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DETERMINANTS OF WATERSHED GOVERNANCE AND FOOD SECURITY AMONG HOUSEHOLDS' IN THE LOWER SIO RIVER WATERSHED, BUSIA COUNTY, KENYA

Namenya Daniel Naburi, Edward M. Mugalavai and John F. Obiri
School of Disaster Management and Humanitarian Assistance (SDMHA),
Masinde Muliro University of Science and Technology, Kenya (MMUST),P. O. Box 190-50100 Kakamega
Department of Disaster Management and Sustainable Development (DMSD**)**

ABSTRACT

Watershed governance has increasingly become a forum for public engagement in discussions about water and soil management issues addressing food security. Use of the Integrated Water Resources Management approach for decades has not effectively addressed water resource governance issues especially in the developing countries. This study determined households' determinants of watershed governance and food security in the Lower Sio River Watershed, Busia County in Kenya. Cross sectional survey combined with both probability and non-probability sampling techniques were used. 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. Descriptive, bivariate, chi-square and regression analysis were done. Results indicate that only religion, land tenure system and land size showed significant difference among the households with food security and food insecurity. Contrary to other studies, level of education, income and type of occupation did not affect the status of household food security; however, religion did explain 20.8% variations. Male-headed households were 1.42 times more likely to be food secure than those headed by the females. Unlocking watershed governance for food security entails, recognizing religious activities, sex of household head, land size and land tenure system in formulating policy at multi-level governance and multi-sectoral decision making. All variables including those that that never showed significant differences contribute to improved households' food security in the Lower Sio River watershed.

Keywords: Watershed, Watershed Governance, Food Security, Lower Sio, IWRM

1. INTRODUCTION

Watershed governance has increasingly become a pertinent issue in water and soil management in relation to food security. The Integrated Water Resources Management (IWRM)approach has not effectively addressed water resource governance issues especially in developing countries (Ballweber, 2006).Elsewhere, Wani*et al.* (2008) argued that water management approaches are outcomes of political choices which are based on values and preferences of actors including the households or land owners. Therefore, the choice of a river basin as the most appropriate scale of

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water management is politically based but this can be done differently (Wani*et al.,* 2008). After analyzing the institutional context of communal forest management as one of the watershed resources in Honduras Nygren (2005), found that the sustainability of communal forest management depended on many macro-scale forces including land tenure legislation, loan conditions, and national and global forest markets. In watershed governance, adaptive institutions are necessary to move towards sustainability outcomes because of their ability to adjust participation from multiple stakeholders with multiple interests that evolve over time(Foerster, 2011). These interests include households' and land owners who are at the center of the implementation of watershed management programmes.

Most watersheds comprise both public and private land, and so the active participation of landowners is needed to help implement watershed management plans, particularly in more heavily developed watershed areas such as those dominated by agricultural, urban and/or peri-urban interests (Parkes *et al.,* 2008). Upon realization that no one actor or institution can make very significant inroads into the complex and multifaceted issues related to water resources, a wide range of engaged and empowered partners are needed at the smallest scales of a village and household(Parkes *et al.,* 2008). However, this is not the case in the Lower Sio River watershed.

Studies in the Lake Victoria Basin indicate that the basin has been deforested as demand for human settlements, agriculture and grazing land increases which causes land degradation. This is characterized by fertility losses, soil erosion by water, wind as well as increased sediment load at the river mouth as it drains in Lake Victoria (Ogutu *et al.,* 2005). As a result of one of its sub-catchments, Lower Sio River has experienced land use and land cover changes which have exerted negative ecological impacts affecting the livelihoods of communities (Obando *et al.,* 2007). In addition to high poverty levels of 65.9% (GoK, 2007) and high levels of food insecurity 54% (GoK, 2013) with 93.5% of the households in Funyula Sub-county depending on rain-fed on-farm and off-farm activities for their livelihoods. However, decentralized development approaches such as Constituency Development Fund do not adopt watershed management approaches to ensure sustainability (Namenya, 2012). This is due tothe challenges of the implementation of IWRM approach in the watershed that has been occasioned by non-recognition of households. Various factors determine involvement in watershed governance and food security activities. As a result, food insecurity has remained a challenge to the households' development.

Under the current devolved system of governance at multi-level, national and county governments, it is expected that factors that enhance households and landowners involvement in watershed governance for food security are prioritized in development planning. However, no research has been conducted since the beginning of the devolved system of governance in Kenya to profile factors that determine households' engagement in watershed governance and food security in the Lower Sio River watershed. The objective of this study was to determine households' determinants of watershed governance and food security in the Lower Sio River Watershed in Busia County, Kenya. This is aimed at guiding multi-level governance and multi-

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sectoral policy on watershed management and food security at the household level under the national and county governance system in Kenya.

2. RESEARCH MATERIALS AND METHODS

2.1 The study area

The Lower Sio River watershed is trans-boundary, originating in Kenya and flowing into Berkeley Bay of the Lake Victoria basin in Uganda. It originates in Kaujai and Luucho Hills in Bungoma County, Kenya at an altitude of 1800m and flows into Berkeley Bay in Lake Victoria Basin in Uganda. The upper 65% of this sub-watershed is in Kenya, while the remaining portion 35% lies in Uganda (Obando *et al.*, 2007). The watershed lies between latitudes 0^0N and 10^0N and longitudes 30^0E and 36^0E (Wanjogu, 2004)(Figure 1). The drainage pattern of Sio River watershed is dendritic and the drainage density is high.

The mainstream of Sio River stretches approximately 78 km from the source in Kenya to the mouth in Uganda (Albinus *et al.*, 2008). The selected sites Funyula, Matayos and Nambale Sub-counties in Busia County, Kenya are at the Sio River mouth near the entry point to Lake Victoria. The rationale for the selection was based on the interpretation of existing topographic map, literature, observed environmental and land use changes.

