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Threats and Conservation Incentives for Sustainable Management of South West Mau Forest, Kenya

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Authors' contributions

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

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ABSTRACT

South West Mau Forests (SWMF) is an important resource to Kenya and beyond. Despite its importance, there is an imminent anthropogenic threat to its conservation which has altered its current importance. There is a need for urgent implementation of sound and feasible forest conservation strategies with a clear understanding of incentives for sustainable forest conservation. This study was therefore carried out to identify threats to SWMF conservation and to determine incentives for its sustainable management. Purposive and systematically sampling techniques were used to identify study sites. Three transects were laid parallel to forest edge from which nine sites were selected. Households were identified using simple random sampling and a total of 225 questionnaires administered. Kruskal Wallis Test as provided in SPSS Version 12 package was used to test significant differences among forest threats. Chi-square (X^2) test was used to test for overall significant difference between incentives. Significant test levels were expressed at $P < 0.05$.

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Kruskal Wallis Test demonstrated that there was a significant difference ($P < 0.001$) between transects at different distances from the forest edge on threats to forest conservation. A pairwise analysis using the Man Whitney U Test further demonstrated that there were more significant ($P < 0.05$) threats to forests at transects 0-2 Km than at over 5 Km from the edge of the forest with respect to encroachment, logging, charcoal production, grazing, poaching, and poor agricultural practices. Encroachment (52%), logging (49%), poaching of forest products (40%), grazing (35%) and cultivation (27%) posed threats to the conservation of the forest. The main incentives from the forest were firewood (53%), rain (47%), grazing (46%), vegetables (22%), building materials (17%), honey (14%), and medicine (11%). The local community needs to be involved in sharing of benefits accruing from forest conservation so as to help in sustainable forest conservation.

Keywords: Forest; threats; incentives; conservation.

1. INTRODUCTION

Globally, forests play a crucial role in the lives of communities and nations. Apart from being reservoirs of other forms of biodiversity, forests are important as water catchment, soil erosion barriers, the source of timber and non-timber materials, including honey, grazing lands and vegetables [1,2,3,4]. However, about 46-58 thousand square miles of forests are lost each year as a result of illegal logging, encroachment, anthropogenic and non-anthropogenic factors including intentional and natural forest fires, encroachment, illegal logging among other reasons especially in developing nations [4].

In developing countries including Africa, the forest provides important service in the new and growing leisure industry, which involves the 'non' consumptive use of biological diversity for example ecotourism. Forest also provides very important ecosystem services that are generally considered to be 'free'. Such essential services include nutrient cycling, soil formation, oxygen production, carbon sequestration and climate regulation. Forest biodiversity also has a 'hidden' value locked up in the genetic stock whose potential value is not yet known [5]. However, millions of hectares forests in Africa are being cleared particularly for agricultural, settlement and logging purposes [6]. The consequence of this forest degradation is enormous. Many nations in Africa, for example, are facing an unprecedented water crisis, about 25% of Africa's population is living in water-stressed area and this figure will rise dramatically to an estimated 500 million people by 2050 [7].

In Kenya, natural and plantation forests occupy about 3.47 million hectares amounting to 6% according to the United Nation Food and Agriculture Organization, [4]. As noted by [7], it is estimated that about 3 million forest adjacent communities in Kenya depend on the forest for the provision of all households' wood and non-wood products needs. Forest resources and forestry development activities also contribute significantly to the national economy by supplying raw materials for industrial use and creating substantial employment opportunities and livelihoods [7]. However, the increasing population and poverty continue to exert pressure on the country's forest resources. This pressure is witnessed in the current rampant illegal logging, illegal charcoal extraction and encroachment of forests for agriculture and settlement. These challenges according to [5] have undermined the Government's efforts in achieving sustainable forest management.

In Kenya the water stress areas are large as a result of land degradation and deforestation in its major water towers including Mau forest complex whose effects is felt far beyond the borders [5]. In addition, forest degradation and deforestation are creating adverse effects on the biodiversity over a range of connected ecosystems due to loss of habitats and disruption of the food chain. This may affect the Kenyan economy negatively in terms of tourism attraction that is a major foreign exchange earner in the country [8]. To deal with these effects of forest degradation, conservation must be encouraged through a clear strategy. In dealing with this problem, the government of Kenya has enacted a number of policies including Forest Act 2005, charcoal Act 2009, and Forest Policy 2005 that control illegal activities in forests while encouraging participatory forest management.

