Journal of Emerging Trends in Economics and Management Sciences (JETEMS) 4(1): 31-41

jetems.scholarlinkresearch.org

Effects of Drought and Floods on Crop and Animal Losses and Socio-economic Status of Households in the Lake Victoria Basin of Kenya

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Abstract
Most crops and animal losses are witnessed during drought and floods either indirectly through climate induced diseases or directly through the physical impact of floods on crops and livestock or their production. We investigated the effect of drought and floods on crop and animal production and losses among households in six regions within the Lake Victoria Basin (LVB) of Kenya. In this study, a structured questionnaire and focus group discussions were used to collect primary data on the effects of climate variability on houdesholds' income and losses from crops and livestock, while retrospective data on the past climatic events were obtained from media reports and Kenya meteorological department. The demographic information was collecetd from the Kenya population and housing census reports. All (100%) households, from the six regions grew some crops on their farms, though the largest percentage (88%) of households were from Bomet region, followed by Kisii central region (78%). The least was recorded in Bondo region (47%). Most (88%) households also kept a small number of livestock with cattle being most dominant. Livestock losses among households were highest (Ksh. 8,502) in Rarieda and lowest in Bomet (Ksh. 3,115). Pooled average losses per region as a result of crop failure was Ksh. 118,825, with Nyando region recording upto three times (Ksh. 221,709) higher than Kisii central (Ksh. 72,577), Budalangi (Ksh. 73,804) and Bomet (Ksh. 76,365) regions. The disaster prone regions (i.e. Bondo, Rarieda, Budalangi and Nyando) were 25 times more likely to be affected by drought, compared to regions with relatively good weather (i.e. Bomet and Kisii central) (p = < 0.0001). Floods had mostly been experienced in Budalangi and Nyando. Results also indicated that regions with relatively good weather experienced 3 times more rains than the other four disaster prone regions, but the differences were insignificant (p = 0.097). In general, results showed that crops farming had more climate related losses compared to livestock rearing which in this case recorded very minimal losses, suggesting that LVB communities should put more emphasis on livestock rearing which is not as sensitive to seasonal droughts and floods as crop farming.

Keywords: crop and animal production, drought, floods, lake victoria basin, Kenya.

INTRODUCTION

In sub-Saharan Africa, droughts and floods are two extreme climatic events that adversely affect the agricultural sector, and by extension affects 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). Lake Victoria Basin (LVB) is endowed with a wealth of natural resources among them a population of about 30,000,000 (Shepherd *et al*., 2000); with the current estimate putting the population at more than 35,000,000 people, most of whom depend directly or indirectly on the agricultural sector. In this region, human vulnerability to drought appears to be due to high poverty levels, high population growth rates, insufficient sensitization on values of wetlands and politically instigated pressures and interference (IPCC, 2001). However, severe effects of drought are exacerbated by human activities such as deforestation, overgrazing and poor farming methods.

Floods are also 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). Riverine floods are the most dominant in Kenya and mostly occur along floodplains as a result of exceeded stream flow capacity, leading to over spills of the natural banks or artificial embankments (Smith and Ward, 1998). Rivers Nzoia and Nyando experience extensive floods in their lower reaches affecting the

Budalangi and Kano flood plains, respectively, which were the focus of the flood prone regions of this study.

Given that 98% of Kenya's crops are rainfed and only 19% of Kenya's potential area is equipped for irrigation, the high variability of rainfall coupled with climate change markers such as floods and droughts poses a significant risk to farmers. Overdependence on the agricultural sector which is directly impacted by climate change increases the vulnerability of the Lake Victoria Basin inhabitants, while the low economic development and low institutional capacity makes most developing countries within the continent highly vulnerable (IPCC, 2001). Other factors such as widespread poverty, human diseases and high population density also magnify the negative impacts of climatic events particularly on the agricultural sector. High population growth rate within the LVB is expected to double the demand for food, water, and livestock forage within the next 30 years (Davidson *et al*., 2003), making the poor even more vulnerable to the effects of climate change.

The major food crops within the LVB of Kenya are maize, beans, rice and bananas while sorghum, millet and root crops, such as cassava and sweet potato are considered to be important food security crops. In Kenya as well as in the LVB, maize is one of the most important cereal crops and accounts for 80% of the national production of cereals (Ouma *et al*., 2002). The livestock industry on the other hand contributes about 10% of the GDP of the country, with the major livestock types in the LVB being cattle, poultry and goats. Unlike in the arid regions of Kenya where large herds of livestock are kept by single households, most households in the LVB are agropastoralists who keep a small number of livestock, while others practice zero grazing for subsistence purposes. However they tend to rely more on rain fed crop farming, which increases their vulnerability to climatic factors. The impact of crop failure and reduced animal production on the vulnerable communities is usually high as it is often the main source of livelihood. Studies have shown that the magnitude of a disaster depends on the characteristics and intensity of the hazard and the susceptibility of the affected communities based on the prevailing social, physical and environmental conditions (Osbahr and Viner, 2006).

