:** 709–724.

FAOSTAT (2010).Statistical databases and data-sets of the Food and Agriculture Organization of the United Nations. faostat.fao.org/default.aspx (accessed April 2013).

Fazey, I., Kesby, M., Evely, A., Latham, I., Wagatora, D., Hagasua, J. E., Reed, M. S. and Christie, M. (2010). A three-tiered approach to participatory vulnerability assessment in the Solomon Islands, *Global Environmental Change, **20*** (4): 713-728.

Federal Emergency Management Agency. 2002. After Floyd - North Carolina Progress.

Food and Agriculture Organization (FAO) (2011). Food Outlook: Global Market Analysis.

Food and Agriculture Organization (FAO) (2008a).Climate Change, energy and food. High-level conference on food security: the challenges of climate change and bioenergy, Rome, 3-5 June 2008.

Food and Agriculture Organization (FAO) (2008b).*Climate change and food security: a framework document.* Rome.

Gadain, H. M., Bidault, N., Stephen, L., Watkins, B., Dilley, M. and Mutunga, N. (2006). Natural Disaster Hotspots: Case Studies, Reducing the Impacts of Floods through Early warning and Preparedness: A Pilot Study for Kenya', Disaster Risk Management Series No. 6, Washington DC: World Bank.

Gichere, S. K., Olado, G., Anyona, D. N., Matano, A. S., Dida, G. O., Abuom, P. O., Amayi J. and Ofulla, V. O. (2013). Effects of Drought and Floods on Crop and Animal Losses and Socio-economic Status of Households in the Lake Victoria Basin of Kenya.*Journal of Emerging Trends in Economics and Management Sciences (JETEMS) 4*(1): 31-41.

Gitu, K. (2004). Agricultural Development and Food Security in Kenya: Building a Case for More Support. Nairobi: FAO.

GlobeScan (2006).GlobeScan Corporate Social Responsibility Monitor. 30-Country Poll Finds Worldwide Consensus that Climate Change is a Serious Problem. /http://www.worldpublicopinion.org/pipa/articles/btenvironmentra/187.php?nid=&id=&pnt=187S (accessed 20 July 2012).

Government of Kenya (2005). Kenya Integrated Household Budget Survey (KIHBS) 2005/06, Basic Report. Sessional Paper No. 1 of 2005 on Policy Framework for Education, Training and Research, Nairobi: Government Printer.

Government of Kenya (2008).Food Security and Nutrition Strategy: 2nd Draft. Nairobi: Government Printer.

Government of Kenya (2010).Economic Review of Agriculture 2010.Nairobi: Ministry of Agriculture.

Guagnano, G. A., Stern, P. C., Dietz, T., (1995).Influences on attitude behavior relationships: a natural experiment with curbside recycling. *Environment and Behavior* ***27***: 699–718.

Gujarati, D.N. (1996). Econometría.Capítulo 5.p. 102- 139. 2ª ed. Regresióncon dos variables: estimaciónporintervalos y prueba de hipótesis. McGraw-Hill Interamericana, D.F. México.

Gullet, A., Mohamed, A., Abdi, A. and Anthony, M. (2006). Kenya: Floods Update No. 6. 4th December 2006. Operations Update. Kenya Red Cross Society.

Haines, A., McMichael, A. J., Smith, K. R., Roberts, I., Woodcock, J., Markandya, B., Armstrong, G., Campbell-Lendrum, D., Dangour, A. D., Davies, M., Bruce, N., Tonne, C., Barrett, M., Wilkinson, P. (2009). Public Health Benefits of Strategies to Reduce Greenhouse-Gas Emissions: Overview and Implications for Policy Makers. *Lancet*, ***374***: 2006-2015.

Haq, G., Whitelegg, J., Kohler, M. (2008). Growing Old in a Changing Climate: meeting the challenges of an ageing population and climate change, Stockholm Environment Institute, University of York, York. http://sei-international.org/mediamanager/documents/Future/climate/change/growing_old.pdf

Hines, J., Hungerford, H., Tomera, A., (1987). Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. *Journal of Environmental Education,* ***18***: 1–8.