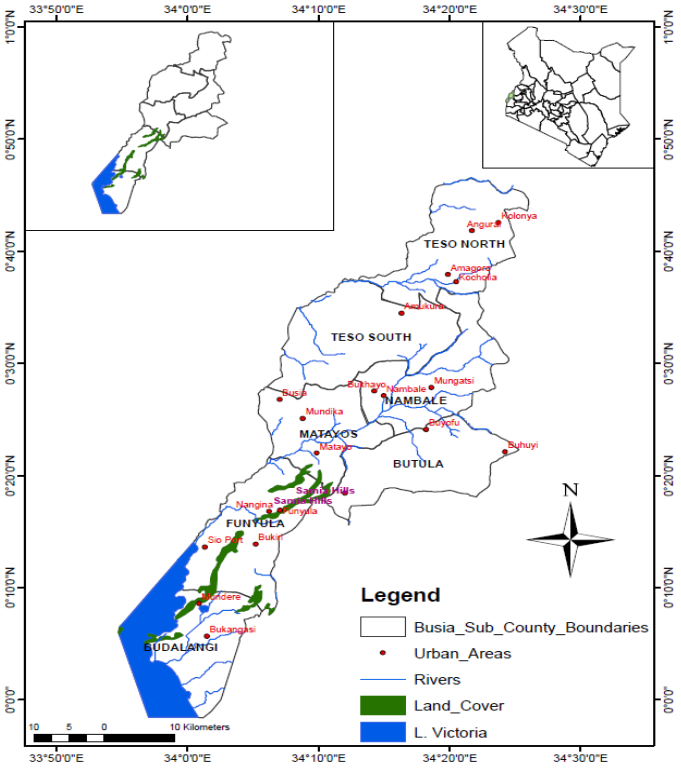

Figure1*Map of the Lower Sio River Watershed*

Source: Researcher, 2018

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2.2 Research Design

The study adoptedcross-sectional survey designs combined with both qualitative and quantitative methods, and probabilistic and non-probabilistic sampling techniques were used in the study (Stringer, 2009). According to Serem *et al.* (2013), survey studies are used to obtain information about existing phenomenon. Therefore, this design was found useful in gathering, summarizing, presenting and interpreting data.

2.3 Sampling Methods

The sampling procedure involved use of quota sampling to select respondents who constituted focus group discussion teams. Primary quantitative data was basically drawn at the individual household level. Purposive sampling was used to select the three sub-counties; Nambale, Matayos and Funyula through which River Sio flow thus forming a common hydrological basin. A two-level multi-stage sampling was conducted. In the first level, simple random sampling techniques were used to select at least 10% (Mugenda and Mugenda, 1999) of the two locations from each of the sub-counties whereas, in the second level two sub-locations from each selected locations 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 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. The sample size was obtained using Yamane (1967) formula for small populations (Equation 1):

$$n = \frac{N}{1 + N(e)^2} \quad \text{.....Equation 1}$$

where:

n = the desired sample size

N= Population of households in the watershed from the sample frame 11,988

e = Margin of error 5 %

From the formula: n = 387

$$n = \frac{11{,}988}{1 + 11{,}988(0.05)^2}$$

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2.4 Data collection

The procedure for qualitative data collection was done using a focus group discussion guide administered in various community groups in the watershed. The quantitative data collection essentially necessitated semi structured questions, open and closed ended questions. Households' socio-demographic variables were used as determinants of the association between watershed governance and food security. 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) inEsikulu Sub-location, Matayos Sub-county excluded from the main study. The Cronbach's alpha reliability coefficient (Cronbach, 1990) obtained using Statistical Package for Social Sciences (SPSS) version 20 for internal consistency was 0.9 which was acceptable since$\alpha \geq 0.7$.

2.5 Data Analysis

There were no statistical measurements for qualitative data however analysis was done based on each thematic area provided for data triangulation with quantitative data 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 means a correct or more positive answer (0-1 for binary; (yes, no). For each of the item measured for the food security variable as the dependent was summed up to compute for an index score of food security. (The index food security score, 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 index score of food security. This is because the variables showed tight coherence with a Cronbach's alpha 0.9 or higher was 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 scored 0-49%' and 1 'indicated households 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 background/households' 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.

To control the results of households' watershed governance determinant characteristics (independent variables) both linear and logistic regression analysis were run using index score for food security and dummy binary food security, respectively as the dependent variable. These were tested against age, sex, level of education, level of income, acreage of land size, religion, household land tenure system, as independent variables. Although age and sex showed no

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relationship they were considered as more important background factors in both regression analyses. Sex, religion and land tenure system variables were considered categorical when running logistic regression and dummy variables when running the linear regression to distinguish between scores.

3. RESULTS AND DISCUSSIONS

3.1 Households Socio-demographic Characteristics

Table 1 shows the descriptive analysis of the demographics of the study respondents. 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 respectively. 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.

Table 1:Households Socio-demographic Characteristics

Characteristics	Categories	Frequency(N=387)	Percent
Sex of the respondent	Male	184	47.5
	Female	203	52.5
Educational level	None	43	11.1
	Primary	179	46.3
	Secondary	131	33.9
	Tertiary	34	8.8
Main Occupation	Farmer	266	68.7
	Civil servant	16	4.1
	Employee in private sector	09	2.3
	Business person	49	12.7
	On farm laborer	16	4.1
	Off farm laborer	21	5.4
	Other specify	10	2.6
Religion	Christians	348	89.9
	Muslims	09	2.3
	Traditional African	01	0.3
	Other specify	29	7.5

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Note: *Other occupations include: house wife, retired officers; Religion others include; Non-believers/Pagans.*

Previous socio-ecological studies indicated that adaptive capacity to climate change varied within communities due to various factors including variations in wealth among social groups, age, gender and sex (Majule *et al.*, 2007). Therefore, to understand the households' determinants of watershed governance household heads; gender, ages, religion, the composition of the households, levels of formal education attained acreage of land, legal status and tenure system of the land held were examined. Chi square tests were performed and presented in Table 2.