Kenya experiences a number of natural hazards; the most common being related to adverse weather change (UNDP *et al*., 2002). Climate variability is therefore one of the defining challenges of the 21st century, whose economic implications on livelihoods of communities within the LVB is likely to be felt by most populations in the next decades and put the lives and wellbeing of millions of people at increased risk (Olago, 2005). Recurrent, extreme weather events have high economic implications on the affected households and can trigger food insecurity, thus impacting negatively on the economic wellbeing of the affected communities and can restrict or hamper long term growth (ISDR, 2002). Climatic variability may affect crop farming and animal production differently, such that it may be favourable to one but lethal to the other. It is therefore important to establish the exact effect of climate variabilities on crop farming and compare with its effect on animal production within the same region. This study was therefore carried out to establish the effects of drought and floods on crop and animal losses and socio-economic status of households in the Lake Victoria basin of Kenya. The methods and results from this study can help quantify the exact economic implications of climate change markers on food security and socio-economic status among households living within the Lake Victoria Basin of Kenya and other regions, as well as advice policy makers on the best livelihood options to adopt for particular regions.

MATERIALS AND METHODS

This study was conducted within the Lake Victoria Basin (LVB) of Kenya located between latitude 0°20'N and 3° 00'S and between longitude 31° 39'E and 34° 53'W, covering an area of about 194,000 Km^2 (Odada *et al*., 2006). The Kenyan side of the lake covers an area of about 4113 Km (6%), a shoreline of 550 Km^2 (17%), a basin area of 38,913 Km^2 (22%), and it is at an elevation of 1134 m above sea level. The current population of LVB of Kenya stands at about 12.5 million people, with over 70% of this population engaged in agricultural activities mostly as small scale farmers keeping a few livestocks some of which are zero grazed (Otiende, 2009).

A total of six regions within the LVB of Kenya were selected for this study and clustered into three groups based on their climatic characteristics as follows: regions prone to droughts (Rarieda and Bondo); regions prone to floods (Budalangi and Nyando); and regions with relatively good weather (Bomet and Kisii central) to help as models for a comparative study of the effects of adverse climatic events and climate change on socio-economic status of vulnerable communities. The study involved both cross-sectional and retrospective investigations, in which quantitative and qualitative data were collected from primary and secondary sources over a three month duration (July 2011 to September 2011). Structured household interviews were conducted in each of the study locations to obtain quantitative primary data, while interactive focus group discussions (FGDs) were also conducted to obtain data on community knowledge of past climatic events and their effects on food security and corresponding socio-economic implications among households. Documentay information including other literature

and reports from bodies such as Kenya Red Cross Society (KRCS) were obtained to establish the exact effects of adverse climatic events (droughts, floods, etc) on food security and socio-economic outcomes of the affected households and communities.

Estimation of Economic Losses Arising From Crop Failure

In estimating the economic losses arising from crop failure during the last growing season, data on actual yield as well as the expected yield was collected from the respondents in the six regions by use of a structured questionnaire. The economic losses resulting from crop failure due to inability by households to reach their expected target yield in the previous growing season was computed for each of the six regions by calculating the difference between the expected yield and the actual yield attained. All the monetary calculations were done in Kenya shillings which is the local currency in the LVB of Kenya. Approximately Ksh. 83 equals one (1) US$. 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 throughout the six 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.

Estimating Economic Losses Arising From Livestock Lost As A Result Of Climate Varability Markers

To compute the cost of livestock lost due to floods and droughts, this study established the type and number of common livestock kept by households across all the six study regions which included cattle, sheep, goats, chicken, pigs and donkeys. The number and type of livestock lost due to adverse climatic events (droughts or floods) by individual households over the last 20 years (1991-2011) were established through a questionnnaire and recorded to give an estimate of the monetary value of the livestock deaths per household. All the monetary calculations were done in Kenya shillings. In performing the computations, several assumptions were made. For instance the current (2012) market prices of the particular livestock type was assumed to be constant across all the study regions. It was also assumed that the respondents were able to accurately recall all the losses arising from livestock deaths incured as a result of droughts or floods during the last twenty years (1991-2011). The average number of livestock owned by each household per region was also assumed to be the same for all households in that particular region.