Hulme, M., Doherty, R., Ngara, T. and New, M. (2005). Global warming and African climate change. *Climate Change and Africa*, P.S Low, Ed., Cambridge University Press, Cambridge, 29-40.

Human Impact Report (2009). Climate Change: The Anatomy of a Silent Crisis. Global Humanitarian Forum, Geneva. http://www.docstoc.com/ docs/6783796/

IFAD, (2009). (Draft) *Comprehensive Report on IFAD's Response to Climate Change Through Support to Adaptation and Related Actions.*

ILRI (2010). An assessment of the response to the 2008-2009 drought in Kenya. A report to the European Union Delegation to the Republic of Kenya. Nairobi: ILRI.

Intergovernmental Panel on Climate Change (IPCC) (2012).*Managing the risks of extreme events and disasters to advance climate change adaptation (SREX).*Special Report of the Intergovernmental Panel on Climate Change (IPCC). Geneva, IPCC Secretariat.

Intergovernmental Panel on Climate Change (IPCC) (2007).IPCC 4th Assessment Report - Climate Change 2007. Working Group II on Impacts, Adaptation and Vulnerability. http://www.ipcc-wg2.org

Intergovernmental Panel on Climate Change (IPCC) (2001).Climate Change: Impacts, Adaptation and Vulnerability, McCarthy, J., Canziani, O. F., Leary, N., Dokken, D. and White K. S., (eds.). Contribution of working Group II to the Third Assessment Report, Cambridge University Press, UK.

ISDR (International Strategy for Disaster Reduction). (2004). Living with risk: a global review of disaster reduction initiatives. Hyogo: United Nations, International Strategy for Disaster Reduction. 588 p.

Jacoby, H., Rabassa, M. and Skoufias, E. (2011).*On the distributional implications of climate change: the case of India.* Policy Research Working Paper 5623. Washington, DC, World Bank.

James, W.H. (2002). Realizing the potential benefits of climate prediction to agriculture: issues, approaches, challenges, Agricultural Systems, Vol. 74, pp.309–30.

Kairu, J. K. (2001). Wetland use and impact on Lake Victoria, Kenya region. *Lakes & Reservoirs: Research and Management, 6*: 117–125.

Karanja, F., Ogallo, L. J., Mutua, F. M., Oludhe, C. and Kisia, S. (2002). Kenya Country Case Study: Impacts and Response to the 1997-98 El Niño Event, Available at http://www.ccb.ucar.edu/un/kenya.html.

Kenya National Bureau of Statistics (KNBS), (2010).Population & Housing Census Results 2009.Minister of State for Planning, National Development and Vision 2030, Kenya.

Kenya National Bureau of Statistics, (KNBS) (2007).*Kenya Facts and Figures.* Nairobi, Kenya: Ministry of Planning and National Development.

Kenya National Bureau of Statistics, Ministry of Planning and Natural Development (2006). *Kenya Integrated Household Budget Survey 2005/6* (2006).

KFSSG (2008). KFSSG's Long Rains Assessment Report. Kenya Food Security Steering Group. http://www.kenyafoodsecurity.org/ (Accessed on 11 December 2012).

Kollmuss, A., Agyeman, J., (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior. *Environmental Education Research* ***8*****:** 239–260.

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change*. 77:45-72. DOI: 10.1007/s10584-006-9059-9.

Loewenstein, G., Weber, E., Hsee, C. and Welch, E. (2001).Risk as feelings, *Psychol. Bull.* ***127***, 267–286.

Lorenzoni, I., Lowe, T. and Pidgeon, N. F. (2005).A Strategic Assessment of Scientific and Behavioural Perspectives on 'Dangerous' Climate Change. Tyndall Centre Technical Report 28, University of East Anglia, Norwich, U.K.

MacDonald, D. N., J. C. Murdoch and H. L. White, (1987). Uncertain hazards, insurance and consumer choice: evidence from housing markets. *Land Economics*, 63, 361-371.

Mango, T. (2003).The Issue of Floods in Budalangi division, (Report for Budalangi Floods Stakeholders Forum, September, 10th – 11th, 2003), Budalangi – Kenya, pg 1-12.

McMahon, P. L., Lipper, L. and Karfakis, P. (2011).*Stability of food security in a green economy environment*.Mimeo. Rome, FAO.

