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Adaptive Watershed Governance: A Missed Prospect for Food Security in the Lower Sio River Basin, Busia County, Kenya

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Abstract: Watershed systems with high adaptive capacity are able to re-configure themselves when subjected to change without significant declines in crucial socio-ecological functions. This study assessed adaptive capacity variables in watershed governance for sustainable food security at the household level in the Lower Sio River Basin, Busia County, Kenya. A total of 387 households were sampled using a combination of multi-stage and simple random sampling. Questionnaires, interview guides, observation and focus group discussion guides were employed to collect primary data. Results indicate that the need to increase or sustain food production was ranked first by 86.8% as a factor that contributed to public involvement in watershed management activities. The results further indicate that creating social resilience to adapt to a changing climate, and clarifying roles and responsibilities of stakeholders at p-value=0.000; enhancing water-use efficiency and improving management at p-value=0.010 were significant governance aims that determined households' food security. Implementation of watershed governance structures such as water resources management policies and plans at p-value=0.000; and roles of water resource institutions such as Water Resource Management Authority and National Environment Management Authority at p-value=0.001 were also significant to enhance households' food security status. Watershed governance did not positively impact on food security in the basin resulting to an increased number of households with food insecurity from 54.0% in 2013 based on government estimates to 55.3% in 2017 the time when the study was carried out. Therefore, enhancing adaptive watershed governance at a watershed level through: common watershed responsibilities, implementation of policies and plans, improvement of structures and institutions is a fundamental condition towards households' food security in the Lower Sio River Basin.

Keywords: *Watershed Governance, Adaptive Capacity, Food Security, Food Insecurity, River Basin*

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1. Introduction

Globally, attainment of food security is described as a situation in which all people, at all times have access to adequate, affordable, safe and nutritious food to meet their dietary requirements and food preferences for a productive and healthy life [1]. Key indicators for food security include food availability, accessibility and utilization and to sum it, food stability [2]. While food availability refers to the physical presence of food where it is needed, food accessibility is the means by which people acquire the food they need; food utilization refers to the way in which people make use of food and finally food stability is how the three indicators balance at equilibrium in a particular community [3]. Therefore, food security requires the interaction of factors such as food prices, agricultural production and trade, poverty reduction, infrastructure, watershed management, education, and timely crisis management in the event of climatic stresses such as drought and floods.

In addition to these interactions, food security governance is about managing the context in which these interactions take place [4]. The Rome declaration identifies poverty and environmental degradation as the main causes of food insecurity. Further, The Heads of State and their governments also recognized the need for urgent action to combat natural resource degradation, including desertification and erosion of biological diversity as a means towards the attainment of food security. They recommended that poverty eradication and food security must be achieved without putting additional stress on natural resources. In many situations, therefore, food security and natural resource protection go together [1].

In developing countries, there are a number of key challenges that undermine food security such as rapidly growing demand and changes in consumption patterns;

competition for agricultural lands for other uses; the effects of global environmental change; serious degradation of agricultural soil; erosion of the genetic base of agricultural biodiversity and water scarcity [5]. It was proposed that prescriptions for meeting the identified challenges range from the need to increase productivity, through the development and diffusion of different forms of technologies, to an integrated system for meeting challenges of soil degradation, loss of biodiversity, efficiency in agricultural water and energy use. Studies concluded that generating and sustaining agricultural growth is seen as an important element in reaching and sustaining food security especially in developing countries [6]. On the other hand, Kropff *et al*. (2013) indicated that food security cannot be realized by means of idealistic plans or new technologies only, but it needs advanced steering strategies that involve governments as well as companies, NGOs and citizens at a watershed level [7].

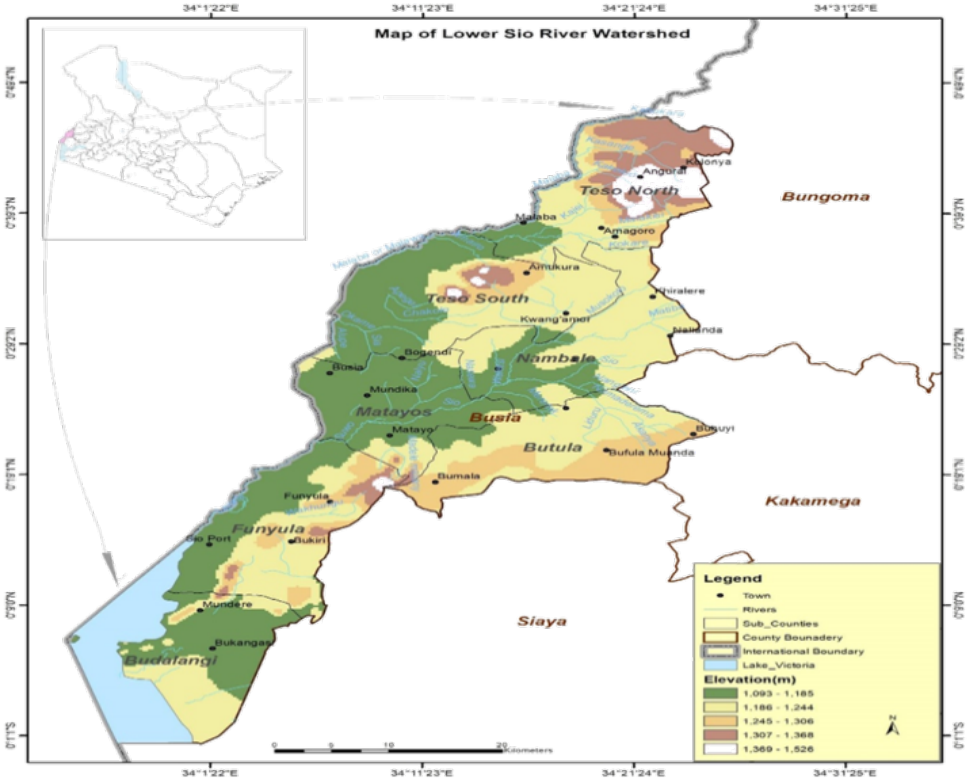
Further, recent studies reveal econometric substantiation on the relationship between institutions, human capital, and agricultural productivity growth in developed and developing countries while other studies found no evidence that political institutions could necessarily cause growth in agricultural productivity [8]. As a result, researchers have expressed that human capital accumulation emerges as an important factor in driving the process towards food security [9]. On the other hand, Candel,(2014) noted that within the recent food security debates, the role of governance has been attracting increasing attention for both researchers and policy makers [8].

