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Household Livelihood Strategies and Socio-Economic Conditions Influencing Watershed Degradation in Kaiti Sub-watershed, Makueni County, Kenya

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Authors' contributions

This work was carried out in collaboration between all authors. Author KRN designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the literature searches. Authors KMK and KDP managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of the study was to find out how livelihood strategies and socio-economic conditions influence watershed degradation in Kaiti sub-watershed in Makueni County, Kenya, and their effects on the environment. The study examined the livelihood strategies and options of the people as well as the socio-economic conditions contributing to watershed degradation, investigated the land use methods practiced and how they affect the sub-watershed.
Study Design: The study used a descriptive survey research approach to obtain data on socio-economic characteristics of the study sites as well as historical trends of land use.
Place and Duration of Study: South Eastern Kenya University, Kitui County, Kenya; between June to August 2015.

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Methodology: The study used multiple methods such as household surveys, observations, Focus Group Discussant interviews (FGDs), key informant and experts' interviews, drawn from sampling of households systematically along vertical and horizontal transect lines. Structured and semi-structured questionnaires were used to collect data from 101 community and key informants. The data collected was analysed using Statistical Package for Social Sciences (SPSS) and Microsoft Excel 2010.
Results: The study established that low food production as reported by the farmers (78%) and reduced income and livelihood (75%) were consequences of watershed degradation in the study area. Landlessness at 39% (S.E=0.311 z= 1.311 sig.0.190), illegal encroachment at 18% (S.E=0.555 z= -0.604 sig.0.546), and laxity in law enforcement at 27% (S.E=0.481 z=0.227 sig. 0.821) were other factors mentioned by the farmers as contributing to watershed degradation.
Conclusion: The study concluded that these conditions predisposed farmers to adopt inappropriate farming methods and unsustainable livelihood strategies which compromised the watershed's environmental integrity. The study sought to make recommendation for efficient watershed management.

Keywords: Land use; watershed degradation; household livelihoods; Makueni.

1. INTRODUCTION

Watershed degradation in the world is a major problem emanating from human activities leading to pollution, deforestation and changes in sediment generation [1]. The functionality of watershed's provide essential goods and services, now threatened by increasing land/ watershed degradation.Watersheds continue to be altered, due to population increase, mismanagement of water resources and increased water erosion and run-off, [1] and [2]. The African continent is faced with the unprecedented environmental degradation with about 70% of its population being rural, directly depending on land and natural environment for its livelihoods and wellbeing [3]. The savanna landscapes in sub-Saharan Africa provide ecological and economic services to sustain local livelihoods as well as national economies, [4] and [5]. According to UNEP, [6], rapid population growth, poverty and social inequities contribute to watershed degradation globally. Decreased vegetation cover due to inappropriate land management practices, charcoal burning, expanding substistence cropping farming and livestock grazing, [7,8] and [9], continue to impact negatively on people's livelihoods.These studies indicate that reduction of vegetation cover,soil erosion and siltation has also, led to land denudation, habitat loss and farm lands losing their soil fertility and compromising food security. Infrastructure and particulrly roads in rugged terrains accelerates soil erosion processes, [10]. More conscise and multidimensional approach for management, rehabilitation and protection of natural and sensitive areas is a preliquisite to healthy and funtional watersheds, [2]. This should be done with, the aim of protecting the environment and maximising the aesthetics, social and economic benefits of the watersheds [11]. Easdale [12], argues that the concept of human dimension to the sustainability of dryland management should be considered,which is relevant to management of watersheds,because it is focused in totality on sustainable livelihoods, beyond the sustainable land practices and soil management.

Kaiti sub-watershed degradation is aggravated by rapid population growth, high poverty levels, land use changes, poor land use systems and deforestation leading to food crisis and land/watershed degradation [13] and [14]. These changes impact negatively on, livelihood strategies and socio-economic situation which affects the environmental integrity in the sub-watershed [15,16] and [17]. Population growth does not necessarily cause environmental degradation, rather the anthropogenic activities people undertake in their actions to exploit the environment, a factor well articulated by Tiffen et al. [15] in her book ``More people, Less Erosion: Environmental recovery in Kenya". Watershed degradation happens in Kaiti sub-watershed, despite the well known theory that population growth does not necessarily lead to environmental degradation. It is important to appreciate that conditions have changed in the last thirty years such as the economic outlook, off-farm and livelihood diversification options (decline of employment and small-scale business opportunities) and availability of land to absorb excess population which has dramatically changed with new challenges facing the farmers within a situation of diminishing farm sizes.

However, in farms and communities where SWC measures, increase of vegetation cover (both exotic and indigeneous vegetation) is maintained as well as fertiliser applicaton, [5,14], and [18], there is optimum ecological conservation irrespective of the population density. Laxity in enforcement of land laws and inefficient natural resource management contribute to watershed degradation [19] and [5]. Land use changes complicate in the manifestation of food insecurity, water scarcity, loss of livelihoods, reduced income and increased poverty, exposing the communities into vulnerability to drought/famine and disruption of socio-economic equilibrium with adverse effects on the environment [19] and [12]. This situation poses new challenges of conflict in water use, and other resources with negative impact on the watersheds, and their ecological and socio-economic functions in environmental conservation and their ability to sustain the needs of the people [19] and [20].