Mendelsohn R, Nordhaus W, Shaw D (1994). The impact of global warming on agriculture: a Ricardian analysis. *Am Econ Rev* 84:753–771.

Mendelsohn, R. (1996). Estimating the market impacts of global warming in Brazil.63 p.In Conference on environmetrics in Brazil, São Paulo. Abstracts.*Instituto de Matemática e Estadística, Universidade de São Paulo, São Paulo*, Brazil.

Mendelsohn, R., Basist, A., Kurukulasuriya, P. and Dinar, A. (2007).Climate and rural income. *Climatic Change, **81***:101-118.

Mendelsohn, R. (ed). 2001. Global warming and the American economy: A regional assessment of climate change. 224 p. Edward Elgar Publishing, Cheltenham,United Kingdom.

Michael D. M., Amy L. L., Stephen H. S. (2006). Changing Perceptions of Changing Risks: Climate Change and the California Public .

Mogaka, H., Gichere, S., Davis, R. and Hirji, R. (2006). Climate variability and water resources degradation in Kenya: improving water resources development and management, World Bank. Working paper No 69, Washington DC.

Muckleston K. W., M. F. Turner and R. T. Brainerd, (1981).*Floodplain regulations and residential land values in Oregon*. Office of Water Resources Technology (No.A-054-ORE) and Water Resources Research Institute, Oregon State University, Corvallis, Oregon.

Mugisha, A., McLeod, A., Percy, R. and Kyewalabye, E. (2007). Socio-economic factors influencing control of vector-borne diseases in the pastoralist system of south western Uganda. *Tropical Animal Health and Production, **40***(4):287-297.

Musambayi, J. N. (2013). The impact of Land Fragmentation/Segmentation on Production and Food Security (Case study: Three major regions in Kenya). *Elixir Agriculture**56***: 13493-13495.

Ng'ang'a J. (2006).An Analysis of Climate Change Impacts, Vulnerability and Adaptation Assessment in East Africa. Presented at the United Nations Framework on Climate Change Convention (UNFCCC) African Regional Workshop on Adaptation, 21-23 September 2006, Accra, Ghana by the Department of Meteorology, University of Nairobi.

Niaber, J.A. and Hahn, G. L. (2007). Livestock production system management responses to thermal challenges. *International Journal of Biometeorology*, ***52***(2): 149-157. ISSN: 0020-7128

Nisbett, R. E. and Ross, L. (1980).*Human Inference: Strategies and Shortcomings of Social Judgment*. Prentice-Hall, Englewood Cliffs, NJ.

Norton, A. and Leaman, J. (2004). The Day After Tomorrow: Public Opinion on Climate Change. MORI Social Research Institute, London, U.K.

Odada, E. O., Olago, D. O. and Ochala, W. Eds. (2006). Environment for Development: An Ecosystems Assessment of Lake Victoria Basin. UNEP/PASS.

Ogallo, L. A., Boulahyam, M. S. and Keane, T. (2000). Applications of seasonal to interannual climate to agricultural planning and operations. *Agricultural and Forest Meteorology* ***103***(1-2): 159-166.

Okayo, J., Odera, P., Omuterema, S. (2015). Socio-economic characteristics of the community that determine ability to uptake precautionary measures to mitigate flood disaster in Kano Plains, Kisumu County, Kenya. *Geoenvironmental Disasters*, 2:26.

Olago, D. (2004). Climate and Hydrological variability and extremes in Lake Victoria basin. In: messages from Dakar: Report of the Second AIACC Regional Workshop for Africa and the Indian Ocean islands, Dakar, Senegal, 24-27 March, pp 5-9.

Olago, D. (2005). Climate Change and Malaria in Lake Victoria Basin. Paper presented at the CIERO, ACTS and IIED-UK policy Consultation on "Vulnerability to Climate Stress-Local and Regional Perspectives" held at ACTS, World Agro Forestry Research Center Campus, Nairobi, January 27-28th.

OST and MORI, (2004).Science in Society—Findings from Qualitative and Quantitative Research. Conducted for the Office of Science and Technology, Department of Trade and Industry by MORI Social Research Institute, London.