The reason advanced for this course is that food security solutions or approaches should not only address the technical and environmental dimensions of the issue, but also take social, economic, and political aspects into account [10,11,12,13]. However, Candel, (2014) argued that there may be changes over time as global institutions, regions, national governments and communities attempt to make use of different resources within their reach to attain agricultural growth objectives [8]. Further, added that in spite of various calls for food security governance, it is not very clear yet what food security governance entails, what its essential characteristics or features are and how it could be enhanced. The study looked at watershed governance as a prerequisite for food security conceding that food security governance also contributes to watershed management.

2. Research Materials and Methods

2.1. The Study Area

The Lower Sio River is a transboundary basin that lies between latitudes 0^0N and 10^0N and longitudes 30^0E and 36^0E (Figure 2.1) along the Kenya- Uganda border [14]. The mainstream of Sio River stretches approximately 78 km from the source in Kenya to the mouth in Uganda [15]. Funyula, Matayos and Nambale Sub-counties in Busia County, through which the stream flows, were selected as a hydrological unit. In addition, the basin had high poverty levels of 65.9% [16] with 93.5% of the households in Funyula Sub-county depending on rain-fed on-farm and off-farm activities for their livelihoods [17]. The basin had a high population density exceeding 300 persons per square kilometer [18] and cattle density of 38 per square kilometer, and continue to increase, pressing heavy demand on the watershed resources – water, soil, vegetation [19].



Source: Researcher, 2018

Figure 2.1. Map of the Lower Sio River Watershed

2.2. Research Design

The study adopted correlational research designs combined with both qualitative and quantitative methods, whereby probabilistic and non-probabilistic sampling techniques were used in the study [20]. Therefore, this design was found useful in gathering, summarizing, presenting and interpreting data from the household heads in the Lower Sio River basin.

2.3. Sampling Methods

Purposive sampling was used to select the three sub-counties of Busia County, Kenya; Nambale, Matayos and Funyula through which River Sio traverses thus forming a common hydrological basin. Quota sampling was used to select respondents who constituted focus group discussion teams. Primary quantitative data was basically drawn at the individual household level. A two-level multi-stage sampling was conducted to select a representative number of households. In the first level, simple random sampling technique was used to select at least 10% [21] of the locations hence two locations from each of the sub-counties whereas in the second level, two sub-locations from each selected location were identified using simple random sampling technique.

Proportionate sampling was used to distribute the samples in the sub-locations based on their population in the sample frame. The list of households from each sub-location obtained from Kenya National Census of 2009 Census result was updated using the list of households at the respective chief's offices. Finally, a simple random technique was used to select the households that formed the unit of analysis while the household heads formed the unit of observation during data collection process. A sample size of 387 was obtained using, Yamane (1967) formula for small populations [22].

2.4. Data Collection

The quantitative data collection essentially necessitated semi structured questions, open and closed ended questions. The procedure for qualitative data collection was done using a focus group discussion guide administered in various community groups in the basin. Key informant interview guide was used to obtain data from national and county governments' departmental officers and representatives of non-governmental organizations. The primary data was collected from the respondents in the period between June to December, 2018, while secondary data present was accessed from documents that existed between the same period. To test the validity of data collection instruments, a pre-test study was conducted in thirty-nine (39) households of the total calculated sample size (10% of 387) in Esikulu Sub-location, Matayos Sub-county which was excluded from the main study.

2.5. Data Analysis

There were no statistical measurements for qualitative data, however analysis was done based on each thematic area to provide for quantitative data triangulation for coherent results. Quantitative data were analyzed using SPSS version 20 and excel spreadsheet. Frequencies were run to all variables to check for missing cases if any as well as for explanations. The constructs of dependent variables (food security) were recorded whereby a higher score meant a correct or more positive answer (0-1 for binary; (yes, no). The items that measured the dependent variable (food security) were summed up to compute for an index score of food security. The food security index score using Modified Bloom's cut-off point, was created for the purpose of performing inferential statistics. Further, independent variables concepts' values were summed up and computed to form different independent index scores for the specific concept. All the 17 variables used to measure food security were included in the calculation of food security index score. This is because the variables showed tight coherence with a Cronbach's alpha 0.9 or higher which is considered sufficient. Depending on the number and nature of independent variables (for the dependent, all the 17 variables), index scores were summed up and recalculated to a score of 0-100 through multiplying by 100 and dividing with the number of variables. Further, a binary food security variable was generated on a scale of 0 to 1 where '0' indicated households that scored 0-49% and '1' indicated households that scored 50-100%.

Bivariate analysis was done to ascertain the association and level of significance between the generated groups of households with food security and food insecurity and each variable for the household's background and watershed governance determinant factors. In running chi square tests by the groups for households' watershed governance determinant factors, p values were used to show the level of significance/differences between the groups of food secure and food insecure households. Linear regression analyses were carried out separately, using the explanatory variables such as; watershed governance structures, watershed expertise, satisfaction towards watershed governance and co-management of watershed, and index scores towards watershed governance. Since R^2 is affected by the sample size and number of variables, the adjusted value of R^2 was used to explain the variation in predictors on the indices used.