Table 2: Food security and insecurity households' measurement comparison association amongst the factors that determine watershed governance at household levels

Variable		Food Insecurity (n=214)	Food Security (n=173)	Difference	$\chi 2$	p-value
Age group	18-35 years	35	37	2	1.182	0.554
	36 - 64 years	57	57.8	0.8		
	65 - 87 years	7.9	5.2	-2.7		
Sex	Male	49.1	45.7	-3.4	0.444	0.505
	Female	50.9	54.3	3.4		
Sub County	Funyula	15	19.1	4.1	1.484	0.476
	Matayos	33.2	34.1	0.9		
	Nambale	51.9	46.8	-5.1		
Education level	None	11.7	10.4	-1.3	0.173	0.982
	Primary	45.8	46.8	1		
	Secondary	33.6	34.1	0.5		
	Tertiary	8.9	8.7	-0.2		
Religion	Christians	86	94.8	8.8	20.589	0.000***
	Muslims	1.4	3.5	2.1		
	Traditional African	0	0.6	0.6		
	Other specify	12.6	1.2	-11.4		
Main Occupation	Farmer	65.4	72.8	7.4	6.506	0.369
	Civil servant	4.2	4	-0.2		
	Employee in private sector	1.9	2.9	1		
	Business person	16.4	8.1	-8.3		
	On farm labourers	4.2	4	-0.2		
	Off farm labourers	5.6	5.2	-0.4		
	Other specify	2.3	2.9	0.6		
land size	less than 2 acres	27.1	46.2	19.1	15.476	0.000**

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(acres) Categorical	2 - 4 acres	53.7	41	-12.7		*
	More than 4 acres	19.2	12.7	-6.5		
Average monthly income	<3,000	52.8	56.1	3.3	2.785	0.594
	3,000 - <10,000	37.4	31.2	-6.2		
	10,000 - <20,000	7.5	8.1	0.6		
	20,000 - <30,000	0.9	1.7	0.8		
	>30,000	1.4	2.9	1.5		
HH land tenure system	Free hold	56.5	60.7	4.2	6.634	0.085*
	Lease	2.3	5.2	2.9		
	Communal	41.1	32.9	-8.2		
	Other specify	0	1.2	1.2		
Age	Mean	43.15	42.20	-1.0	t-test (F=0.43)	0.835
	Standard Deviation	13.22	13.29	0.1		
Land size (acres) (interval)	Mean	2.90	2.52	-0.4	t-test (F=1.241)	0.266
	Standard Deviation	2.19	2.87	0.7		

**p>0.1 ***p> 0.01 statistically significant difference between the households with food secure and insecure*

3.2 Households' Gender Distribution

Tables 2 indicates that the chi-square test performed on households' responses showed no difference between households' gender and households' food security status in the study area. This suggests that household gender did not have influence to food security as a factor of watershed governance. Women in Kenya play a critical role in food production, availability, consumption and access in many households (African Women's Studies Center, 2014). In addition, women are also charged with duties on household fuel which is mostly dependent on watershed resources for firewood and charcoal (Kariuki, 2014). Thus gender issues need to be fully integrated in watershed governance and food security debate. Like in any other African rural community, majority of males in the study areaown the land resource while females are the workers for agricultural food crop production. Evidence from earlier studies (Adhikari and Lovett, 2006) indicated that increased female representation in decision making always leads to improved performance of collective action in institutions. An example given is in the domestic water supply while women exclusion in watershed decision making negatively affected collective watershed management action (Agrawal, 2001). Although gender was expected to have a significant difference among the households with food security, the finding is similar to Bekele and Drake (2003) who found that gender had no significant factor in influencing farmers' decision on climate change adaptation measures.

3.3 Households' Levels of Education

The results in Table 2indicate that there is no statistical significant difference between households' level of education and households' food security status. This suggests that the level

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of education of the household head did not contribute to household food security in the Lower Sio River watershed. However, there was a significant change in the education status as shown in Table 1 compared to the findings from a study by Albinus *et al.* (2008) who found that the number of respondents with primary education in the Sio River basin Kenya was at 58% while those with secondary education was 19% and those without formal education was 21% suggesting an increase in the percentage of the respondents with secondary education and a decrease in the percentage of the respondents without formal education in the study area.

The variations in the statistics of primary, secondary and those without formal education were attributed to the Government of Kenya education policies that were initiated since the year 2002. They include free and compulsory primary education policy, increased education bursaries through devolved funds such as Constituency Bursary Fund, Ministry of Education bursaries, and efforts to regulate secondary school fees to make education affordable as efforts to increase enrollment rates at primary level while increasing transition rate from primary to secondary education. This was also one of the efforts aimed at attaining the Millennium Development Goal (MDG) on education in Kenya.T he household level of education was expected to have a positive effect on food security due to its link with better production and access to non-farm income (Nyariki *et al.,* 2002). Similar findings were reported by Lemba (2009) in the study on food security in Makueni District Kenya. The level of education of the household decision maker determines households' ability to obtain and process information and to implement knowledge intensive conservation practices and agricultural technologies (Kagombe *et al.,* 2018).

On the contrary, a study in the neighbouring Bungoma County found that there was a statistical association between educational levels and food security (food supply) in the county (Wabwoba *et al.,* 2015). Elsewhere, Terry and Israel (2004) found that the higher the farmers' education level the greater their likelihood of satisfaction in any form of extension service offered to them. Moreover, Elias *et al.* (2015) noted that education not only increased the farmer's resources and the capacity to achieve goals but also it expanded farmer's awareness of alternatives and the rewards expected from farmer's activities. Further, Maddison (2007) emphasized that educated and experienced farmers were expected to have more knowledge and information about climate change and adaptation measures to use in response to climate challenges. Therefore, despite the fact that in the study the household head's education level was found to be statistical insignificant to household food security, education is a key determinant to watershed governance and thus food security.