Otiende, B. (2009). The Economic Impacts of Climate Change in Kenya: Riparian Flood Impacts and Cost of Adaptation. Kenya National Advisory Committee for the DFID funded study on the Economic Impacts of Climate Change in Kenya.

Ouedraogo, M., Somé, L. and Dembele, Y. (2006). Economic Impact Assessment of Climate Change on Agriculture in Burkina Faso: A Ricardian Approach, CEEPA Discussion Paper No. 24, Centre for Environmental Economics and Policy in Africa, University of Pretoria.

Ouma, J., Murithi, F., Mwangi, W., Verkuijl, H., Gethi, M. and De Groote, H. (2002).Adoption of Maize Seed and Fertilizer Technologies in Embu District, Kenya. Mexico, D. F.:CIMMYT.

Oyugi, A., Obiero, N. and Awanga, J. L. (2003)."Poverty reduction" a challenge for Lake Victoria Basin (Kenya).

Palm, R. I., and Carroll, J. (1998).*Illusions of Safety: Culture and Earthquake Response in California and Japan*. Boulder: West view Press.

Palm, R. (1982). Earthquake hazards information: the experience of mandated disclosure. In: *Geography and the Urban Environment: Progressing Research and Applications* (D. T. Herbert and R. J. Johnston(eds.)), 5, 241-277, Wiley, Chichester.

Parry, M. (1990). Climate change and world agriculture. Earthscan Publications ltd. London. ISBN 1 85383 065 8.

Phiri, M., Ibrahim, G. and Saka, R. A. (2005).The impact of changing environmental conditions on vulnerable communities of the Shire valley, southern Malawi. Lilongwe, Malawi.

Poortinga, W., Pidgeon, N. (2003). Public Perceptions of Risk, Science and Governance: Main Findings of a British Survey of Five Risk Cases. University of East Anglia and MORI, Norwich.

Ringler, C., Zhu, T., Cai, X., Koo, J. and Wang, D. (2010). Climate change impacts on foodsecurity in Sub-Saharan Africa. Insights from compréhensive climate change scenarios. IFPRI Discussion Paper 01042.

Rowshan, R. (1992). Women in Disasters, in: *Journal of Social Studies,* Centre for Social Studies, University of Dhaka (BD), ***57***: 81-88.

Saarinen, T. F., Seamon, D. and Sell, J. L. ***(eds)*** (1984). *Environmental Perception and Behavior: An Inventory and Prospect.* Department of Geography Research Paper Number 209. Chicago: University of Chicago.

Save the Children UK (2007). Vulnerability and Dependency in 4 Livelihood Zones in North Eastern Province, Kenya.

Scawthorn, C., Iemura, H., Yamada, Y. (1982). The influence of natural hazards on urban housing location. *Journal of Urban Economics*, 11, 242-251.

Schmidhuber, J. and Tubiello, F. N. (2007). Global food security under climate change. Proceedings of the National Academy of Sciences of the United States of America. ***104***(50): 19703-19708.Senbeta A. F. (2009). Climate Change Impact on Livelihood, Vulnerability and Coping. Mechanisms: A Case Study of West-Arsi Zone, Ethiopia. MSc. Thesis Submitted to Lund University Masters Program in Environmental Studies and Sustainability Science (LUMES). 54 pp.

Sheaffer, J. R. and L. S. Greenberg, (1981).*Evaluation of the economic, social and environmental effects of floodplain regulations*. Report for the U.S. Department of Housing and Urban Development and the Federal Emergency Management Agency, Washington D.C.

Skoufias, E. (ed.) (2012). The Poverty and Welfare Impacts of Climate Change: Quantifying the Effects, Identifying the Adaptation Strategies. Washington, DC: World Bank. DOI. 10.1596/978-0-8213-9611-7 License: Creative Commons Attribution CC BY 3.0.

Smith, K. and Ward, R. C. (1998). Floods: Physical Processes and Human Impacts, John Wiley and Sons, Chichester.

Sniffer (2009).Differential Social Impacts of Climate Change in the UK, Scotland and Northern Ireland Forum for Environmental Research, Edinburgh, Scotland.http://www.sniffer.org.uk/our-work/climate-change.aspx.