The study examined the livelihood strategies and options of the people as well as the socio-economic conditions contributing to watershed degradation. Agro-pastoralism is the main economic activity in the area. It includes some non-farm activities like petty trade and casual labour, which, largely depend on agriculture based economy. This is commonly affected by climate change and rainfall variability [21] and [19]. Frequent droughts and famines occur in the area [14], distressing livelihood strategies, affecting food security often leading to inappropriate farming methods and livelihood intercession like charcoal burning and sand harvesting which invariably affects the environment [7] and [20]. Poverty is widespread, coupled with lack of livelihoods diversification and adequate economic opportunities [19] and [20]. Farmers are faced with challenges such as lack of capital and appropriate agricultural technologies to maximize on crop production [19]. Mitigation measures undertaken by farmers to increase livelihood outcomes also have impact on land management practices like soil and water conservation which influence watershed degradation. Inspite of the challenges, farmers in their recognition of soil erosion drivers in their farms, increased awareness of benefits of SWC and adoption of modern farming technologies, [14] and [18], as well as embracing afforestation and conservation of indigineous forests, [5] have an opportunity for enhanced livelihood resilience. Rural livelihoods diversification and increased off-farm activities, [12] and [19], will also ensure, there is resilience and environmental sustainabilty obtaining from their livelihoods outcomes.

In Kaiti-sub-watershed, there exist gaps in farmers' knowledge on natural resource management, Soil and Water Conservation (SWC), appropriate crop and livestock production skills with modern farming technologies [16] and [22]. Soil and Water Management (SWM), knowledge and commitment to sustained practice, has declined as well as the neglect of the old conservation measures and especially the terraces structures. Earlier studies firmly hailed the success of such conservation measures in the area [15]. Despite the past studies efforts to address some of the issues affecting the watershed, these problems have not been adequately addressed for effective watershed management framework. Their focus has been predominantly on famines and droughts, agricultural production, agro-pastoralism as means for livelihoods from crop production, marketing, livestock keeping and sale [14] and [19]. The intensive SWC practice was happening more than three decades ago existing in a different set of conditions with most of the farmers who made those structures, being beneficiaries of robust government supported conservation Programmes, NGOs and enhanced agricultural extension services. This paper therefore addresses some of the pertinent issues contributing to watershed degradation in the study area to make recommendations on appropriate remedies in dealing with these problems.

2. METHODOLOGY

2.1 The Study Area

The study was done in Kaiti sub-watershed, and data was collected between the months of June-August 2015 using household survey, Focus group Discussion and key informant questionnaires. Kaiti sub-watershed was chosen based on its high population density of 120,116 and 248 persons per square kilometre respectively as compared to the average of 110 persons per square kilometre for the county [20]. According to Muriuki et al. [14], high population has a bearing on the state of the watershed due to the increasing human activities and their effects on the wellbeing of the downstream communities in the county. Soil erosion in the sub-watershed is a major problem due to farming on steep slopes with siltation of manmade reservoirs experienced in the downstream of Kaiti River.

Kaiti sub-watershed covers an area of 660 km2 and is located between 10º 38 South and 10º 51´ South and 37º14´ East and 37º41´ East. Kaiti sub-watershed (Fig. 1) shows the specific study site in Makueni County. It lies in the fertile upper parts of the county which experience average rainfall of 800 mm-1200 mm. It comprises of Kilungu, Kee, Kalama, Kaiti and Wote divisions. The sub-watershed topography is characterized by mountainous terrain including Kilungu and Mbooni hills. Kaiti River and its numerous tributaries originating from the hills serve the watershed which influence surface water sources and ground water recharge capacity [14].

2.2 Data collection

The study used a descriptive survey research design [24]. Both qualitative and quantitative methods were used to gather and evaluate primary and secondary data from the field and past studies/reports respectively. The study used multiple methods of data collection such as field/household surveys, observations, Focus Group Discussant interviews (FGDs) and key informant/experts interviews to gather information and sampling of households along a vertical transect lines. It also used triangulation which is a form of cross-checking and the use of multiple methods both qualitative (inquiry) and quantitative (validation) methods in studying the same phenomenon for the purpose of increasing study credibility [25].

Kaiti sub-watershed was purposively selected for investigation based on its population distribution, density and varied physical characteristics [14] and [20]. Line transect approach [26] was used as part of the sampling framework traversing much of the ecological, socio-economic/land uses and environmental variability in the study site. Random point samples along the transect line were used to sample respondents to obtain information. Three divisions Kilungu, Kaiti and Wote, which fall within the delineated boundaries of Kaiti sub-watershed, were selected for sampling of the respondents. Kilungu division represented the upstream communities, Kaiti division the midstream and Wote the downstream communities of the sub-watershed. A total of 51 respondents were interviewed. In each of the 3 divisions 12 farmer respondents were interviewed, additional 5 respondents from each of the divisions from among those aged above 60 years were interviewed. Thirty respondents (30) for focus discussion groups were interviewed in Kaiti division. The 20 key informant respondents were drawn from among people with technical expertise in the divisions and from the county headquarters.