3. Results and Discussions

3.1. Households' Socio-demographic Characteristics

Descriptive analysis of demographics of the study showed that out of 387 targeted households, 52.5 % (203) were female while 47.5% (184) were of male gender. The study found that majority (46.3%) (179) had attained the basic primary level of education, 33.9% (131) had the secondary education while 8.8% (34) had attained the tertiary level of education. However, it was also noted that a large portion of the respondents, 11.1% (43) did not have formal education. Further, majority (68.7%) (266) of the households depended on farming as their main occupation, 4.1% (16) and 5.4% (21) were on-farm and off-farm labourers respectively, while 12.7% (49) practiced small businesses, 4.1% (16) were civil servants and 2.3% (9) were

employees in the private sector respectively. Furthermore, the majority (89.9%) (348) of the households practiced Christianity while 2.3% (9) practiced Islam and 0.3% (1) practiced Traditional African religion.

3.2. Households Food Security Goals

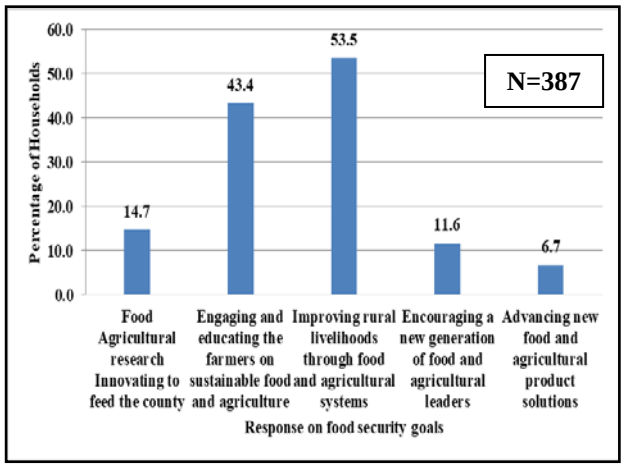
Data analysis from household interviews in Figure 3.1 showed that at the household level, household food security goal was known to the majority whereby, (53.5%) (207) of the households was to improve rural livelihoods through food and agricultural systems. During the group discussions, the households were able to associate their agricultural activities to the fact that agriculture was the main economic activity and occupation.

The interviews with local administrative leaders such as assistant chiefs and chiefs showed that at the village level, the government or even key stakeholders in agriculture sector had not instilled a culture of a common or collective food production purpose to the farmers. This resulted in fragmentation of farming activities and neglect of a large percentage of farmers from governmental and non-governmental actors' agricultural activities and programmes respectively. More so, interviews with the community leaders confirmed that lack of a common purpose in farming occasioned unsustainable food production practices since every household had to struggle on its own with the resources at their disposal.

On the other hand, 43.4% (168) of the households observed that the common goal for food security was to engage and educate farmers on sustainable food and agriculture, while 14.7% (57) observed that food agricultural research innovation to feed the county was the goal for food security. In the group discussions, the argument focused on these goals since most of the respondents indicated that a small portion amongst them who worked closely with the county government thought about the county as a whole, an example given was a slogan "*food in the mouth and money in the pocket*" which respondents associated with the County Executive Member of Agriculture and Livestock Development who used the slogan to mobilize farmers during county agricultural workshops. The Constitution of Kenya (2010) aims to rally all Kenyans to zero tolerance to hunger in Article 43 (1) (c), as food security is regarded as a key indicator of the nation's level of development [23]. The qualitative analysis from both group discussions and key informants agreed that this was a vision that was far from realization in the study area since households did not associate themselves with the Article.

On the other hand, 11.6% (45) of the households identified encouraging a new generation of food agricultural leaders while 6.7% (26) indicated advancing new food and agricultural product solutions as goals for food security as shown in Figure 3.1.

Studies showed that globally, efforts to eradicate poverty and to ensure sustainable economic growth, the key developmental goal of all governments has been to eradicate hunger and poverty, ensuring access to basic needs such as clean water, access to food, and medical treatment [24]. However, the findings showed that food security as a global and national development goal has never been realized in the Lower Sio River Basin.



Source: Field data (2018)

Figure 3.1. Food Security Goals in the Lower Sio River Basin

3.3. Watershed Management Policies that Contribute to Food Security Goals

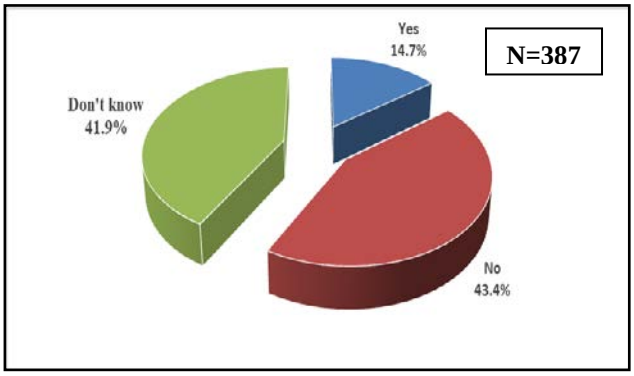
The study sought to examine households' knowledge of watershed-related policies and their contribution to food security in the basin. The results (Figure 3.2) indicated that 43.4% (168) of the households did not agree that existing watershed management policies and programmes contributed to food security while 41.9% (162) indicated that they did not know whether watershed management policies in the watershed contributed to food security. Only 14.7% (57) of the households agreed that policies for watershed management also contributed to food security.

Rajaonarison (2014) suggested that failure to achieve food security is due to ignorance of the agricultural sector in the national building agenda [25]. On the other hand, policies directed towards addressing food security are often politically instigated and manipulated to control all aspects of food from production to distribution and utilization in any socio-ecological set-up. Elsewhere, Grobler, (2016) in the study on perception of poverty; a study of food secure and food insecure households in the urban areas in South Africa found that food insecure households who also happened to be poor households, felt that the government was responsible for their predicaments and therefore, the study concluded that the government should provide social security to lift them out of the food insecurity situations [24]. However, it is important to note that the Lower Sio River Basin has been a beneficiary of the implementation of government and donor agricultural policies and programmes related to environmental protection and food security in the past decades. The results from such policies or co-management have not translated in improved watershed governance or improvement in households' food security status.

The Constitution of Kenya (2010) under the Bill of rights, states that national security includes the protection of the fundamental rights and freedoms of every Kenyan. Thus Kenyans in the study area have and need to enjoy the freedom from hunger, access to information and participation in decision making on matters that pertain their lives [23]. The results of this study clearly indicate that majority of households in the watershed do not contribute to legitimizing watershed management policies

hence experience trickledown effect to ensuring food security.