Despite the evident importance of Mau forests to Kenya and beyond, there is imminent anthropogenic threat to its conservation. The forest degradation by people living around and far has altered the current importance of the forest and as a result, there is an urgent need to

implement sound and feasible forest conservation strategies [7]. To achieve this demands a clear understanding of incentives that can motivate stakeholders to engage in sustainable forest conservation and the possible conservation measures is inevitable. Failure to do this may result in conservation investments that may perform dismally since no or little consideration is taken on motivating engagement in conservation.

This study was designed to identify incentives for sustainable management of the South West Mau Forest so as to inform designing of conservation strategies since the continued degradation of the Mau Forest Complex has resulted in drastic changes downstream leading to floods, drying rivers, reduced underground aquifers, poor water quality, siltation and loss of habitat for wildlife [9]. Multi-million government projects including Sondu Miriu Hydro Electric project were only achieving 50% of their capacity due to the reduced amount of water in rivers [10]. Specifically, findings from the study identified strategies for sustainable management of the forest.

2. MATERIALS AND METHODS

2.1 Study Area

The study was done in South West Mau which is part of the Mau Forest complex (MFC) in Rift valley, Kenya. It lies within central coordinates of 35° 38.88 E and 0° 33. 00 S and an altitude of 1800 – 3000 m above sea level.

South-West Mau Forest Complex (Fig. 1) was gazetted as a forest reserve in 1932, vide legal Notice No. 44. The forest occupied an area of 83,395.5 hectares and is the largest portion of the Mau Forest Complex (171, 251.5 hectares). This area has since been reduced to only 111,517.77 hectares after several excisions [11] and is a home to about 515 households living around the forest [12,13].

The topography of the area is mainly rolling terrain with some steep portions. Soils are mainly of fertile soils of volcanic origin, well drained shallow to moderately deep dark reddish brown, friable, gravelly, clay loam to clay with acid humic topsoil. The temperature of the area ranges from 16°C to a maximum of 20°C with average rainfall varying between 1400 mm and 2000 mm per annum. The area lies within Agro ecological zone LH_3 which is wheat/maize (barley) zone and supports a wide range of social economic activities such as production of wheat, maize, poultry in addition to providing medicinal plants and grazing for livestock [14].

2.2 Data Collection and Sampling Methods

The study was based on Mt. Brackett, Chebewor and Kedowa study sites. Mt. Brackett (*Tulwab Kipsigis*) study site is a dome shaped mountain situated in Kedowa location and it was purposely selected for the study due to its cultural benefits in the area. Chebewor and Kedowa were selected due to their importance for commercial and farming activities. Three transects were laid at 0-2 Km, 2-5 Km and over 5 Km and parallel to the edge of forest. Three study sites were selected from each transect giving a total of nine (9) study sites that were used in the study (Fig. 2).

Chebewor and Kedowa study sites were about 2 Km and 4 Km, respectively to the west of Mt Brackett. Mt Brackett is a sacred hill, and to a large extent was covered by forests, whereas Chebewor was a newly settled area and Kedowa was commercial area with quarrying activities.

Transects were laid at 0-2 Km, 2-5 Km and beyond 5 Km as shown in Fig. 2.

The sample size was calculated based on Israel [15] equation (equation 1) at 0.5 margin error

$$\boldsymbol{n} = \left[\frac{N}{1+Ne^2}\right] \quad (1)$$

Where n = Sample size
e = margin error = 0.05 corresponding to 95% confidence level
N= total population size = 515 households

Therefore: $\boldsymbol{n} = \left[\frac{\mathbf{515}}{\mathbf{1+515\times 0.05^2}}\right]$ = 225.13661202 = 225 households.

Simple random sampling technique was used to select the households for the study.

Questionnaires were therefore administered to seventy five (75) respondents per transect.

2.3 Data Analysis

Kruskall Wallis test, a pair wise analysis using the Man Whitney U Test and Chi-square (X^2) test were used to test for overall significance levels using SPSS Version 12 package.