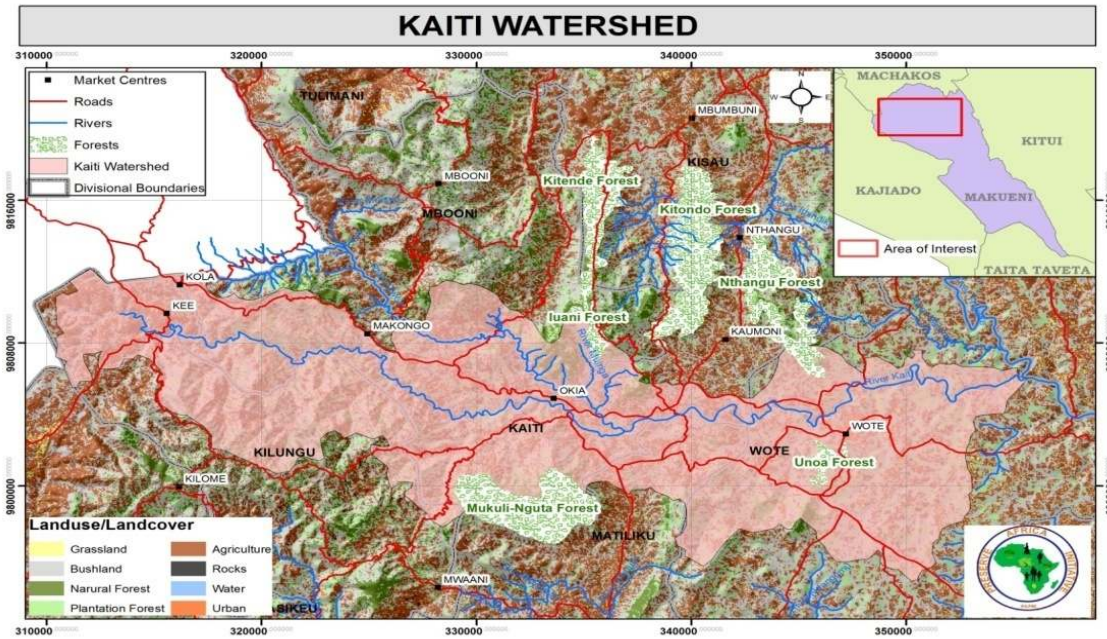

Fig. 1. Map of Kaiti sub-watershed
Source: Preserve Africa Initiative (PAFRI), [23]

2.3 Data Analysis

Data collected was managed and analysed using Statistical Package for Social Sciences (SPSS), version 19 and Microsoft excel 2010. Descriptive statistical tools like percentages, means and frequencies were used to analyse quantitative data.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Selected Households in the Study Area

According to the results (Table 1), of the surveyed 51 households, where semi-structured interview questionnaires were administered 32% of households had no formal education, 35% had primary education. In the study area, male headed households comprised of 69% while the female headed households were 31%. The majority of the respondents were women because most of the men were out either in employment or doing other off-farm activities. The average household's size was 6 members and the average farm size was 4.3 acres. The average age of the household heads was 57 years; with 32% of the household heads reporting that they had no formal education. These factors influenced watershed degradation, as majority of these farmers relied on traditional farming and livestock rearing methods as opposed to modern agricultural practices, which are known to enhance production and promote soil and water conservation.

3.2 Household Livelihood Strategies

Availability of land and favourable climatic conditions influences livelihood choices in the study area. The study established that crop and livestock production at 100% and 10% respectively (Table 2), continue to be the dominant livelihood strategies among the households; providing them with food and their financial needs. This is happening in the background of considerable reduction of farm sizes and grazing land in the study area.

Agro-pastoralism was found to be supplemented by other non-farm activities like petty trade, small-scale business enterprises at 24% and unskilled casual labour representing 27% respectively. Generally off-farm activities were

Table 1. Selected household characteristics (N=51)

Characteristics	Ecological zones								
	Lower zone wote		Mid zone Kaiti		Upper zone Kilungu		Kaiti sub-watershed		
	Freq	%	Freq	%	Freq	%	Freq	%	Ave.
No. of Households	17	100	17	100	17	100	51	100	-
Gender of respondent									
1. Male	3	24	6	35	3	18	13	25	-
2. Female	13	76	11	65	14	82	38	75	-
Gender of household-head									
1. Male	10	59	14	82	11	65	34	69	-
2. Female	7	41	3	18	6	35	17	31	-
Marital status									
1. Married	10	59	13	76	11	65	34	67	-
2. Widowed	7	41	4	24	6	35	16	33	57
Mean age household-head	60	-	55	-	56	-	-	-	6
Household size	6	-	6	-	6	-	-	-	-
Educationhousehold-head									
1. None	5	30	8	41	4	24	17	32	-
2. Primary	7	41	4	24	7	41	18	35	-
3. Secondary	5	29	5	29	5	29	15	29	-
4. Tertiary	2	-	-	-	-	-	2	3	-
Occupation									
1. Farming	17	100	17	100	17	100	51	100	-
2. Livestock	3	18	1	6	1	6	5	10	-
Ave. in acres per farmer	8	-	3	-	2	-	-	-	4.3

Table 2. Household livelihoods strategies (N=51)