Ethical Considerations

Authority to conduct this study was obtained from Maseno University and also from the local administrative officers in the six regions, i.e., district Officers, area chiefs, or other government officials. Verbal consent was obtained from study respondents prior to their participation in the study. To help assure anonymity, names of the respondents were not recorded.

DATA ANALYSIS

The data obtained were first entered in Excel spreadsheet, then cross checked and transfered to SPSS V16, Epi Info and SAS V9.2 softwares for analysis. The FGDs data were analyzed thematically. Frequencies and percentages were used to describe the distribution of variables, while the relationship between the dependent variables; crop yield and animal produce and the independent variables (geographical region, drought and floods) were analyzed using the GENMOD procedure in SAS; ordinal logistic regression was used to determine the relationships between the variables, through which Odds Ratios were computed to further show the direction of the relationships. A chi-square test was used indicated the significant associations between the variables. A statistical values of $P \leq 0.05$ was considered significant.

RESULTS

Demographic Characteristics of the Study Population

The household population in the surveyed homes constituted of 2,602 individuals, 50.9% of whom were females and 49.1% males. The populatation of both sexes were similar (Chi square =23.6, p = 0.352). Less than 9% of the respondents (household heads) across all the study regions had attained more than secondary school education, with Rarieda region having recorded the highest percentage (8.7%) and Budalangi the lowest (2.3%). Most (20.8% and 17.8%) of the uneducated respondents were from the flood prone regions of Budalangi and Nyando, respectively.

Main Sources of Livelihoods for Households and Adequacy of Generated Income

Agropastoralism was the main land-use activity for most (60%) households followed by agriculture (39%). Only 1% of respondents across all the regions combined reported pastoralism as their main land use activity. Most respondents, from the six regions grew some crops on their farms, though the largest percentage (88%) of households that practiced crop farming were from Bomet region (a region with relatively good weather) while the least (47%) was recorded in Bondo (a drought prone region). The main sources of food for households were crops grown on the farm (52%) and food bought from the market (40%). Crops grown on the farm accounted for 94% of main source of food for households living in Bomet, followed by 68% for Kisii central. However, they accounted for less than 50% of main

source of household food for Bondo, Budalangi, Nyando and Rarieda households.

Livestock keeping was also practiced across all the regions, though to a lesser extent. Fishing activities were recorded in regions bordering Lake Victoria (Bondo, Budalangi and Rarieda). In total, only 18% of the respondents reported that all their sources of livelihood generated adequate income for their household needs in the last one year. However, considering study regions separately, over 40% of respondents from Bomet region reported generating adequate income for their households in the previous year, compared to all other regions where less than 20% of the respondents stated the same.

Distribution and Effects of Adverse Climatic Conditions in the Study Regions

All the six regions studied had experienced drought though it was recorded to a lesser extent in Bomet region. Floods had mostly been experienced in the flood prone regions of Budalangi and Nyando. Generally, Bomet and Kisii central were less vulnerable to adverse climatic conditions while Nyando followed by Rarieda were more vulnerable, Figure 1.