3.4 Households' Main Occupation

The Chi-square test performed on households' responses presented in Table 2 indicate unexpected results, there was no statistical difference between occupation and households' food security and food insecurity status in the study area.This suggests that the main household occupation did not determine the household food security status in the study area. This is despite the fact that majority (68.7%) (266) households depended on farming as their main source of livelihood. However, the study by Shitote (2013) found that there was a significant difference in the occupation and food security status of fish farmers in the neighbouring Siaya County

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while,Wabwoba *et al.* (2015) found a highly significant variation in the source of income and households' food security status in Bungoma County.Studies revealed that farmers are the key determinants in the success of watershed governance as they are expected to make major decisions on the willingness to accept incentives in conservation (Kagombe *et al.,* 2018). Further, household occupation is the main determinant of household disposable income which is vital in efforts to invest in watershed management activities and access to food. According to Anley *et al.* (2007), improving education and employment was necessary to stimulate local participation in various adaptation measures and natural resource management initiatives. Therefore, integrating household type of occupation in watershed governance for food security at a rural river watershed is a critical step for watershed policy makers.

3.5 Households' Religion and food security

Religious ethics and morals are inherent in determining human behaviour related to watershed resources management and utilization in attaining food security. In Table 2 the studyrevealedthat there was a highly statistical significant difference between the households with food security and those without food securityamong the households who practiced Christianity(d= 8.8; p-value=0.000), Islam (d=2.1; p-value=0.000), and even, among the households who practiced traditional African religion(d=0.6; p-value=0.000). This implied that religious activities were important in promoting and determining watershed governance for households' food security in the study area.In Christianity, environmentalism is enshrined in the story of creation in the Holy Bible, scriptures including; (Genesis 2:15, New International Version) guide on Environmental Stewardship, (Deuteronomy 20:19, New International Version) guide on Care for Earth, (Leviticus 22: 28, New International Version) guide Environmental Sustainability, (Deuteronomy 22:6, New International Version) which talks of Biodiversity/Sustainability and (Leviticus 25: 5-6, New International Version) guide on Responsible Agricultural Practice.Therefore, in the absence of the formal governance structures from the national, county or non-state actors, there was some level of watershed governance, necessary for food security, in the study area that was contributed by religious activities.

Table 3: Socio-demographic Characteristics on interval scale

Characteristic	Mean	Median	Std. Deviation	Variance	Range	Min	Max
Age (in completed years)	42.73	42	13.24	175.40	69	18	87
Land size (acres)	2.73	2	2.52	6.35	25	0	25
How many male are in the household?	3.11	3	1.70	2.90	10	0	10
How many female are in the household?	3.26	3	1.81	3.28	11	0	11
How many members are aged below 18 years in this HH?	2.83	3	1.80	3.25	10	0	10

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How many members are aged 18-64 years in this HH?	3.41	3	2.31	5.34	15	0	15
How many members are aged 65 years and above in this HH?	0.21	0	0.49	0.24	2	0	2

3.6 Households' Members Average Age

The age of the respondents was considered to be an important variable in determining the status of understanding watershed governance issues and the status of households' food security. The average age of 43 years of the respondents was documented and other descriptive statistic measures drawn as presented in Table 3.However, the Chi-square test results presented in Table 2 shows that there was no statistical significant difference between age and households' food security status in the study area. However, based on results from previous studies, age was expected to have a positive impact on food security (Lemba, 2009).This finding is similar to Bekele and Drake (2003) findings where age had no influence on farmer's decision to participate in climate change adaptation activities which is a key determinant of households' food security. Age of the beneficiaries of any project is important in determining the participation, satisfaction and knowledge about a given phenomenon. According to Lavis and Blackburn (1990) and Terry and Israel (2004) in the study of farmers satisfaction on extension services in Ethiopia, it was concluded that older farmers were more satisfied with the services provided by extension officers compared to younger farmers the factor that was attributed to differences in farm experience. However, in the same study, older farmers were viewed as less flexible in addition to lack of willingnessto engage in the new or innovative activity as a result of fear of risk while younger farmers were found to be more risk averse to implement new farming technologies on their farm (Elias *et al.*, 2013). On the contrary, Bayard *et al.* (2007) found that age was positively related to some climate change adaptation measures in Haiti. Thus household age is a key determinant to household involvement in watershed governance for food security interventions.

3.7 Household Size and Composition

The size of the households based on the number and composition of members was considered an important determinant of household engagement in watershed activities and food security thus an influencing factor in watershed governance. Therefore, households' sizes were classified based on gender and age of members. Table 3 shows that on average the households had 3 male members and 3 female members. An average of 3 members was aged below 18 years while 3 members in the household were aged between 18 years and 64 years. Further, on average 1 member of the household was aged above 65 years. In an earlier study by Albinus *et al.* (2008) in the Sio River basin Kenya it was noted that family labour was the main soil tillage practice with 21.8% of the households using it. However, during the interviews in group discussions, most old aged and females who were heads of the households argued that it was difficult for them to

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engage in simple soil management activities such as digging of terraces because they lacked the energy to do so even though they were willing. For those who had school going male youth, some engaged them in digging terraces and digging tree planting holes especially on the slopes of hills where land had formed hardpans. In the Kenya Rural Household Budget Survey of 1981-1982, it was found that women in Kenya spent 65% of their time in agricultural crop production as compared to men who spent 35% of their time on similar activities (African Women's Studies Centre, 2014). A similar finding was reported by Kumar (1994) study in Zambia who found that women were responsible for 49% of the agricultural crop production family labour, compared to men 39% and children 12% respectively. Further, family size of farmers was found to help mitigate farm labour issues in Ethiopia (Ayalew and Deininger, 2012).Elsewhere, studies indicate that the composition of the household in a watershed is important since it helps mitigate farm labour issues (Elias *et al.*, 2015) hence how watershed resources are utilized as well as how the resources are managed.