Livelihood component	Ecological Zones							
	Lower zone Wote		Mid zone Kaiti		Upper zone Kilungu		Kaiti sub watershed	
	Freq	%	Freq	%	Freq	%	Freq	%
Crop production	17	100	17	100	17	100	51	100
Livestock rearing	3	18	1	6	1	6	5	10
Small business/petty trade	3	18	5	30	4	24	12	24
Employed (salaried)	2	12	0	0	0	0	2	4
Daily wage labour (unskilled)	5	30	3	18	6	35	14	27
Firewood/charcoal	5	30	1	6	0	0	6	10
Timber harvesting	0	0	1	6	10	59	11	22

found to be limited with many people lacking opportunities, even for casual jobs. The findings indicated that both farm and off-farm activities are influenced by the agro-ecological gradient zones and climatic conditions in the study area. Most of the households in the upper watershed depended on local markets for their domestic food consumption, because they hardly produced enough food to take them through longer periods in a year. These off-farm activities largely depend on agriculture based economy, often affected by climate change and the frequent droughts in the area. Firewood and charcoal burning was also reported to have been higher at 30% in Wote (lower catchment area), with only one household reported to have engaged in the activity in the midstream watershed, while in the upper stream none of the households engaged in charcoal burning. Timber harvesting on the other hand was reported by 59% of respondents in the upper watershed area, 6% in Kaiti and none in Wote area. The climatic conditions and altitude of these areas were more favourable for agro-forestry than in the low lands.

In addition to determination of livelihood components of the people, where crop production was identified as the major component, the study went further to look at types of crops grown. Growing of maize, millet, sorghum, beans, cow peas, pigeon peas and cow peas (Fig. 2), subsistence farming represented the biggest type of land use in Kaiti sub-watershed. Maize at 92% constituted the largest percentage of land use grown by all the farmers interviewed. In nearly all instances, it was intercropped with pulses which, are seldom planted alone in the area.

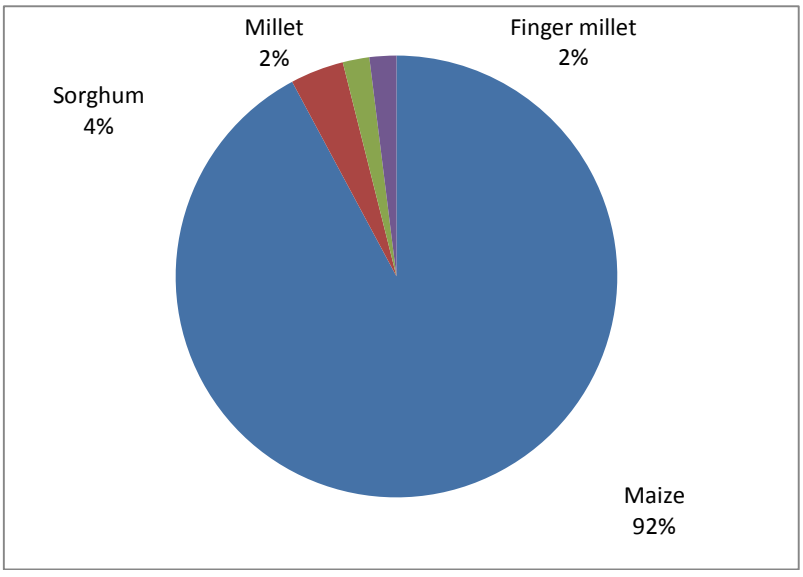

Fig. 2. Types of cereals grown in the watershed

Agro-forestry and activities such as planting of *Grevillea robusta* and blue gum trees along farm edges and rivers banks was common with *Grevillea robusta* dominating the mid and the lower catchment, while blue gum and other exotic tree species were common in the upper hilly parts of the watershed [14]. In the three divisions, farmers in the recent years have intensified agro-forestry activities with these tree species also being found planted in the farms forest reserves and in institutions like schools and shopping centres.

Socio-economic factors were estimated using a regression model with anthropogenic independent variables against watershed degradation causes (Table 4). The results from the survey research showed that age, gender and education levels of the household head were significant at 10% in understanding watershed degradation. Population growth, poverty, landlessness, illegal encroachment, laxity in law enforcement and inappropriate farming methods were all significant at 10% in explaining watershed degradation. The increase of men as household heads increased the chances for better watershed management (S.E=0.073 z=0.-512 sig. =.0.609), while women being household heads were likely to contribute to negative impact on the watershed (S.E=0.103 z= 0.186 sig. =0.853). This could be explained by the fact that men have better income options and employment opportunities, hence their ability to afford and initiate soil conservation measures on their farms. The increase of education levels of the household head (S.E=0.159 z=0.455 sig. =0.649) led to better soil and water management while the increase in average farm size for the families (S.E=0.133 z=0.095 z=1.395 sig. 0.163) increased the chances of better management and reduced degradation chances.

Increase in poverty was mentioned by 69% (S.E=0.633 z=0.633 sig. 0.570) of the respondents as another cause of degradation in Kaiti. Livelihood strategies were limited and their ability to sufficiently address the people's basic needs remained a major concern, largely contributed by inadequate food security and limited livelihood diversification options. People require human and physical capital in order to exploit the natural capital to the maximisation of their livelihood outcomes [18]. Majority of the households hardly produce enough food for their domestic consumption and the little surplus and horticultural produce they have is constrained by lack of ready markets. Cash crop farming has been on the decline, now practiced in insignificant levels. Just like population growth (90%) (S.E=0.633 z= -0.568 sig. = 0.570), poverty is of major concern in the mid and the lower watershed area due to minimal livelihood diversification and limited off-farm activities. Although cash crop farming of cotton is viable in these areas, farmers have almost abandoned growing it. Droughts and famines have also depleted livestock or forced the farmers to keep a number they can manage. Traditionally livestock used to be a key source of income especially in the lower area where ranching is favourable.