The Kenya National Food and Nutrition Security Policy (2011) recognized the importance of environmental management in food security thus watershed management, climate change adaptation and mitigation were identified as key determinants of food security in the country [26]. In addition, the long-term national development blueprints, the Kenya Vision (2030) and the Strategy for Revitalization of Agriculture in Kenya are just a few of the national frameworks that recognize the importance of environmental management and people's participation for ensuring sustainable agricultural development in the country.



Source: Field data (2018)

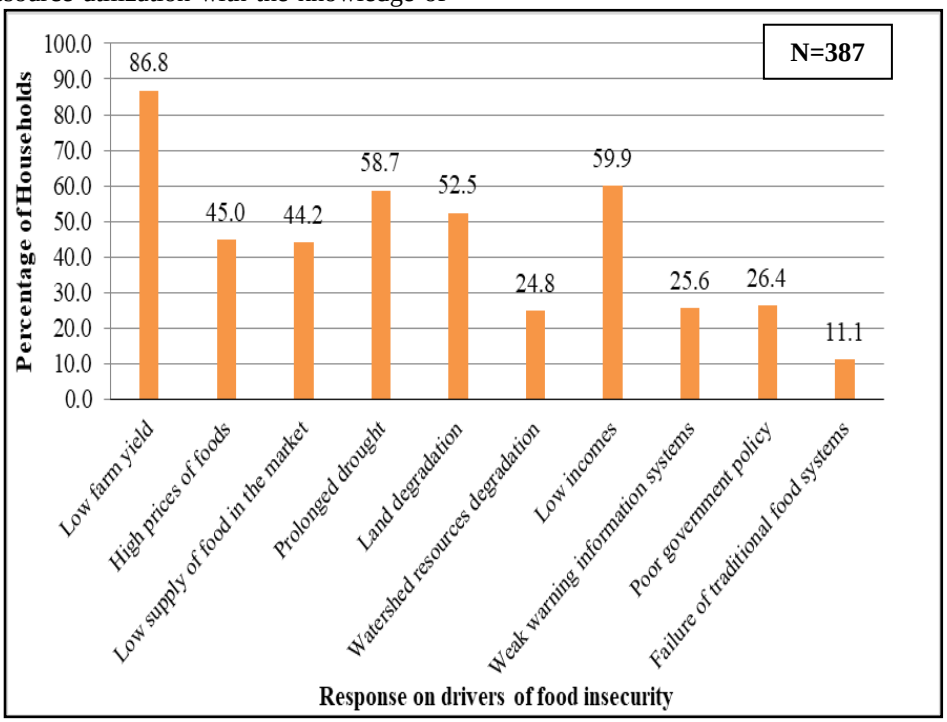
Figure 3.2. Contribution of Watershed Management Policies and Programs to Shared Food Security Goals

At the county level, the Constitution of Kenya (2010) in the Fourth Schedule devolved agricultural functions and what was left at the national level is national agricultural policy and research. As a result, the county governments are mandated to domesticate and modify ratified international conventions, national policies on agriculture and watershed resource utilization with the knowledge of primary beneficiaries to fit into local needs and conditions [23]. In order to deliver on this mandate, the First Busia County Integrated Development Plan (BCIDP) (2013) also indicated the necessity of environmental management and climate change adaptation and mitigation strategies and involvement of the people in all matters directly or indirectly relating to their lives as key elements in ensuring food security for the citizens of Busia County [27].

The finding indicated that most of these efforts were only on paper and were never implemented in the Lower Sio River Basin. To make it worse, ineffective governance and political will and the on-going negative impacts of donor policies such as Structural Adjustment Programmes (SAPs) of the World and IMF continue to hinder governments at both levels (National and Counties) from providing incentives and support systems to farmers to improve in their production capacities [28].

3.4. Drivers of Food Insecurity and Households Food Security

It is worth noting that '*it's the wearer of the shoe, who knows where it pinches*.' Food insecurity is a major threat to human development and human security in the watersheds. During the field study when households were asked to list drivers of food insecurity, Results in Figure 3.3 indicate that the majority,86.8% (336) blamed low farm yield recorded in recent years as a key driver of food security. This was attributed to various factors in the basin including: the prolonged drought episodes by 58.7% (227); failure of traditional food systems by 11.1% (43) households; weak early warning systems, 25.6% (99); land degradation ,52.5% (203); and watershed resource degradation 24.8% (96) of the respondents.



Source: Field data (2018)

Figure 3.3. Drivers for food insecurity in the Lower Sio River Basin

A study by Makalle *et al.* (2008) found that in the Sio basin, Kenya, land productivity had been declining over time due to various reasons; this was confirmed by 42% of the respondents who indicated that land productivity was currently lower than that of 30 years back. The main reasons advanced for the declining land productivity included; over cultivation due to land fragmentation and thus reduction in cultivated land in the basin and overgrazing. Further, poor cultivation techniques, use of fire to clear land, inadequate use of fertilizers, mono-cropping and drought were also experienced in the watershed [15]. Elsewhere in Kapingazi, Embu Kenya, studies showed that farmers preferred adoption of riparian area management by removing eucalyptus planted along the rivers, capacity building on good environmental practices and diversification of income base by introducing nature-based enterprises like beekeeping that would lead to a win-win in economic and environmental impacts [29]. Other factors that contributed to food insecurity in the Lower Sio River Basin that were identified by the respondents included; low levels of income which was identified by 59.9% (232) of the households. Furthermore, 44.2% (171) of the households observed that there was a low supply of food in the market. This resulted in elevated food prices which were indicated by 45.0% (174) of the households as a driver to food insecurity.