3.8 Average Households income

Findings shows that on average majority, (54.3%) (210) of households earned less than KES.3000 (USD 30) monthly income while 34.6% (134) on average earned income ranging from KES. (3000 = USD 30 to KES. 10,000= USD 100) monthly respectively. In the study by Namenya (2012) in Funyula Sub-county, one of the study sites found that majority (60.2%) of the households reported earning an income below KES. 15,000=USD 150. Given that the majority of households were farmers, the low levels of income were attributed to low productivity of agricultural land in the study area. However, unexpected results in Table 2 shows that the Chi-square test carried out on the responses did not establish any statistical significant variation between various levels of household income among the households' with food security or food insecurity. This is contrary to earlier study findings in the neighbouring, Siaya County where highly significant variations in the level of income and households' food security status were reported among fish farmers (Shitote, 2013).

Gebregziabher, (2016)found that in Ethiopia (Oromia, Amhara and Tigray) where the actors concentrated on watershed management activities as an approach to increase household income and thus food security, watershed management improved farmers' incomes and food security by an average of 50% and 50%, respectively. This affirmed that investment in watershed management activities as a long-term development agenda in a watershed has a positive impact on natural resource conservation, crop and livestock production and productivity, socioeconomic conditions and sources of livelihood through increasing level of household income.

3.9 Households' Land Tenure System

Based on the findings presented in Figure 2, the majority (58.4%) (226) of the respondents reported that the household land tenure system practiced was freehold. In addition, communal land tenure system was practiced by 37.5% (145) while lease land tenure system was practiced by 3.6% (14) of the households respectively. In addition, 0.5% (2) reported other land tenure systems such as donations and gift in the watershed. The Chi square test in Table 2 shows that

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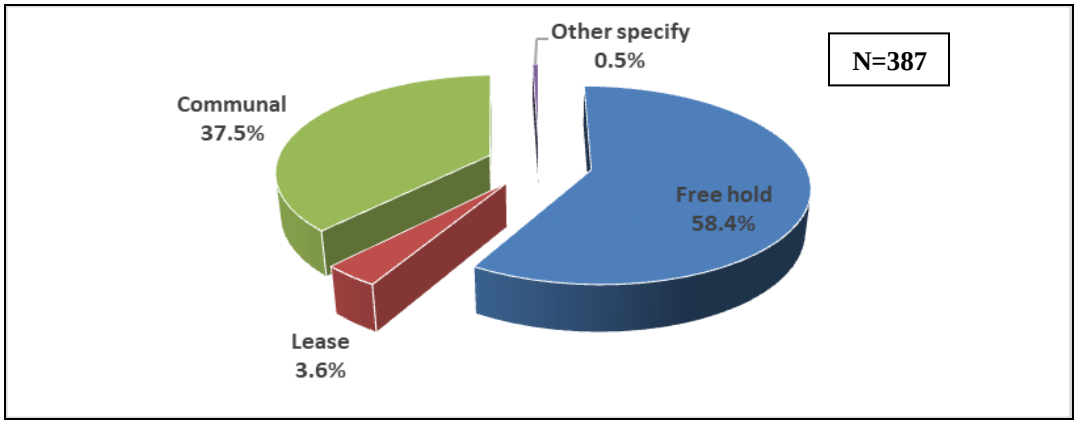
household land tenure system had positive marginal statistical differences with food security status at the household level at p-value =0.085. Households with freehold (d=4.2) and lease (2.9) land tenure systems reported being more food secure than those with communal (d=-8.2) and others (d=1.2) land tenure systems.

The focus group discussions also indicated that the land tenure system favored the male members in the households where the land cultural practices including inheritance rights only considered the males in the households with freehold, lease and communal tenure systems. This reduced the adaptive capacity toward food security for women in the watershed since women were left with limited options for holding productive land other than depending on males for them to access land and decision making.



Note: *Other include; donations and gifts*
Figure 2: Household Land Tenure System in the Lower Sio River watershed

Some respondents acknowledged that the land ownership rights in the Constitution of Kenya (2010) were a key milestone and a game changer in female land ownership in the watershed although reported that they were yet to be affected. In addition, Table 2 presents a Chi-square test that established a positive statistical significant difference at p-value =0.085 in households with freehold and lease land tenure systems and households with food security. On the other hand, communal land tenure system had a marginal significant variation in households' food insecurity status. Elsewhere, a study by Wabwoba *et al.* (2015) found a significant variation in household heads decision making on land allocation and food security in Bungoma County. Land tenure was found to have an influence on natural resources management with many environmental problems such as soil degradation and forest depletion characterized as a result of incomplete, inconsistent and non-enforceable property rights (Kagombe *et al.*, 2018).

The study findings were similar to the World Bank (2012) where it was found that women's access to land in Kenyan agricultural communities through the local power dynamics in both formal and informal justice systems underpin control and ultimately undermined the access to land by women. Further, it is indicated that past formal titling initiatives led to men holding almost all land titles in Kenya through patrilineal landholding practices where inheritance

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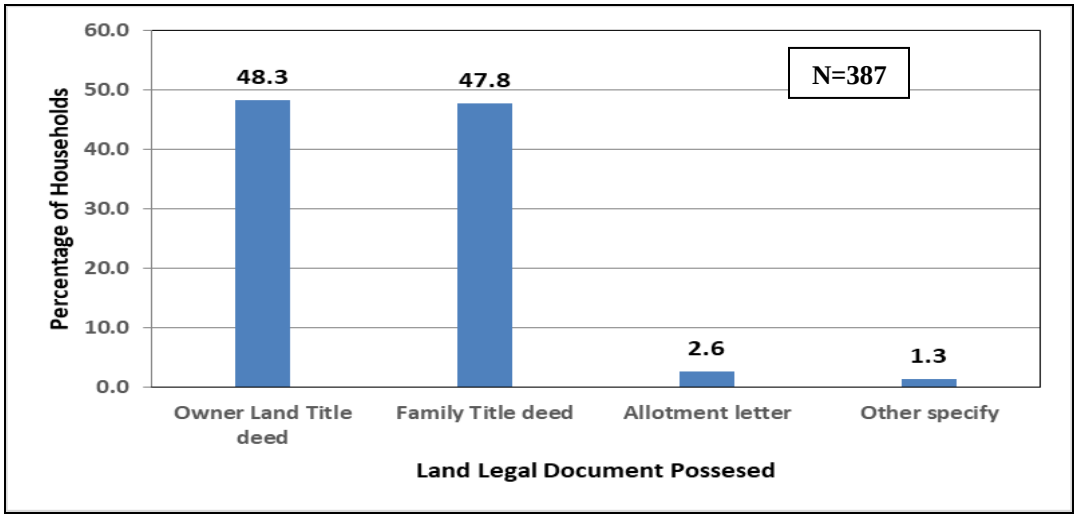
systems through kinship structure were also found(African Women's Studies Center, 2014).Security of land tenure is inherent inhaving control over major decisions on land use such as what crop to grow, what conservation and management techniques to be used, what to consume and what to sell. In addition, the security of land tenure also determines soil and land management practises (Economic Commission for Africa, 2004). Land governance is a pre-condition for watershed governance and food security; however, land legislations in Kenya have been seen as a failure since they have not reflected the guiding principles in the Constitution of Kenya 2010 (Manji, 2015).