About seventy five percent (S.E=0.376 z=-0689 sig.=0.491) of the respondents in Kaiti sub-watershed felt that inappropriate farming methods like inadequate SWC structures in farms e.g. terraces and encroaching on fragile ecosystems play a major role in watershed

Table 3. Socio- economic watershed degradation indicators (N=51)

Indicator	Ecological zone							
	Lower zone wote		Mid zone Kaiti		Upper zone Kilungu		Kaiti sub watershed	
	Freq	%	Freq	%	Freq	%	Freq	%
Population growth	17	100	16	94	13	76	46	90
Increase in poverty	12	71	11	70	12	71	35	69
Inappropriate farming methods	14	82	15	88	10	59	39	76
Low food production	15	88	16	94	9	53	40	78
Reduced income/livelihoods	12	71	11	65	15	88	38	75
Landlessness	1	6	6	36	13	76	20	39
Laxity in law enforcement	9	53	4	24	1	6	14	27
Illegal encroachment*	2	12	3	18	4	24	9	18

** Steep slopes and riverbanks*

Table 4. Logistic regression results for causes of watershed degradation

Parameter	Estimates	Std. error	z-score	Significance
Age of household head male	-.037	.073	-.512	.609
Age of household head female	.019	.103	.186	.853
Education level of household head	.072	.159	.455	.649
Farm acreage	.133	.095	1.395	.163
Population growth	.359	.633	-.568	.570
Poverty	-.221	.362	-.610	.542
Landlessness	.408	.311	1.311	.190
Illegal encroachment	-.335	.555	-.604	.546
Laxity in law enforcement	.109	.481	.227	.821
Inappropriate farming methods	-.259	.362	-.689	.491

Note: Significance level of 10%

degradation. This situation is confounded by lack of information and the decline of agricultural ecosystems play a major role in watershed degradation. This situation is confounded by lack of information and the decline of agricultural extension services. Many farmers interviewed expressed the view that they are currently left on their own in soil and water conservation matters as well as obtaining information on appropriate farming methods, except for the emerging trend where the media and in particular the radio offers most of the information on agriculture and environmental conservation. Agricultural extension services have declined over the years, which have also affected farmer's ability to acquire and use appropriate farming technologies. Low food production was reported by the farmers 78% and reduced income and livelihood by 75%, as consequences of watershed degradation in the study area. Landlessness 39% (S.E=0.311 z= 1.311 sig.0.190), illegal encroachment 18% (S.E=0.555 z= -0.604 sig.0.546), and laxity in law enforcement 27% (S.E=0.481 z=0.227 sig. 0.821) were other factors mentioned by the farmers as contributing to watershed degradation.

3.3 Soil and Water Conservation Measures as Land Management Practices

Land management practices such as SWC influences watershed degradation and crop production levels. Farmers' choices on SWC practises determine productivity of their farm plots and subsequent crop yields. The 1990s decades saw the introduction of Structural Adjustment Programmes (SAPs), the government down-scaled agricultural extension services and liberalised the agricultural and marketing services which further affected the farmer's SWC measures in their farms. In the 2000 decades human settlement increased as well as institution and infrastructure development in form of roads and sub-surface dams and sand dams and expansion of horticultural farming in form of oranges, mangoes and avocado trees as well as agro-forestry. This tremendous expansion of farming activities occurred amidst lack of proper land use management Programmes, decline of conservation efforts, agricultural extension services and enforcement of basic SWM laws.

It was observed that SWC, (Fig. 3) is widely practiced with 49% using bench `Fanya juu' terraces, 6% narrow based terraces and 37% napier grass, agro-forestry 6% and run-off water harvesting 2%. Some farmers had cut off drains to divert water from the roads and pathways into their farms. Planting of *Grevillea robusta* and blue gum crop trees along farm edges was observed in all areas but were highly pronounced in the mid and upper catchment areas. Despite all these conservation measures, soil and water erosion along the roads and river bank erosion was commonly observed in the study area.

SWC is constrained by neglect of terrace structures in most of the farms, with some not laid into contour posing danger of increased erosion in the farms, roads and in the open fields. Most of the farmers admitted that their terraces were done several years back and were not regularly repaired as required. They cited poverty and lack of resources as the reasons for non-maintenance of terrace structures regularly. Some farmers planted grass on the terraces embankment which provided the much needed livestock feed during drought and times of scarcity, hence the reluctance to disturb the structures in renewing the terraces. Government efforts and involvement in SWC was found to

have declined in the area, with most of the farmers disregarding, SWM measures and regulations.

Most of the soil conservation structures (terraces) were in a state of disrepair due to negligence. SWC was observed to have been highly practiced in the farms as opposed to the open grazing fields, most of which were denuded as a result of past overgrazing/overstocking and general neglect by farmers. Gabion construction, weirs and sand dams were observed across the study area, with most of them undertaken by NGOs and the local communities. Where these structures were constructed, SWC was evident in the form of regenerative land cover vegetation and retention of sand and water in rivers and streams.