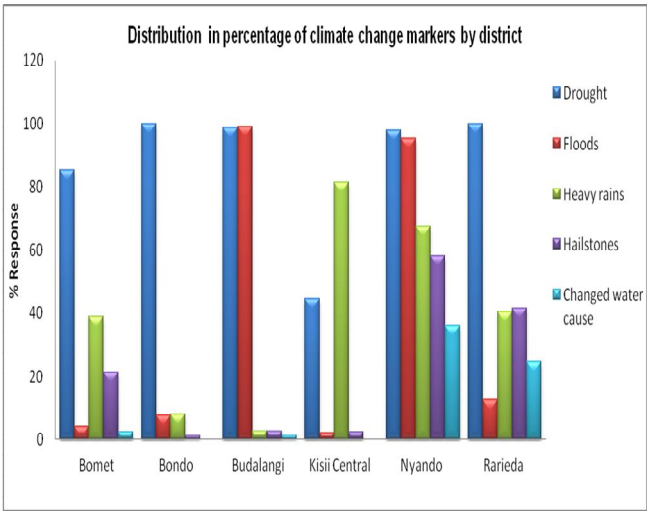

Figure 1. Percentage distribution of climate change markers by study region

The frequency and magnitude of adverse climatic events mainly, floods was reported to have increased by both the FGD participants and media reports. Statistical analysis showed that households living in flood prone regions (Nyando and Budalangi) and drought prone regions (Bondo and Rarieda) were 25 times more likely to be affected by drought, compared to those living in regions with relatively good weather (Kisii central and Bomet), (OR = 24.78, 95% CI (12.5-49.2), $p < 0.0001$). Further statistical analysis showed that regions with relatively good weather, experienced 3 times more rains compared to the four disaster prone regions, though the difference was not statistically significant (OR = 2.91, 95% CI (0.82-10.25), P=0.097). Drought was cited as the major climate change marker after floods by most respondents across all the six climatically different regions, with 100% of respondents from Bondo and Rarieda, over 90% from Nyando and Budalangi, over 80% from Bomet and less than 45% of respondents from Kisii central region having witnessed drought in their regions. Focus group discussion participants cited damage to crops and property and increased pest and animal diseases, rotting of mature crops and drowning of livestock as some of the consequences of heavy rains and floods.

Sufficiency of Food Harvested in the Previous Seasons

In general, 36% of the respondents reported that food harvested in the previous season lasted less than 3 months, 31% reported 4-5 months, 17% reported 5-8 months, 5% reported over 8-10 months, and 11% reported that food harvested lasted throughout the year, across all the study regions combined. Most respondents from Budalangi, Nyando and Rarieda reported that food harvested in the previous season lasted less than 3 months, while 33% of respondents from Bomet region reported that the food lasted throughout the year. The odds ratio showed that food harvested in flood prone and drought prone regions were three times more likely to last less than three months as opposed to the whole year, though these differences were not significantly different. Focus group discussion participants across all the study regions cited crop failure, poor crop yield and increased pests and diseases as the main impacts of drought on crop farming, while lack of pasture and water, reduced animal productivity, stunted growth and increased animals diseases and pests were cited as the main effects of drought on livestock keeping.

Economic Losses Arising From Crop Failure among Households in the Study Regions

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 to Ksh 52,626 and lowest losses in peas (Ksh. 2,358). Maize recorded an average loss of Ksh. 9,599 per household as a result of crop failure, Table 1.

Table 1. Estimated economic loss in Ksh due to crop failure per household in Nyando region

	Maize	Beans	Peas	Sorghum	Millet	Green grams	Ground nuts	Rice	Vege tables	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	9,599	8,784	2,358	13,396	29,308	44,822	48,222	52,626	7,215	5,379

In Bondo region, the actual amount of maize harvested were only 3.2 bags out of the expected 7.2 bags per household, translating into a loss of of Ksh. 11,600 worth of maize yields lost in the last growing season in the region. However, millet recorded the largest losses (Ksh. 58,407) per household since the actual amount harvested was far below the expected yield, (table not shown). The subsequent results layout are similar as presented in Table 1. In Bomet region, maize produced over 60% of the expected yield, while economic losses arising from crop failure was highest in potatoes (Ksh. 23,668) followed by maize (Ksh. 15,254), beans (Ksh. 14,701), vegetables (Ksh. 9,964), millet (Ksh. 9.175) and peas (Ksh. 3,603). In Budalangi (a flood prone region), only maize and potatoes yielded more than half (> 50%), the expected yield during the previous growing season. Despite this, the highest monetary losses were recorded in maize (Ksh. 15,283) and sorghum (Ksh. 13,134) yields.

Despite Kisii central region having relatively good weather, both the expected and the actual agricultural yields were generally low for all the food crops as compared to other regions. The highest expected yields were from sorghum, followed by maize then potatoes. Apart from green grams which recorded 100% actual yield of the expected yield, the actual yields of all other food crops were below 50% with some such as sorghum, groundnuts and potatoes, recording less than 20% of the expected yield, translating to a loss of Ksh. 17,288, 16,446 and 11,403, respectively, per household. In Rarieda region the actual yield of most food crops was far below (less than half), the expected yield usually realized, with crops like potatoes recording complete loss since nothing was harvested of the expected 8.5 bags (90kg bags), translating to a 100% loss of Ksh. 30, 481. Sorghum, green grams and maize also registered high losses.

The pooled average presumed monetary losses per region as a result of crop failure was Ksh. 118,825 with millet yield registering the highest losses, while peas recorded the least.However, the losses presumed to have been incurred by households due to failure to reach the target crop yield was upto three times (Ksh. 221,709), higher in Nyando (a flood prone region),

compared to Kisii central (Ksh. 72,577), Budalangi (Ksh. 73,804) and Bomet (Ksh. 76,365) regions, during the previous growing season. In addition, households from Rarieda and Bondo regions (both areas with relatively dry climate), also recorded relatively high losses (Ksh. 154,166 and 114,294, respectively) resulting from crop failure during the previous growing season Table 2.