3.10 Households' Land Legal documents

Figure 3 shows that 48.3% (187) of the households in the study area held own land title deeds while 47.8% (185) held family title deeds. Land allotment letters were land legal documents held by 2.6% (10) of the households while other 1.3% (05) of the households indicated that had no physical document hence families' informal agreements were considered during allocation of land. During focus group discussions it was noted that collective family title deeds prohibited most households from practicing watershed management activities including tree planting and soil conservation through terraces and gabions. This was attributed to ownership conflicts that emerged during the informal sub-division of family land. Some householdmembersabandoned soil and water management activities for fear of ownership conflicts over benefits accrued fromconservation initiatives.



Note: *Other include; No land legal document*

Figure 3: Household Land Legal document possessed

In the interview with a key informant, it was observed that most of those who held land title deeds either had purchased land or acquired it through formal succession process. Land ownership disputes were on the rise since most of those title deeds held were issued in the 1970s. However, since then families with numerous adult male children have increased resulting to

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family land sub-divisions without following the legal procedure of acquiring land title deeds. In addition, it was reported that:

> The Land and Environment Court in Busia had also recorded an increased number of land succession matter as well as land disputes that result from deaths of grandparents whose land parcels were registered in the 1970s. The court process was reported to be expensive and take long, a minimum of five years which was also another challenge to ownership and use of land as watershed resources.

The study findings agree with (USAID, 2010) finding that observed that inheritance is the most widespread method of obtaining land rights in Kenya, followed by purchase while land leasing is common in some rural areas in Kenya.FAO (2011)noted that gender inequalities in control of livelihood assets limited women's food production. A study in Ghana found that insecure access to land, led women farmers, to practice shorter fallow periods than their male counterpartswho securely owned land, hence reduced women yield, income and the availability of food for the households headed by women (African Women's Studies Center, 2014).

3.11 Households' watershed landform occupied, main land use and source of food

Results showed that majority 74.7% (289) of the households in study area were inhabitants of plain landforms, 12.1% (47) mountain slopes, 9.8% (38) valley bottoms and 3.4% (13) hilltops as illustrated in Figure 4 respectively. On the other hand, the results indicated that land size in acreages (on interval scale) showed no statistical significant difference with households food security status, suggesting that households with less land size were more food secure while those with more acreage of land were food insecure at p-value=0.000. The landforms occupied by households determined access to water resources thus the quality of agricultural production. During transect walks; it was observed that numerous streams formed the tributaries of river Sio. Water pans, wetlands along the streams and the main river channel, shallow wells in the settlement areas, boreholes, protected and unprotected springs and roof water from rainfall were the possible sources of water for domestic and agricultural production. Through consensus, the groups acknowledged that the amount of water in all sources had reduced in recent years due to frequent prolonged droughts. Studies show that upstream and downstream areas of a watershed are linked through hydrology (Gebregziabher *et al.,* 2016). However, during discussions with communities groups, it was reported that there were no mechanisms in place to regulate the activities of the upstream land users for the sustainability of the downstream water users' activities in the Lower Sio River watershed.

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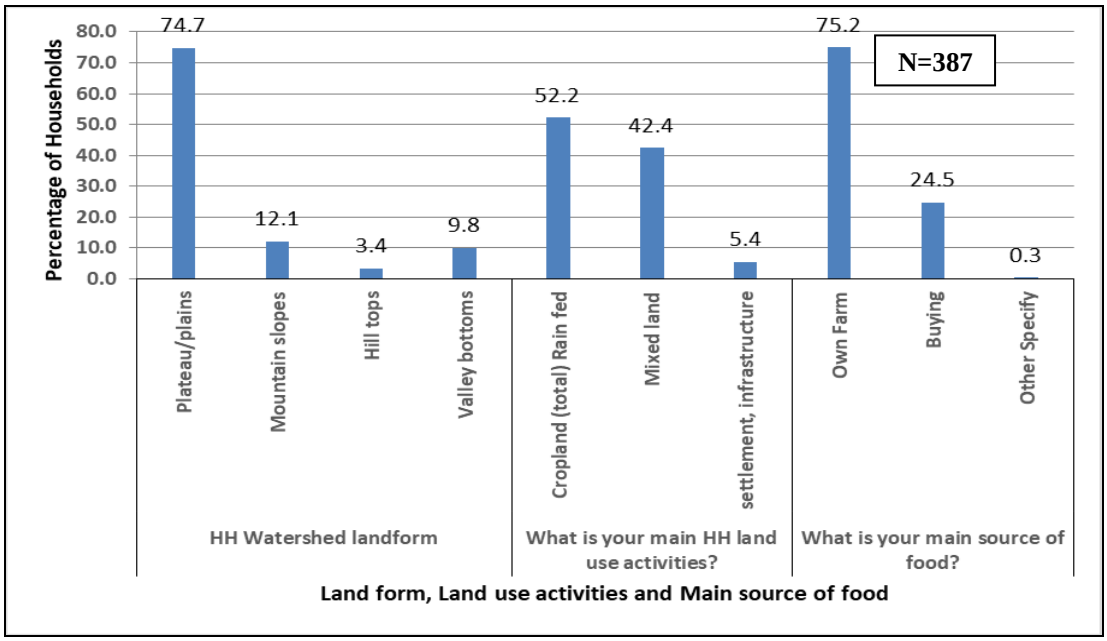