3.4 Constraints to Livelihood Strategies and Coping Mechanisms

The choice of livelihood strategies and mitigation measures undertaken by farmers, often influence watershed degradation. Using the Sustainable Livelihood (SL) framework [27], the study established that factors beyond farmers control like poverty and climate change affect individual farmer livelihood strategies, with varied consequences to their livelihood outcomes and the physical environment on which they depend for their wellbeing. Their land management practices, choice of crop varieties and land use methods has impact on the health of the watershed in terms of its continued productivity and sustainability of the livelihood strategies. The respondents indicated that high cost of agricultural inputs, including labour, draught power and improved drought resistant and quality seeds, formed the bulky of farmer's constraints to adequate crop production (Table 5).

To the majority of the households, family labour (63%) was the main mode in crop production. In the past, farmers reported that they relied on their children for their farm labour requirements. Most of them now are in schools. Majority of those who complete their education ignore farming and immigrate to the urban centres and cities in search of jobs. To mitigate these problems, some farmers (35%) resorted to hired labour of people and draughts animals to do the tilling and weeding. However, they insisted that the initial capital inputs in such measures more than often exceeded the returns from their crop production, owing to high rate of crop failure and farm produce marketing limitations. Communal labour in form of ``mwethya'' (Self Help Groups) has been on the decline or not evident in the area. Most of the activities of these groups are largely confined to merry go round and welfare, unlike in the past when they were involved in soil and water conservation efforts.

Ninety four percent of the farmers indicated they used manure or fertiliser in their farms, 69% use improved planting materials, (drought resistant quality seeds), while 94% of the farmers revealed that they use intercropping to mitigate the high rate of crop failure due to rainfall variability and frequent droughts in the area. The diminishing farm sizes also influence intercropping to maximise and diversify their crop varieties.

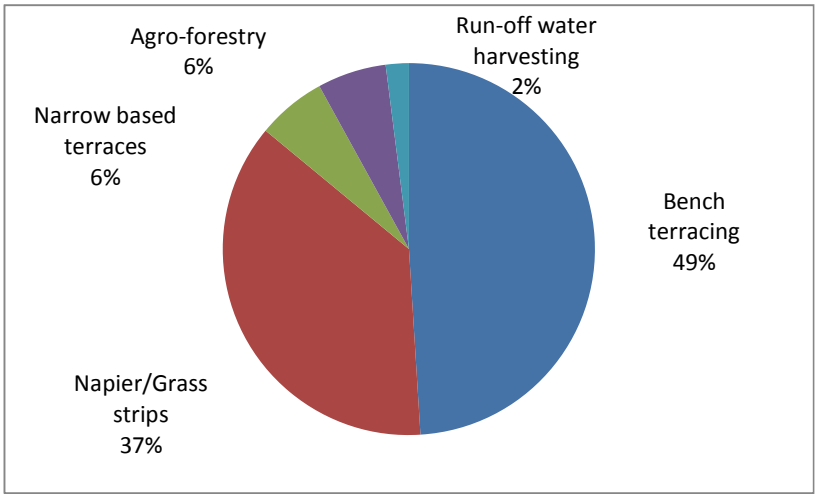

Fig. 3. Soil and water conservation

Table 5. Crop production constraints and mitigation (Kaiti sub watershed) (N=51)

Indicator	% of farmers reporting constraint	% of farmers identifying indicator as mitigation factor
Use of family labour	63	35
Use of manure/fertiliser	94	6
Use of improved planting materials	69	31
Cropping system	Inter cropping (94)	Mono cropping (6)
Use of recent harvest for consumption	82	18 (sold)
Months harvest lasted < Half a year	92	8> Half year
Regular selling of farm produce	43	57
Indigenous cattle ownership	84	16
Improved dairy breeds	6	94
Place of produce sale		
1. Middlemen	35	
2. Local market	49	
3. Cereal Board	6	
4. Cooperative	10	

These measures however are faced with numerous problems, including high unit cost of the inputs. Use of fertilisers is pegged on the goodwill of the government supplies which is erratic and irregular. Most of the farmers could not afford it from commercial outlets and when they buy, it is usually in small quantities not adequate for their farms.

Some farmers also acknowledged that they apply fertiliser when it is available and may go for several seasons without applying any fertiliser. Manure application faces a similar dilemma as livestock numbers decline. Most of the farmers lack adequate farm yard manure (FYM) to apply on their farms. It was found that FYM (63%), was widely used in the lower watershed area where it is found to be plenty as opposed to the mid and the upstream watershed areas where farmers kept less livestock. Continuous planting of maize on the same plot was noticed in all the areas. It may not auger well for crop production due to the threat of crop diseases and the decline of soil fertility [14].

All the households had planted food crops in the last season, October- December 2014 short rains and harvested. A large number of the respondents 82% reported to have used the harvest for domestic consumption as opposed to only 18% who got surplus to sell. The rains were erratic, unevenly distributed and short lived which affected crop production to the majority of the farmers. Over 92% of the respondents indicated, that the harvest was projected to last less than 6 months. It was only 43% of the farmers who said they regularly sold their food, when they had surplus from their farms depending on availability of adequate rainfall during the planting season. A large proportion at 57% did not have surplus to sell. The majority of those who regularly had surplus (staple food, cereals and legumes) were found to be in the lower and the mid-stream watershed area.