Table 2. Total economic losses in Ksh per food crop in each study region

	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**
Bondo	11,803	7,625	720.5	11,525	58,407	6,698	-	-	15,722	1,793	**114,294**
Bomet	15,254	14,701	3,603	0	9,175	-	-	-	9,964	23,668	**76,365**
Budalangi	15,283	10,065	5,502	13,134	10,434	-	10,152	-	6,580	2,690	**73,840**
Kisii central	6,902	6,649	-	17,288	10,434	-	16,446	-	3,455	11,403	**72,577**
Rarieda	18,792	6,649	-	12,386	13,579	21,786	38,578	-	11,915	30,481	**154,166**
Mean	**12,939**	**9,079**	**2,031**	**11,288**	**21,889**	**12,218**	**18,900**	**8,771**	**9,142**	**12,569**	**118,825**
Total	**77,633**	**54,473**	**121,184**	**67,729**	**131,337**	**73,306**	**113,398**	**52,626**	**54,851**	**75,414**	**712,951**

Climatic Factors and Livestock Husbandry

Most respondents (88%), kept a few livestock while the remaining 12% did not keep any livestock at all in all the study regions combined. The common type of livestock kept across all the studied regions included cattle (69%), chicken (67%), goats (34%), sheep (13%), donkeys (4%), ducks (3%) and pigs (3%).

Factors Affecting Livestock Keeping

Floods, drought, heavy rains, and change in water course were the major factors affecting livestock rearing according to 93% of the respondents. Droughts and floods were reported by most respondents (68% and 70%, respectively), to have had severe effects on livestock keeping. Upto 77% of

the study respondents across all the study regions combined reported having lost livestock directly as a result floods or droughts in the last 20 years. Cattle were the most (54%) affected livestock typewith livestock diseases, lack of pasture, inadequate grazing land and lack of water being the major problems encountered by livestock keepers, while most livestock diseases were experienced during droughts (35%) and during rainy seasons (23%).

Economic Losses Arising from Livestock Lost as a Result of Climate Change Markers

The most common livestock kept by respondents of Nyando region included cattle, goats, sheep and poultry. Study findings showed that annual losses per household arising from catlle were highest (Ksh. 6717), while those from poultry were the least (Ksh. 485), Table 3.

Table 3. Costing the average livestock losses in Ksh/household/yr in Nyando region

	Cattle	Goats	Sheep	Poutlry
Total number of livestock lost among households in the last 20 years[a]	290	35	15	1026
Total number of households who lost livestock[b]	41	11	4	36
Average number of livestock lost per household[c]	7.07	3.18	3.75	28.5
Total household population in the region[d]	78,225	78,225	78,225	78,225
Percentage of household population that lost livestock in the region[e]	79%	21%	8%	67%
Actual household population that lost livestock in the region[f]	61,798	16,434	6,258	52,411
Actual number of livestock lost in the previous year in the region[g]	436,912	52,260	23,468	1,493,714
Current market prices per livestock type[h]	19,000	4,000	3,500	340
Total cost of livestock lost per region in the last 20 years[i]	8,301,328,000	209,040,000	82,138,000	507,862,760
Annual cost of livestock lost in the region[j]	415,066,400	1,0452,000	4,106,900	25,393,138
Annual average loss per household (in Ksh)	**6717**	**636**	**656**	**485**

Notes on table 3

[a] the total number of livestock lost among households in the last 20 years was obtained from our field questionnaires

[b]total number of household who lost livestock is obtained from our field questionnaires

[c]average number of livestock lost per household is obtained by dividing total livestock lost by total household who lost livestock

[d]household population is obtained from Kenya National population census 2009

[e]percentage household population that lost livestock in the region is obtained from our field study

[f]actual household population that lost livestock in the region is obtained by multiplying the pecentage household population that lost livestock by the total household population

[g]actual number of livestock lost in the previous year in the region is obtained by multiplying the average livestock lost per household by the actual household population that lost livestock

[h]current market prices per livestock type are obtained from the *Kenya Livestock Markets Report 2011*

[i]total cost of livestock type lost in the last 20 years is the product of actual number of livestock lost and the current market price of livestock type

[j]annual cost of livestock lost is obtained by dividing the total cost of livestock lost in the last 20 years by 20.

[k]annual average loss per household is obtained by dividing the annual cost of livestock lost in the region by the actual household population that lost livestock in the region

Similar computations were done for all the other regions and the results showed that in Bondo region, cattle losses were highest (Ksh. 3192), followed by goats (Ksh. 952), while poultry recorded the least losses (Ksh. 304). In Budalangi, highest loses (Ksh. 2,850) per household were recorded among cattle followed by pigs (Ksh, 815), goats (Ksh. 550) and poultry (Ksh. 243).