Chi-square test carried out on the households' responses shown in Table 3.1 indicate that there was a highly significant variation among the households with food security and the households with food insecurity with the four drivers of food insecurity namely: high prices of foods, low supply of food in the market, incidences of prolonged droughts and low levels of income at p-value=0.000 while poor government policy at p-value=0.007. However, the Chi-square test on respondents' socio-demographic characteristics found that the various levels of households' incomes were insignificant to households' status of food security. This is attributed to the fact that food security is determined by multiple factors whereby the household with low levels of income might depend on other factors such as their farming activities or relatives' donations for food. Therefore, low levels of households' income in the basin might not necessarily mean households food insecurity.

Other drivers of food insecurity that showed significant variations among the two types of households included; weak warning information systems at p-value=0.030 and failure of traditional food systems at p-value=0.089. These findings implied that the mentioned drivers for food insecurity were significant in determining the status of households' food security in the Lower Sio River Basin. However, results showed that low farm yield, land and watershed resources degradation were found to be insignificant in determining the household food security status.

During the transect walk in various study sites, it was observed that crop production practices in the watershed were characterized by traditional methods such as the use of hoe for Ploughing, burning farms for clearance with very few farmers practicing improved farming methods due to low affordability of farm inputs. A large percentage of farmers practiced intercropping or mixed cropping systems which utilize a combination of crops on the same piece of land, with the aim of intensifying crop production both in time and space. The crops mostly intercropped by the small-holder agricultural producers were legumes and cereals specifically beans and maize.

Overgrazing was another major important land use practice identified in focus group discussions as well as key informants' interviews that contributed to watershed degradation in the basin. The major types of livestock kept were cattle, goats, and sheep. During the periods of pasture shortage, most of the interviewed livestock keepers along the streams and the river bank indicated that they moved their livestock from one place to another in search of pasture especially in the riparian wetland of the Sio River and its streams river banks. In Mango sub-location, it was disclosed that the same practices applied to colleagues from the Uganda side. Those with one to three animals practiced tethering at the homesteads where they searched and transported fodder.

3.5. County Governance Impact on Watershed Management and Households Food Security

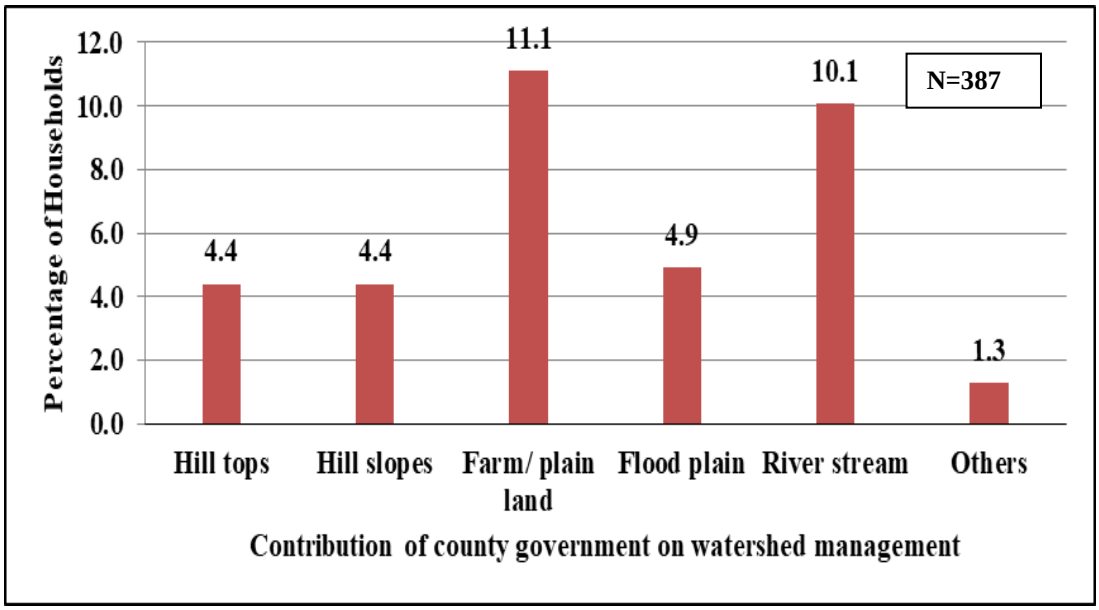
Overall, the results showed that the county government through its activities had insignificant impact on watershed management for food production in the watershed. The results (Figure 3.4) indicate that only 11.1% (43) of the respondents observed that farmland is a watershed aspect that the county government activities have impacted. From the discussions with groups it was reported that although not all respondents had benefited from the county government agricultural production investments, the county had invested in: tractors for ploughing, grading and murram of rural roads, subsidized fertilizers and lime for farmers, in some areas supplied improved seeds, banana tissue cultured seeds and soil testing activities targeting improving food security in the watershed. However, 10.1% (39) of the respondents felt that the county government had impacted the river stream. For example, siltation and sedimentation along the streams where the county roads and bridges were done, and eutrophication that resulted from fertilizers washed to the streams and rivers. The respondents were concerned that the roads opened all over the basin without proper drainage systems were contributing to increase surface runoff leading to sedimentation and erosion in the streams and farmlands respectively.

Result showed that 4.4% (17) of the respondents felt that the county government activities had impacted negatively on hilltops and hill slopes. Much of the observed impact was that roads had been opened on the hill slopes without proper runoff drainage systems especially in Matayos and Funyula Sub-counties. At the hilltops quarrying activities for building stones had increased as the county government spending on increased construction of buildings throughout the county. According to the respondents, activities at hilltops had contributed to increased gullies in the hilltops since no rehabilitation efforts had been put in place by the county government (Figure 3.4).