Note: *Other source of food include; Donations from neighbours, government*
Figure 4: Household watershed landform occupied, main land use and main source of food

The main challenges identified in the Lower Sio River during the key informants' interviews include: lack of clear ownership of the water sources and facilities by the communities, ineffective water management practices and lack of clear laws and regulations at the grassroots to protect water sources threatened with pollution and environmental degradation. Consequently, increased human activities were also blamed for water scarcity in the watershed. These included; unsustainable farming practices that resulted to a negative impact on the water cycle reducing underground water recharge. As a result high evaporation occasioned huge water shortage during the dry spells from September to March every year. Further, it was noted that most affected areas with water scarcity in the watershed were small urban markets including Busia town, Mundika, Nambale, Matayos, Namboboto and Funyula within the study area which had experienced immigrants who come from rural areas in search for economic opportunities as a result of the devolved system of governance.

According to Gebregziabher *et al.* (2016), natural resource management interventions at the watershed level in Ethiopian Highlands were used to reduce the rate of soil erosion, sedimentation in the downstream reservoirs and river systems for improved soil moisture and increased crop yield. On the contrary, in the Lower Sio River, the ineffective natural resources management in the upstream was blamed for causing flooding and destroying livelihoods in the downstream of both rivers. Further, a comparative study showed that a successful watershed management intervention strategy increased groundwater recharge and raised the sub-surface water levels which in turn led to increased irrigated land and increased crop yields across the watershed in Ethiopia (Gebregziabher *et al.*, 2016).

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3.12 Households' Main Source of Food and Land use activities

The findings in Figure 5 further indicate that 75.2% (291) of the households' main source of food was from own farmlands while 24.5% (95) of the households depended on bought food. Other sources of food including government, civil society organizations and neighbours donations contributed to 0.3% (01) of the households food requirements in the study area. Furthermore, the results revealed that 52.2% (202) of the households relied on rain-fed cropland while 42.4% (164) practiced mixed farming with5.4% (21) used the land for settlement and infrastructure development respectively. During transect walks; it was observed that the mainland use activity in the Sio River watershed wasrain-fed subsistence farming. Studies in East Africa have shown that diversification of options at the household level is critical for income generation and food security. Further, it was found that the households that were engaged in more cropping and non-agricultural activities tended to be better off than those who engaged in fewer activities (Thornton *et al.*, 2011; Patti*et al.*, 2012). However, during the focus group discussions, a respondent reported that:

> Farming practices in the watershed have not been sustainable whereby the expanded cultivated land had exacerbated soil erosion. In addition, large areas of forest cover especially on the hill slopes in Matayos and Funyula Sub-counties and riparian zones along River Sio and its tributaries were lost to agriculture due to increased demand for food as the population increased. Further, watershed degradation was on the rise as soil erosion and sedimentation increased as a result of increased county government activities such as grading murram roads, ploughing using tractors and increased use of subsidized inorganic fertilizer in farms.

On the lowlands along the main streams and River Sio channel, small-scale farming was observed to be practiced by the households. In most cases, due to the undulating terrain, as a result of hills in Matayos and Funyula sub-counties, the County Irrigation Officer revealed that farmlands suitable for irrigation were located at higher elevations than the river level, together with lack of sufficient fund among the households to procure water pumping systems restricted irrigation to small-scale plots for food production.

During transect walks; it was further observed that the Lower Sio River Watershed, especially in Nambale and Matayos sub-counties, were dominated by farmlands which comprised of areas under cultivation for either commercial or subsistence agriculture purposes. Therefore, farmlands formed the main livelihood opportunities, especially for the rural population. In commercial sugar cane farming areas, agricultural production was reported to be done by farm machinery in large plantations, using agro-chemicals and inorganic fertilizers. The farms had access roads for machinery, animals and humans; therefore in most cases, the roads acted as a runoff concentration area which resulted in enhancing gully erosion. In addition, the compacted road areas promoted surface runoff generation. On the other hand, machinery movement also caused compaction of the subsoil in the farms hence reducing infiltration and recharge ofthe

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groundwater. Consequently, the surface runoff generated builds the potential for soil erosion and flooding.

As a result of subsistence agricultural practices other areas, simple tools were used for cultivation in advanced households, where animal power was employed. The Sio River watershed was characterized by small-sized farmlands most of which were demarcated down slope as a result of the high population growth and the cultural requirement of formation of the new households for married adults which contributed to land fragmentation. This encouraged waterways between the small land sub-divisions which in most cases ran down slopes. As a result, runoff concentrated along the farm boundaries since the neighbouring farms discharged runoff into the waterways. This led to increased runoff volumes and accelerated gully erosion in most farmlands adjacent to graded roads in the watershed. Studies have shown that soil erosion has been associated with the persistent reduction in crop yields and river sedimentation and flooding in the downstream areas (Fiona *et al.*, 2013). A study in Sasumua watershed showed that contour farming combined with grass strips had highest effects of reducing sediment load, followed by terracing, contour farming and grasses waterway (Kagombe *et al.*, 2018). However, such activities were not witnessed in the Lower Sio River watershed. Table 4 presents a summary of observed land use activities and its implications in various sections of the watershed.