In Rarieda region, highest annual economic losses per household were from cattle (Ksh. 5,548), followed by goats (Ksh. 1,210), sheep (Ksh. 788), donkeys (Ksh. 592), and poultry (Ksh. 364). Households from Kisii central region reported cattle losses as being highest (Ksh. 3,126), followed by pigs (Ksh. 1,750), goats (Ksh. 600) and poultry (Ksh. 255). In Bomet region, cattle recorded the highest (Ksh. 2,375) losses among households followed by goats (Ksh. 400), then poultry (Ksh. 340).

Considering all the regions, annual losses per household due to livestock deaths were highest (Ksh. 8,502) in Rarieda (a drought prone region) and lowest (Ksh. 3,115) in Bomet. Cattle were the main livestock lost in all the study regions translating to an annual average loss of Ksh. 3,968 or Ksh. 79,360 in the last 20 years per household per region, with Nyando registering the highest cattle losses and Bomet the least, Table 4.

Table 4. Approximate cost of losses in Ksh per household resulting from livestock death per year

Average loss per household per region during the previous one year		Cattle	Goats	Sheep	Donkey	Pig	Poultry	Total cost of livestock lost per household
	Nyando	6,717	636	656	0	0	485	**8,494**
	Budalangi	2,850	550	0	0	815	243	**4,458**
	Rarieda	5,548	1210	788	592	0	364	**8,502**
	Bondo	3,192	952	438	740	0	304	**5,626**
	Kisii central	3,126	600	0	0	1750	255	**5,731**
	Bomet	2,375	400	0	0	0	340	**3,115**
	Total cost of each livestock lost	**23,808**	**4,348**	**1,882**	**1,332**	**2,565**	**1,991**	**35,926**

DISCUSSIONS

Distribution and Effects of Adverse Climatic Conditions

Climate change markers were a source of concern among the Lake Victoria basin (LVB) inhabitants since all the regions were affected, albeit to varying degrees. Study respondents and focus group discussion participants in the current study concured that climate change markers (particularly droughts and floods) had increased in frequency, variability and magnitude over the years. These findings were consistent with those of DFID (2004), which reported that there was convincing evidence of increased frequency and magnitude of natural disasters in both developed and developing countries, with poor communities being disproportionately affected. Likewise, recent reports by the Ministry of Agriculture (2012), show that acute food stress (famine) occurences have reduced from 20 years apart (1964 and 1984) during the last few decades, to two years (2004 and 2006) in the last few years, to almost annually (2007/2008/2009/2011) currently, probably due to the increased frequency and severity of drought. The current study findings showed that drought events were not restricted to areas perceived to be arid i.e. Rarieda and Bondo alone, as other regions, such as those perceived to have good climatic conditions i.e. Kisii central and Bomet or regular floods i.e Budalangi and Nyando were also prone to periodic droughts. These findings were consistent with those of Wilhite and Glantz (1985) which reported that drought is a chronic problem in arid and semi-arid regions but frequently occurs in humid regions as well.

Effects of Adverse Climatic Conditions on Socio-Economic Status

The wide fluctuations in agricultural output that have occurred throughout human history attest to the fact that agriculture is an economic activity dependent on the prevailing weather patterns. Consistent with the current study findings, research shows that whenever droughts and 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 affected households socio-economically. A study carried out in some divisions of Lake Victoria Basin between 1990 and 1995 reported that as a result of poor productivity, the residents reduced agricultural activities in many areas including Rusinga Island, Muhuru bay, Kadenge and adjacent areas as was exemplified by several pieces of land that remained uncultivated even when rains were expected; attributable to past experiences of crop failure which then demoralised the LVB households with significant impacts on agriculture and generally on the lives of the affected (Olwero, 1998).

Sufficiency of Crop Yield and Animal Produce

Study findings showed that the largest (88%) percentage of those who practiced crop farming were from Bomet region, followed by Kisii central (78%) while the least was recorded in Bondo (47%), followed by Rarieda (56%). This could be attributed to the favourable climate of the former two regions compared to the latter. These findings clearly show that regions with relatively good weather such as Bomet produced much more food which could be relied on, as reported by most (96%), respondents compared to drought prone regions where majority (65%) of respondents relied on food bought from the market. 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. Studies by URT (2003), carried out in Tanzania reported that interference with food security was probably the worst impact of climate variability.