Table 3.1. Food security and Insecurity households' measurement comparison association amongst households' drivers for food insecurity

Drivers to food insecurity	Food insecurity (n=214)	Food Security (n=173)	Difference	χ^2	p-value	Significant?
Low farm yield	85.5	88.4	2.9	0.715	0.398	No
High prices of foods	31.3	61.8	30.5	36.059	0.000***	Yes
Low supply of food in the market	31.3	60.1	28.8	32.190	0.000***	Yes
Prolonged drought	50.5	68.8	18.3	13.238	0.000***	Yes
Land degradation	51.4	53.8	2.4	0.213	0.645	No
Watershed resources degradation	22.0	28.3	6.3	2.075	0.150	No
Low incomes	68.2	49.7	-18.5	13.656	0.000**	Yes
Weak warning information systems	29.9	20.2	-9.7	4.704	0.030**	Yes
Ineffective government policy	31.8	19.7	-12.1	7.243	0.007***	Yes
Failure of traditional food systems	13.6	8.1	-5.5	2.886	0.089*	Yes
Other Specify	6.1	5.2	-0.9	0.136	0.712	No

*p<0.1 **p<0.05 ***p< 0.01 statistically significant difference between the households with food secure and insecure
Others included; political instability, conflicts among neighbours including from Uganda.
Source: Field data (2018)



Source: Field data (2018)

Figure 3.4. Contribution of County Government on Watershed Management for Food Production and Distribution

On the other hand, 4.9% (19) of the respondents observed that the county government had impacted on the floodplain along River Sio and its tributaries. The main reason given during discussions was that sedimentation in the floodplain with runoff from farms ploughed by tractors and graded roads were deposited on the floodplain causing the floods to increase towards farms during heavy rainfall seasons March-May and Sept-November. According to 1.3% (05) of those interviewed other watershed resources such as forests were also impacted by the county government activities since most of the construction contracts were awarded to local people who went on using local resources such as timber from the local private forest for construction. There was a general observation from respondents that the negative impacts of increased county government activities if unchecked, in the long run, the projects will be unsustainable due to ignored consideration of watershed management approaches in planning and implementation of the projects.

This finding is similar to Namenya (2012) findings where it was concluded that due to lack of adoption of watershed management approaches in Constituency Development Fund Projects in Funyula Constituency, the projects were not sustainable, although studies indicate that economic gains from environmental rehabilitation are realized in the long term [17]. Kagombe *et al.* (2018) found that in Ndakaini Dam watershed, there was a significant relationship between farmers' acceptance of environmentally conservation practices and incentives given by water providers. Similarly, there may be delays in economic impacts from the county governance arrangements in Kenya due to the low net value of changes in watershed governance investments [29]. Some economic gains related to watershed management as well as food security are short-term and may have been realized in the first five years after the devolved system of governance in Kenya, 2013 to 2017 period.

Although it was acknowledged by majority respondents in both households' interviews and focus group discussions that the county government had put in place efforts to improve food production, results in Table 3.2 show that 42.4% (164) of the households observed that the existing watershed governance structures such as policies and plans did not have impact on the rural agricultural crop

production while 16.5% (64) did not know if such impact existed in the watershed. It was observed by 44.7% (173) of the respondents that there was no impact on rural agricultural livestock production as well. This was a result of low investments by the county government in these food security domains. Only 39.0% (151) of the respondents observed that the watershed governance structures had positively contributed to rural food trade. This was attributed to opening up of access roads and establishment of smallholder market centres in the watershed, the reasons which the county government was praised for.

On the other hand, only 13.2% (51) of the households felt that the watershed governance structures in the Lower Sio River Basin contributed positively to aquaculture activities, while 40.8% (158) observed that the structures had not impacted on ecosystems and environmental activities. Nevertheless, 46.0% (178) and 37.5% (145) observed that the watershed governance structures had no impact on development cooperation and traditional production systems respectively. Governments' policies are meant to carry out watershed and food security interventions on behalf of the households, to avoid a situation whereby the governments are blamed for watershed resources degradation and households' food insecurity problems. Therefore, policies to eradicate food insecurity and poverty, in general, should take note of food insecure household's perception that the households are not responsible for food insecurity situation, and that it is the sole responsibility of government to solve food insecurity situation [24].

Table 3.2. Impact of Watershed Governance Structure on the Domains of Households food security

	Ranks			
Domains of food security	Positively	No impact	Negatively	Don't Know
	Percentage of HH (N=387)			
Rural agriculture crop production	40.8 (158)	42.4(164)	0.3(01)	16.5(64)
Rural food trade	39.0(151)	39.8(154)	2.1(08)	19.1(74)
Rural agriculture livestock production	34.9(135)	44.7(173)	1.6(06)	18.9(73)
Traditional production systems	28.9(112)	37.5(145)	4.1(16)	29.5(114)
Ecosystems/Environmental activities	28.2(109)	40.8(158)	3.6(14)	27.4(106)
Development cooperation	15.5(60)	46.0(178)	3.6(14)	34.9(135)
Aquaculture activities	13.2(51)	43.7(169)	1.0(04)	42.1(163)

Source: Field data (2018)

Table 3.3. Variables Measuring the Impact of Watershed Governance Structures on Various Factors of Households Food Security

Factors of Households Food Security	HH reported Yes (N=387)	HH (%) reported Yes
Foods are available		
HHs willingness to change food production practices	214	55.3
HH farmers access to productive technologies and practices	161	41.6
HH farmers access to resources, labour, finance, agricultural inputs	129	33.3
HH farmers secure and timely access to fertile land, water and ecosystem services	140	36.2
HHs knowledge and skills to improve food production	192	49.6
On Average, Availability of food	167	43.2
Foods are accessed		
Women have a strong say in HH economic decision making	192	49.6
Increased HH income	126	32.6
HH engage in secure income generating activities	133	34.4
On Average, Access to food	142	36.7
Food stability		
Farmers grow climate adapted crops	191	49.4
HH are energy efficient	110	28.4
Land restoration including soil and water conservation and management	160	41.3
HHs have and implement preparedness plans to protect lives and assets	87	22.5
HH have coping strategies	126	32.6
Resource assets, income exists which can be mobilized by HHs	123	31.8
On Average, food stability	198	51.2
Foods are utilized effectively		
Access to clean water	273	70.5
HHs willingness to change diets	198	51.2
HHs skills and knowledge to ensure good nutrition, food safety and sanitation	179	46.3
On Average, utilisation of food	220	56.8
The overall Index Score of food security		
Mean (SD)	41.21 (30.0)	
Median	41.2	
Food insecurity	214	55.3
Food Security	173	44.7

Source: Field data (2018)

The results show that on average 55.3% (214) of the households in the watershed were foods insecure (Table 3.3), slightly higher level of food insecurity than the Government of Kenya estimation of food insecurity in Busia County which placed it at 54.0% in 2013 [27]. This implied that the situation of food insecurity was worsening despite recent changes in the governance system expected to have positive impacts on watershed governance and food security. Only 44.7% (173) of the households observed that the watershed governance interventions by the national and county governments and other stakeholders had made the households' food secure.