Stamm, K.R., Clark, F., Eblacas, P. R. (2000). Mass communication and public understanding of environmental problems: the case of global warming. *Public Understanding of Science* ***9***: 219–237.Printed in UK

Stoll-Kleemann, S., O'Riordan, T. and Jaeger, C. C. (2001). The psychology of denial concerning climate mitigation measures: evidence from Swiss focus groups. *Global Environmental Change* ***11***: 107–117.

Thompson, H. F., Berrang-Ford, L. and Ford, J. D. (2010). Climate change and Food Security in Sub-Saharan Africa: A systematic literature review. Sustainability No. 2, p. 2719-2733.

Traore, S., Owiyo, T. and Sokona, Y. (2013).Dirty drought causing loss and damage in Northern Burkina Faso, Int. J. Global Warming, 5, No. 4, 2013.

Twigg, J. (2003). Early Warning Systems for Natural Disasters Reduction, Zschau J. and Kuppers A. Editors, Springer, pp. 19-26.

United Nations Office for the Coordination Humanitarian Affairs (2006). 'Kenya Floods: OCHA Situation Report No. 3'. Ref: OCHA/GVA 2006/0243.

UNDP (2008). Kenya National Disaster Profile. United Nations Development Programme, Enhanced Security.

UNESCO (2000).*Education for All. Status and Trends 2000.Assessing learning achievement, International Consultative Forum on Education for All.* Paris: UNESCO. Retrieved January 15, 2013 from: http://unesdoc.unesco.org/images/0011/001198/119823e.pdf.

UNFCCC (2006).Background paper on Impacts, vulnerability and adaptation to climate change in Africa. UNFCCC Secretariat. Bonn, Germany. http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200609_background_african_wkshp.pdf

United Nations Development Programme (UNDP) and Ministry of the Environment and Natural Resources (SEMARNAT). (2006). *Capacities and synergies. The environmental challenge in Mexico*. Mexico.

URT (2003). Initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC).Vice President's Office. 166pp

USAID (2008).Kenya Food Security Outlook Report. United States Agency for International Development. http://www.fews.net/pages/country.aspx?gb=ke&l=en (Accessed on 27 October 2008).

USDA (1993). West Virginia erosion and sediment control handbook for developing areas. USDA. Sol conservation service: Morgantowa, W. V. West Virginia Division Highways (WVDOH) (2000). Standard specifications for roads and bridges, State Government, Charleston, W. V.

Van de Steeg J. A., Herrero, M., Kinyangi, J., Thornton, P. K., Rao, K. P. C., Stern, R., Cooper, P. (2009). The influence of climate variability and climate change on the agricultural sector in East and Central Africa - Sensitizing the ASARECA strategic plan to climate change. Research report 22.ILRI (International Livestock Research Institute), Nairobi, Kenya, ICRISAT (International Crop Research Institute for the Semi-Arid Tropics), Nairobi, Kenya, and ASARECA (Association for Strengthening Agricultural Research in Eastern and Central Africa), Entebbe, Uganda.

Walker, B., Evers, M. (2010). Animal health problems following floods and drought-breaking rains, PRIMEFACT publication, Australia, No. 849, 2ND Edition.

Weber, E. U. (2010). What shapes perceptions of climate change? Wiley Interdisciplinary Reviews: *Climate Change*, ***1***(3), 332-342. doi: 10.1002/wcc.41.

World Bank (2010). World Development Indicators: 2010. 1818 H Street NW, Washington, D.C. 20433 USA, 2010.

World Bank (2007).Development and the Next Generation, World Development Report. Washington: World Bank.

Yamaga, H., Nakagawa, M. and Sato, M.(2002). Earthquake risk and land price: the case of Tokyo. *Discussion Paper Series* No. 966, Institute of Policy and Planning Sciences, University of Tsukuba, Tsukuba.Zajonc, R. B. (1980). Feeling and thinking: preferences need no inferences. *Am. Psychol.* ***35***: 151–175.

Zorom, M., Barbier, B., Mertz, O. and Servat, E. (2012). Review: diversification and adaptation strategies to climate variability: A farm typology for the Sahel, Agricultural Systems [online]http://dx.doi.org/10.1016/j.agsy.2014.11.20