Consistent with current study findings, earlier studies by Parry (1990) reported that the effects of climate change pose a serious threat to agricultural production, a factor that is aggravated by population pressure in the high agricultural potential areas such as Kisii central region. 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 espisode, 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).

The finding that food harvested lasted throughout the year in Bondo region may need further investigation since this particular region is actually generally dry most part of the year. This could probably have been due to low population density or inaccurate response by study participants. Kisii region, an area with favourable weather patterns and fertile soils, did not produce enough food for the household, with only 68% of respondents reportedly relying on food from their farms while the rest (32%) relied on food bought from the markets. This could have been due to insufficient crop yields probably due to increased land fragmentation practice among the inhabitants of Kisii central region or the high human population in the region.

Focus group discussion participants across all studied regions admitted that climate change markers had become increasingly difficult to predict, with food insecurity being among the major consequences of unpredictable weather patterns. The current study also established that food harvested in the previous growing season lasted less than 5 months for 67% of the household, probably due to high household population, land fragmentation or adverse climatic events that destroy crops resulting in low yields. The IPCC (2001) also linked global climate change and population growth to food insecurity among affected communities.

The current findings imply that households living in Bomet region were likely to be more food secure (since over 33% reported that food harvested in the previous season lasted throughout the year), probably owing to the relatively large pieces of land owned by households and favourable climatic factors in the region, compared to those from disaster prone regions where a majority admitted that food harvested during the previous season lasted less than three months. This is a clear pointer that climate change markers 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.

According to FAO (2011), Kenya is a food deficit country barely achieving the recommended calorie intake. As exemplified by the study findings, there is inadequate food to even last most household throughout the growing season. Climate variability, pest and diseases, population increase and land fragmentation could be some of the major causes of low agricultural productivity especially in the Lake Victoria Basin where majority of households depend solely on rainfed agriculture. According to Kakubo-Mariara (2007), the agricultural sector, which relies heavily on predictable rainfall and temperatures, suffers most following climatic variations, thus affecting the livelihood of most households who rely on rain fed agriculture as was the case in the current study. Muyanga *et al.* (2003) cited limited alternative sources of income, exploitative cereal marketing channels, unavailability of drought and disease resistant crop varieties, low limited crop diversification, poor storage methods, lack of credit services, inaccessibility to agricultural services, illiteracy and poverty as some of the factors that lead to food crisis in ASAL. Some of these factors were also cited by FGD participants in the current study. The level of destruction of livelihoods by floods and droughts in the LVB has become severe in recent times. It is believed that frequency and severity of drought has increased mainly due to increased destructive nature of human activities to the environment (UNEP and GOK, 2000). The impact on socio-economic status of the affected people will continue to rise as evidenced by the high crop losses destruction of property as well as livestock deaths, coupled with increased disease outcomes, among other negative outcomes. All these factors have the capacity to reverse economic gains made by area residents as all their investments are literally swept away or destroyed each time floods occur (Republic of Kenya, 2003).

Economic Losses Arising from Crop Failure Among Households in the Study Regions

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 diffferent 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.

Kisii central region did not record impressive yields despite having relatively good weather as most households from the region reported insufficiency in the food harvested during the previous season. Probable reasons for the low yield could be land fragmentionhigh population density and reduced soil fertility due to continous tilling in an attempt to produce enough to meet the household's needs. The current study findings also indicate that households residing in disaster prone regions are more likely to diversify their agricultural produce probably to secure themselves against famine in case one type of crop fails. The exceptionally high losses resulting from crop failure in Nyando region could have been attributed to the high diversity of food crops grown in

the region, some of which perform poorly in terms of yield coupled with high expectations placed on the yield by households in the region. For instance, the expected yield of groundnuts and green grams and rice could have been too unrealistic resulting in presumed high cost as a result of failure to meet the target yield.

Economic Losses Arising from Poor Livestock Produce Among Households in the Study Regions

Some respondents in the current study reported having lost livestock as a result of droughts and floods. Cattle were the main type of livestock lost per household across all the regions, followed by goats then chicken. The actual number of livestock lost due to floods or droughts over the last twenty years (1991-2011) were considerably low probably due to the fact that most households kept only a small number of livestock, instead concentrating more on crop production. Considering all the regions, the total annual economic losses attributed to dead livestock per household were highest among households living in Rarieda region and lowest among those living in Bomet region. These findings further attest to the fact that drought has severe impacts on livestock even more than floods, probably because drought leads to water scarcity, covers a large area and last for a relatively longer time compared to floods which only last for a while and mainly cover flood plains. According to UN OCHA (2006), those who are unable to move their livestock to safety during floods or droughts often incur full (100%) losses.