Based on the study findings, on average 43.2% (167) of the households indicate that the current watershed governance structures have ensured that food is available. On specific variables that were used to measure food availability in the study area, 55.3% (214) reported that the recent watershed governance interventions by actors had enhanced their willingness to change food production practices in their farms. In addition, 41.6% (161) reported that the interventions had promoted farmers access to productive technologies and practices, 33.3% (129) reported that household farmers' accessed resources such as labour, finance, agricultural inputs to name a few.

Evidence from the neighbouring Bungoma County showed a highly significant association between access to credit, finance and agricultural with food security [30]. Moreover, 36.2% (140) reported that the interventions ensured that household farmers' secured and timely access to fertile land, water and ecosystem services while 49.6% (192) reported that the interventions provided the households with knowledge and skills to improve food production. In their findings, Elias *et al.* (2015) alluded that family size, credit, off-farm income, perceived economic return and frequency of extension contact were significant determinants of farmers' satisfaction with agricultural extension services [31]. Only 49.6% (192) of the households indicated that the watershed governance structures had ensured that women have a strong say in household economic decision making.

Moreover, 32.6% (126) reported that the interventions had increased household income levels, while 34.4% (133) noted that the watershed governance structures had ensured that the households engaged in secure income generating activities. Thus on average, the study indicates that only 36.7% (142) of the total population of households in the study area had access to food as a consequence of the current watershed governance structures. Further, studies show that soil preparation and ridging tended to be done predominately by males early in the cropping seasons while weeding and harvesting of crops were predominately women's tasks and thus women work more than men in the rural food production [32]. Moreover, farming decisions at the watershed level have a higher level of influence based on the gender and hence the need to integrate gender issues in agricultural and watershed management programmes for successful implementation and uptake of new adaptive technologies and crops. As recommended by the African Development Bank (2004), poverty reduction strategies in rural agricultural economies must focus on influencing the factors that affect women participation in decision-making process since it ultimately affects access to resources and ability to generate income at the household level [33].

In addition, based on the analysis from the study, on average 51.2% (198) of the total population of households in the Lower Sio River Basin found that the watershed governance structures would contribute to the general stability of food in the watershed. Analysis of specific variables that contribute to food stability showed that 49.4% (191) indicated that the watershed governance structures had ensured that farmers grew climate adapted crops, while 28.4% (110) of the households were energy efficient, 41.3% (160) were engaged in land restoration including soil and water conservation and management, 22.5% (87) household had and implement preparedness plans to protect lives and assets, 32.6% (126) household had coping strategies, and 31.8% (123) resource assets, income exists which can be mobilized by households. Wabwoba (2015) found that there was a significant variation in households' assets and households' food security status in Bungoma County [30].

Additionally, despite laws that protect women rights to property, men together with women often are unaware of their rights [32]. Furthermore, the study revealed that increasing vulnerability to environmental conditions such as diminishing biodiversity, soil degradation, growing water scarcity can easily threaten the stability of food security for populations which depend on the products of the land, forests, pastures and marine environments for their livelihoods [30]. Therefore, limited investments by the stakeholders in the management of the mentioned activities as revealed in the study implied low levels of food stability in the Basin.

Finally, on the last aspect of food security which entails ensuring that foods were well utilized, the findings show that on average (56.8%) (220) of the households indicated that the watershed governance structures had contributed to food utilization in the watershed. More specifically, 70.5% (273) reported that the structure had impacted on access to clean water for domestic and livestock consumption, 51.2% (198) reported that the structures had impacted on households' willingness to change diets, while 46.3% (179) indicated that the watershed governance structures had contributed to households' skills and knowledge to ensure good nutrition, food safety and sanitation. In focus group discussions, it revealed that the county government had drilled shallow wells and rehabilitation of springs to ensure that clean and safe water was available for domestic use. This was in support of Lake Victoria North Water Service Board and non-governmental organizations such as Sustained East Africa, World Vision among others.

Another factor given was the devolution of health functions whereby the county has employed enough public health officers who offered extension services to the households in collaboration with Community Health Workers who were trained and facilitated by AMREF and UNICEF. The findings on the current state of food security in the Basin contributes to the findings from earlier studies which warned that both poverty levels and household food insecurity were rising across East Africa [34] despite the fact that governments are heavily investing in measures to combat hunger threats in the region.

3.6. Regression Analysis Results on Watershed Governance and Food Security

The bi-variate analysis between dependent and independent variables showed varied results. Therefore, to confirm if both background and controlling variables have the effect on households' food security both linear and logistic regression analyses were run. Linear regression analyses were carried out separately, using the explanatory variables such as; age in complete years, sex, and religion, land tenure (freehold and communal), watershed governance structures, watershed expertise, satisfaction towards watershed governance and co-management of watershed index scores towards watershed governance in the Lower Sio River Basin. Since R^2 is affected by the sample size and number of variables, the adjusted value of R^2 was used to explain the variation in predictors on the indices used.

Results indicate that age (significance=0.667), sex (significance=0.106) and land tenure system had no effect on the status of households' food security (Table 6.4a). Other than age and sex, Table 3.4a presents the regression results using food index score against explaining variables (items) retained as most coherent i.e. showed a significant difference in the bivariate analysis. The results show that religion, watershed expertise, level of satisfaction towards watershed governance and co-management of watershed could only explain 20.8% variation between households' food security and food insecurity differences at household levels, implying that religion, satisfaction, watershed expertise and co-management had the effect on households' food security.