Marketing of farm produce in the study area was faced with numerous challenges. The study revealed that 49% and 35% of the respondents (Fig. 4) sold their farm produce in the local market centres and to middlemen/ brokers respectively. The study established that most of the farmers felt that they were exploited in these marketing avenues, where the prices were low making them unable to get maximum returns for their farm produce.

The study indicated that 84% and 6% respectively of the households kept indigenous and improved dairy breeds in the area. The average number of indigenous cattle per farmer has significantly dropped due to diminishing grazing land for majority of the farmers. Some farmers were found to lack adequate SWM skills leading to the decline of crop and livestock production. This situation impacts negatively to the people's livelihoods increasing their vulnerability as well as that of the immediate environment upon which they depend to derive their livelihoods. The depression of their economic wellbeing thus predisposes them to inappropriate farming methods and unsustainable livelihood strategies such as charcoal burning, sand harvesting and brick making, commonly found near river banks, and contributing to serious watershed degradation.

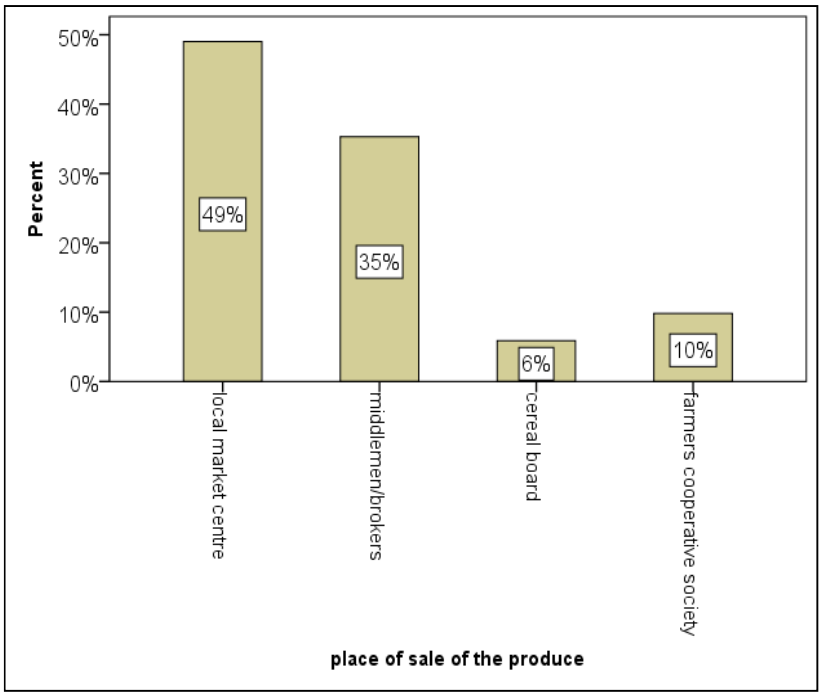

Fig. 4. Marketing of farm produce in the watershed

4. CONCLUSION

There is watershed degradation in Kaiti sub-county owing to choices of livelihood strategies and inappropriate land use systems. Population growth and demographic changes over the years has influenced watershed degradation in the area. High poverty rates, diminishing farm sizes and encroachment of fragile ecosystems as well as frequent droughts and climate change have also impacted negatively on food production. Farmers are increasingly adopting unsustainable livelihood strategies, unsuitable agricultural technologies and inappropriate land use and farming methods. Watershed degradation occurs with the threat of increasing environmental problems; which continue to impact negatively on their livelihood strategies. Unsustainable exploitation of natural resources and inappropriate land use methods, leads to further decline of the ecosystems ability to adequately provide environmental goods and services.