Table 4: Summary of Observed Land Use activities and their Environmental Impactsin the Lower Sio River Watershed

Ecological Zone	Land use activity and its implications
Valley bottoms areas	The valleys between the hilltops in Matayos and Funyula sub-counties had increased clearing of the land for farms, gullies were observed, No proper runoff structure had been put in place. Footpaths were all-over; there were several types of spring for water used in homes. **Impact:** Loss of fertile top soils to soil erosion that negatively reduced crop yield.
Mountain slope areas	There was cultivation on hill slopes in Matayos and Funyula Sub-counties, farms had been eroded, crop looked unhealthy. Homesteads could be observed especially in Nangoma location. There were also increased graded roads by the county government. The land had very few trees on farms boundaries. **Impacts:** Uncontrolled run off with high velocity leading to soil and water resources degradation, siltation and sedimentation in the streams and main river.
Hill tops areas	There was observed burning of the hilltops especially in Matayos and Funyula sub-counties also hilltops were experiencing gullies. Indigenous trees were cut down, and rocks could be observed occupying most hilltops due to massive erosion. **Impacts:** Uncontrolled run off with high velocity leading to the forest,

	soil and water resources degradation, siltation, sedimentation and eutrophication.
Plateau/ Plain land	In Nambale, Matayos and Funyula sub-counties increased open farms were observed, increased gullies along the roads, sediment deposited in bridges. Increased settlement as new homes was witnessed; there were newly opened access roads by the counties. Very few trees were observed in the plot boundaries and homestead fences. Most farms in December and January fire was used to clear farms. There was increased clearing of trees to give way for electricity line and roads in most parts. Shallow wells were witnessed in most homesteads. **Impacts:** Uncontrolled run off with high velocity leading to the forest, soil and water resources degradation, soil erosion, reduce water levels in wells.
Streams	Along the roads there were massive gullies due to poor drainage systems of roads, sedimentation was observed, people had cleared their farms to the main river furrow without leaving a buffer zone; sand harvesting was witnessed and some respondents reported the stream gradients had reduced over a period of time, Riverbank erosion. Along road bridges, there were washing of motorbikes and cars directly into the main streams. **Impacts:** Uncontrolled human activities leading to forest, soil and water resources degradation

An earlier study indicated that 42% of the households in the Sio River Watershed in Kenya hadlower land productivity compared to 30 years before (Albinus*et al.,* 2008). The declining land productivity was attributed toover cultivation since owned and cultivated land was decreasing as a result of overgrazing and increase in human settlements that reduced acreage under cultivation. Consequently, poor cultivation techniques such asuse of fire to clear land, inadequate use of fertilizers, mono-cropping and persistent drought periods contributed to the decline in agricultural productivity and were cited as the main causes of declining land productivity in the Lower Sio River watershed (Albinus*et al.,* 2008). The study findings show that since the time the study by Albinus *et al.*,2008, little interventions have been implemented to increase land productivity through watershed management as a result of ineffective watershed governance in the Lower Sio River watershed.

According to Gebrehaweria *et al.,* (2016), cultivated areas need grasses and leguminous plants to stabilize and reinforce soil and water structures in addition to soil fertility improvement measures such as the use of compost and nutrient-fixing plants. However, in the study area, such watershed management activities were never witnessed as a result of non-prioritization of the activities in the local watershed governance policies.

The decrease in farm sizes in the Sio River Watershed was attributed to the increased subdivision of land parcels as a result of population increase, extensive soil erosion which was associated

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with river siltation and sedimentation on the river bank resulting to papyrus reeds growth (Albinus*et al.*, 2008). Despite the fact that respondents in focus group discussions acknowledged the decrease in land productivity and diversion to alternative sources of livelihoods such as sand harvesting and charcoal burning, fish farming was not widely practiced along the hilltops and streams of River Sio. Reasons given included; threats from dangerous wildlife such as crocodiles, snakes, monitor lizards along the River Sio and its tributaries. In addition there islack of adequate finances at the household level to invest in fishing ponds and other fishing farming infrastructure, limited skills and extension services to promote fish farming. Evidence shows that fish farming is a key contributor to households' food security and management of water resources in Siaya County (Shitote, 2013).

3.13 Regression analyses

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) towards watershed governance in the study area. 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 (0.667), sex (0.106) and land tenure system had no effect on the status of households' food security (Table5). Further, results showthat religion could only explain 20.8% variation between households' food security and food insecurity differences at household levels, indicatingthat religion had aneffect on households' food security suggesting that religious doctrines are necessary to promoting watershed governance for food security in the study area.

Table 5: 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
R^2	0.227				
Adjusted R Square	0.208				
ANOVA F Value	12.295				
Significance	0.000				

***Note:B** stands for Beta Coefficient value*

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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. However, in relation to age, sex, religion and land tenure against retained independent variables (Table 6). The results showedthat 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. Men have access to diverse job opportunities which translates to more incomes that could be invested in food security activities. A study by Wabwoba *et al.* (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 significant with food security.

Table 6: 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
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

Similarly, 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 did not exist in privately or freehold land system. This finding is similar to that of the Economic Commission for Africa (2004) in which 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 areused to prevent what Hardin in 1968 posited as “The Tragedy of Commons”.

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4. CONCLUSIONS AND RECOMMENDATIONS

The results show that among the households' determinants of watershed governance for food security in the Lower Sio River watershed including; household gender, ages, the composition of the households, level of income, levels of formal education attained, acreage of land, legal status and land tenure system, religious doctrines and land size.The study established that male-headed households in the Lower Sio River watershed were 1.42 times more likely to be food secure than those headed by the females due to inequalities between men and women engagement in economic activities and decision-making processes that determine watershed governance.

To improve watershed governance at a household level in the Lower Sio River watershed; the study recommends integrated watershed management and food security policy framework that aims at improving the household capacities in watershed management by targeting the identified determinants. These should be backed by a strong legal framework for implementation, exercise responsiveness and equality, and give voice to a wide range of diverse interests, including those of the food insecure and hungry at the local level.There is need for policy makers in watershed management and food security sectorsin the Lower Sio River watershed to concentrate on watershed governance as a means towards improving farmers' equality towards sustainable food security.

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