Interestingly, watershed governance structures did not have an effect on households' food security and in reverse order the higher the score of watershed governance the lower the level of households' food security. This is attributed to the study findings which showed that watershed governance structures in the Lower Sio River Basin did not contribute to household's satisfaction, households' adaptive capacity and adaptive co-management respectively. The watershed governance structures which include policies, plans and pieces of legislation are not implemented and remain in government offices shelves as tools for public relations. Further, regression results show that the households' food security score increased with increased watershed expertise, satisfaction towards watershed governance and co-management of watershed scores, meaning that these variables had a positive influence on households' food security. Thus, an increase in the levels of watershed expertise, co-management and households' satisfaction means an increase in levels of food security in the Lower Sio River Basin (Table 3.4a).

To carry out a robustness check, an alternative logistic regression was run using a categorised (binary) household's food security variable (food security and food insecurity) with the one with linear regression, in relation to age, sex, religion and land tenure against retained independent variables (Table 3.4b). The results show that male-headed households were 1.42 times more likely to be food secure than those headed by the females. This was attributed to inequalities between men and women in engagement in economic activities and decision-making process. In focus group discussions it was revealed that men who were perceived to be household heads had more access to economic opportunities compared to women. This made men to access diverse employment opportunities which translated to more incomes that could be invested in food security activities. A study by Wabwoba (2015) revealed that household heads decision making on land allocation, crop processing, marketing of farm produce and using proceeds from the crop sales had a statistical significance on households' food security status [30].

Similarly, on background factors analysis, households with Christian heads scored better in food security than those with heads of other religions – they were twice likely to be food secure. Results show that for communal and lease land tenure system households scored better in food security than those with freehold land system. During key informant interviews, it was revealed that communal land was better managed collectively by either the community landowners or the leasers. Therefore, the use of such lands for food production was subject to community collective regulations which do not exist in privately or freehold land system.

Table 3.4a. Linear regression results

				95.0% Confidence Interval for *B*	
	B	Std. Error	Sig.	Lower Bound	Upper Bound
Constant	18.153	9.93	0.068	-1.372	37.678
Age (in completed years)	0.046	0.106	0.667	-0.163	0.255
Sex	-4.512	2.785	0.106	-9.988	0.964
Religion	9.824	4.724	0.038	0.535	19.113
Land tenure: "freehold"	-10.961	7.035	0.120	-24.793	2.871
Land tenure: "communal"	-9.126	7.155	0.203	-23.195	4.943
Index score: watershed governance structures	-0.112	0.337	0.740	-0.775	0.551
Index score: watershed expertise	0.99	0.214	0.000	0.568	1.411
Index score satisfaction: questions on satisfaction towards watershed governance	0.207	0.047	0.000	0.114	0.299
Index score: Co-management of watershed	0.272	0.061	0.000	0.152	0.391
R^2	0.227				
Adjusted R Square	0.208				
ANOVA F Value	12.295				
Significance	0.000				

Note: B stands for Beta Coefficient value
Source: Field data (2018)

Table 3.4b. Logistic Regression results

	B	S.E.	Wald	Sig.	Exp(*B*)
Age	-0.001	0.009	0.024	0.877	0.999
Sex(1)	0.351	0.23	2.339	0.126	1.421
Religion(1)	0.684	0.44	2.412	0.120	1.981
Land tenure system			4.861	0.088	
Land tenure system (1)	0.37	0.24	2.383	0.123	1.448
Land tenure system(2)	1.149	0.602	3.643	0.056	3.156
Index score: watershed governance structures	-0.021	0.03	0.487	0.485	0.979
Index score: watershed expertise	0.088	0.021	17.303	0.000	1.092
Index score satisfaction: questions on satisfaction towards watershed governance	0.011	0.004	7.308	0.007	1.011
Index score: Co-management of watershed	0.015	0.005	8.79	0.003	1.015
Constant	-2.669	0.713	14.023	0.000	0.069
Cox & Snell R Square	0.155				
Nagelkerke R Square	0.207				

Note: B stands for Beta Coefficient value
Source: Field data (2018)

This finding is similar to Economic Commission for Africa (2004) that land held by groups of individuals under freehold tenure systems and by the state attracted the least regulation while customary systems attracted numerous land use regulations. Therefore, collective land use regulations were used to prevent what Hardin in 1968 posited as "The Tragedy of Commons". Security of land tenure is inherent to having control over major decisions on land use such as what crop to grow, what techniques to be used, what to consume and what to sell. In addition, the security of land tenure also determines soil and land management practises [35].

Finally, empirical evidence showed that watershed management activities when supplemented with water harvesting technologies in the rural areas increased the availability of water for irrigated agricultural production. This was implemented together with improved agronomic practices contributed to increased land and crop productivity. This was observed in Abraha-Atshaba, Kereba and Bechyti watershed in Ethiopia where the implementation of watershed management increased crop production up to 200-300% [36]. This implies that enhancing food security in the Lower Sio River Basin needed to be approached through watershed governance practices promoted through watershed management. These include; watershed expertise, satisfaction towards watershed governance and co-management of the watershed.

3.7. Conclusion and Recommendations

Majority of the households perceived that watershed governance determined food security. However, were not satisfied with the state of watershed governance, therefore, expected a more collaborative, integrative approach towards watershed governance hence food security. Watershed governance structures, expertise, capacities created, satisfaction towards watershed governance and co-management did not contribute to the desired adaptive capacity at the household level. Watershed governance did not positively impact on food security in the basin resulting to an increased number of households with food insecurity from 54.0% in 2013 based on government estimates to 55.3% in 2017 the time when the study was carried out. Therefore, recommended that watershed governance structures, expertise, level of satisfaction towards watershed governance together with coordination, participation and monitoring framework of actors' activities as well as village management plans were needed to ensure effective co-management of the watershed. Therefore, enhancing adaptive watershed governance calls for a common watershed responsibility, implementation of policies and plans, improvement of structures and institutions as a fundamental condition towards households' food security in the Lower Sio River Basin.

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