Watershed degradation, therefore is much driven by direct (Anthropogenic) causes like poor land use policies/management and planning, unfavourable climatic conditions, continuous farming in the same plots and overgrazing. Limited livelihoods options (Diversification), lack of conservation rules enforcement, inadequate (coordination) watershed management activities and limited or declining SWM knowledge are some of the indirect root causes of watershed degradation. Food insecurity in the area has considerably increased, leaving people with food shortages for domestic consumption and surplus for sale. This scenario limits their ability to meet their daily food and financial needs. The farmers are therefore predisposed to adopting unsustainable livelihood strategies further increasing their vulnerability and the general watershed degradation which affects its environmental health and integrity.Based on the findings the study recommends the county and national governments implement policies and strategies that can improve farmer's choices in increased crop/livestock production. This will enable for them to meet their livelihood outcomes e.g. food requirements and financial needs and motivate them to conserve the environment by adopting sustainable livelihood strategies. This can be achieved through design of pro-poor safety net programmes, value addition, improving food security/quality, minimising the risks of diseases for both human and livestock, as well as improved agricultural and animal husbandry practices.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bach H, Claussen TJ, Nang TT, Emerton L, Facon T, Hofer T, Lazarus K, Muziol C, Noble A, Shill P, Sigouvaanh A, Wensley C, Whiting L. From local watershed management to Integrated River Basin Management at National and Transboundary Levels; Mekong River commission, Lao PDR. 2011;3-12.
2. Shukla S. Watersheds- functions and management. The Institute of Food and Agricultural Sciences, IFAS, University of Florida, ABE350. 2013;1-4.
3. Government of Kenya (GoK). Kenya Joint Assistance Strategy 2007-2012- Improving Aid Effectiveness. Government Printer, Nairobi, Kenya; 2007.
4. Muia VK, Ndunda E. Evaluating the impact of direct anthropogenic activities on land degradation in arid and semi-arid regions in Kenya. Wudpecker Journal of Agricultural Research. 2013;2(6):173-182.
5. Nyssen J, Frankl A, Zenebe A, Poesen J, Deckers J. Environmental conservation for food production and sustainable livelihood in Tropical Africa. Land Degradation and Development. 2015;26(7):629-631.
DOI: 10. 1002/ldr. 2379
6. United Nations Environmental Programme (UNEP). Africa environment outlook-2, our environment our wealth. Nairobi: UNEP. 2006;2-5.
7. Danish Development Assistance (DANIDA). Assessment of potential approaches to charcoal as a sustainable source of income in the arid and semi-arid lands of Kenya; 2003.
8. Erkossa T, Wudneh A, Desalegn B, Taye G. Linking soil erosion to on-site financial cost: Lessons from watersheds in the Blue Nile basin. Solid Earth. 2015;6(2):765-774.
DOI: 10. 5194/se-6-765-2015
9. Keesstra S, Pereira P, Novara A, Brevik EC, Azorin-Molina C, Parras-Alcántara L, Jordán A, Cerdà A. Effects of soil management techniques on soil erosion in apricot orchards. Science of the Total Environment. 2016;551-552:357-366.
DOI: 1016/j.scitotenv.2016.01.182
10. Pereira P, Giménez-Morera A, Novara A, Keesstra S, Jordán A, Masto RE, Brevik E, Azorin-Molina C, Cerdà A. The impact of road and railway embankments on runoff and soil erosion in eastern Spain. Syst. Sci. Hydrol. Earth Discuss. 2015; 12:12947-12985.
DOI: 10.5194/hessd-12-12947-2015
11. Wortman SC, Helmers M, Devlin D, Andersoson S, Franti T, Tomer M, Frees l. Targeting of watershed management practices for quality protection, University of Nebraska-Lincolin; 2008.
12. Easdale MH. Zero net livelihood degradation – the quest for a multidimensional protocol to combat desertification. SOIL. 2016;2:129-134.
DOI: 10.5194/soil-2-129-2016
13. Government of Kenya (GOK). National action programme, a framework for combating desertification in Kenya. National Environment Secretariat. Nairobi, Kenya. 2002;11-14.
14. Muriuki AW, Kaluli W, Ng'ang'a K, Gathenya M. A survey of soil fertility management practices in Kaiti watershed, Makueni, District, Kenya. Kenya Agricultural Research Institute & Jomo Kenyatta University of Agriculture Nairobi, Kenya. 2005;1-2.
15. Tiffen M, Mortimore M, Gichuki F. More people, less erosion: Environmental recovery in Kenya. London: John Wiley & Sons. 1994;72-199.
16. Munyasi JW, Esilaba RA, Emongor AO, Nyamwaro RA, Maina SO, Miruka KM, Wekesa L, Kibet PK. Training needs for mainstreaming integrated natural resources in agricultural research and development in institutions in the greater Makueni District, Kenya. 12th KARI Scientific Conference Proceedings. 2010; 1330-1335.
17. Government of Kenya (GOK). Ministry of water and irrigation, Water Resources Management Authority, National Water Management Plan (NWMP, 2030).

Government Printer, Nairobi, Kenya. 2012; 8-1:8-14.

18. Tesfaye A, Negatu W, Brouwer R, van der Zaag P. Understanding soil conservation decision of farmers in the gedeb watershed, Ethiopia. Land Degradation and Development. 2014;25(1):71-79. DOI: 10.1002/ldr.2187
19. Ifejika SC, Kiteme B, Wisemann U. Droughts and famine, the underlying factors and causal links among agro-pastoral households in semi-arid Makueni District, Kenya. Global Environment Change. 2007;2-5.
20. Government of Kenya (GOK). Makueni first county integrated development plan 2013-2017. Government Printer; Nairobi, Kenya. 2013;2-36.
21. Emongor RA, Esilaba AO, Manyasi WJ, Nyamwaro SO, Maina IN, Miruka KM, Wekesa L, Kibet PK. Appraisal of information communication needs for mainstreaming natural resource management into organizations in the greater Makueni County, Kenya. 12th KARI Scientific Conference Proceedings. 2010; 1252-1257.
22. Tiffen M. Transition in sub-saharan Africa: Agriculture, urbanisation and income growth. World Development. 2003;31(8): 1343-1366.
23. Preserve Africa Initiative (PAFRI). Baseline survey preserve: An assessment of the ecosystems, socio-economic status and identification of local institutions dealing with natural resources management and governance within the Kaiti Watershed. Nairobi, Kenya: Preserve Africa Initiative (PAFRI); 2013.
24. Singh YK. Fundamental of research methodology and statistics. New Delhi: New Age International Publishers. 2006; 101-103.
25. Hussein A. The use of triangulation in social sciences research: Can qualitative and quantitative methods be combined? Journal of Comparative Social Work; 2009.
26. Maitima J, Reid RS, Gachimbi LN, Majule A, Lyaruu H, Pomery D, Mugatha S, Mathai S, Mugisha S. A methodological guide on how to identify trends and linkages in land use, biodiversity and land degradation. LUCID. Working Paper Series Number: 2004;43:1-6.
27. Department for International Development (DFID), Sustainable Livelihood Guidance sheets, Section 2. 1999;1-26.
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