Cattle were the most prefered livestock among households across all the six study regions, though they also registered the highest losses through deaths compared to all other livestock. Rarieda region registered the highest cattle losses followed by Nyando, Kisii central, Bomet, Bondo and Budalangi in that order. Goats, sheep, donkeys, poultry and pigs were also affected by climate variability markers over the last 20 years. Most livestock diseases according to study respondents occurred during the rainy seasons particularly during the month of April, implying that heavy rainfall or floods could be linked directly to livestock diseases probably contributing to their deaths. 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 and human health and in turn, on livelihoods, food security, and the economy.

However in as much as some households reported having lost livestock, the actual number of livestock that were reported to have died over the last 20 years and whose death was attributed to floods or drought was relatively low translating to an equally low monetary loss per household per annum, which if compared to crop losses within the same region may pass as negligible. The current study findings therefore show advantage of livestock keeping in the LVB region over crop cultivation with relation to climatic variability. It is however possible those climatic conditions in the LVB region were somewhat more favourable for livestock keeping than crop farming. In addition, households may have opted for other survival mechanisms such as selling off their livestock during impending droughts thus alleviating losses due to livestock deaths or tranfering the livestock to safer regions during adverse climatic events thus reducing any losses resulting from death, thus keeping the actual losses minimal or inconceivable for the small scale farmers. This fact was mentioned by focus group participants who reported taking their livestock to safer grounds or a relative's place during floods to avoid losses. In the same breath, livestock diseases are also difficult to associate with adverse climatic conditions and therefore households may not have included other livestock lost due to diseases, when indeed climatic variability could have been the cause behind the illnesses.

Another reason for the relatively low monetary losses in livestock among household in the LVB region could have been because these areas (Rarieda and Bondo) are not really ASAL as compared to North Eastern part of Kenya and other drier regions where residents rely fully on livestock keeping and therefore incur huge losses when adverse climatic events occur. Instead the residents of the LVB practice mixed (crops and few livestock) farming, though they tend to prefer crop farming more which is highly vulnerabe to adverse climatic events. Seemingly, people in these regions (and probably elsewhere) tend to go for crops farming because it is convenient (labor saving) and does not need daily attention compared to livestock which have to be herded and taken care of at all times. This is even more difficult in the LVB regions (including our study regions) where people have less open (communal) land for pasture, while some people prefer sticking to farm crops which gives them more time to relax and avoid quarrels with neighbors when their animals stray to other people's farms and destroy crops. However, in as much as people in the LVB region likes this easy trend of crop farming, the climatic conditions in most part of the region does not seem to favor it and so there is need for awareness creation and change in farming practices.

There is also need for advocacy of coping and mitigation strategies against adverse climatic events. Knowledge of wild and famine foods is disappearing, traditional food preservation techniques have been abandoned, and hunting, foraging and pastoral dispersal restricted. Studies by UNFCCC (2007), stress that local coping strategies are an important element in planning for adaptation, especially with

the current unpredictable weather patterns. Traditional knowledge can help to provide efficient, appropriate and time-tested adaptation mechanisms to climate change among vulnerable households (UNFCCC, 2007). However, studies by Anderson (2001) reported that the opportunity costs associated with deployment of various coping mechanisms can be great at household, community or regional level. For instance, the climatic uncertainties often compel farmers, particularly risk-averse ones, to employ conservative risk management strategies that reduce the negative impact in poor years, but often at the expense of reducing average productivity and profitability (Anderson, 2001).

CONCLUSIONS

The current results show that crops farming is relatively risky and has more climate related losses as compared to livestock rearing which in this case recorded very minimal losses some of them negligible. However, despite the fact that crop farming was largely affected by climate change markers, most households in the Lake Victoria Basin region still rely heavily on crop cultivation ignoring other potentially beneficial sources of livelihood. This indicates that the people are either not aware of this fact or are unwilling to embrace change through diversification of their income sources probably due to so much attachement placed on crop farming to the extent that it had become part of their culture. This study highly recommends the adoption of cheaper and affordable alternatives to crop cultivation such as small holder dairy goats ranching and poultry farming among households in the Lake Victoria basin. This study was only done in the LVB of Kenya. A bigger study covering the entire LVB of east Africa should be conducted to better inform regional policy.

ACKNOWLEDGEMENTS

We acknowledge our field assistants and data entry clerks for providing the time, material and technical support. This study was financially supported by East Africa Community - Lake Victoria Basin Commission Secretariat (EAC-LVBC).

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