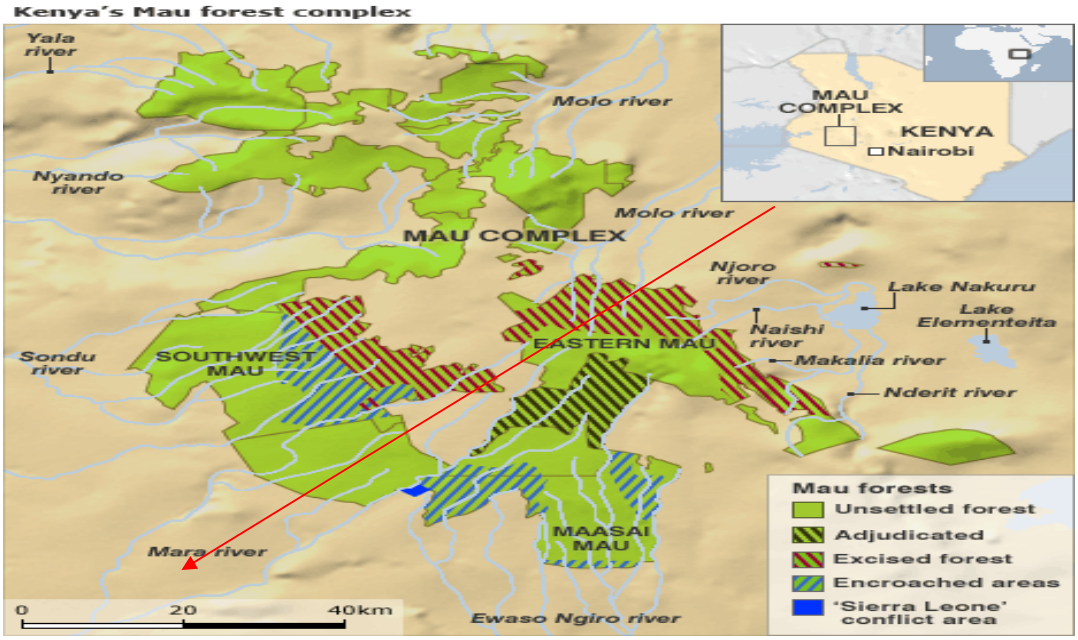

Fig. 1. Map of South West Mau complex [9]

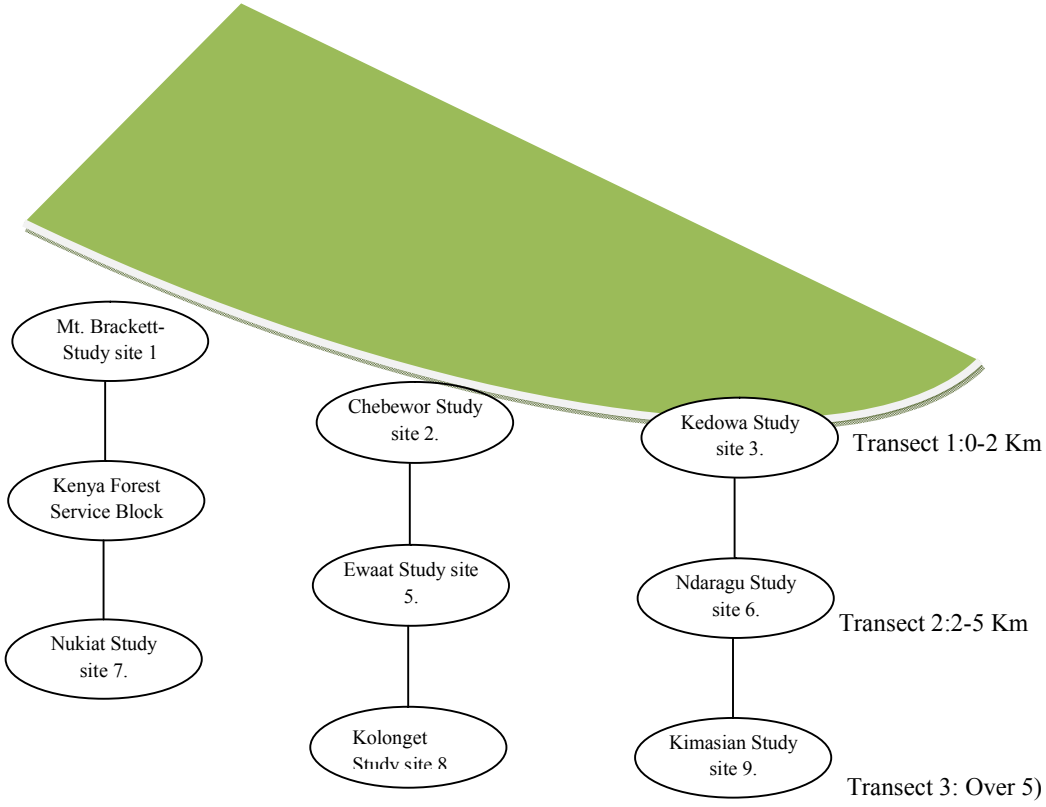

Fig. 2. Layout of the transect (0-2 Km, 2-5 Km and over 5 Km away from the edge of the forest in South West Mau Forest complex, in the northward direction

Kruskal Wallis Test was used to test for the overall significant difference between the study sites on the intensity of forest threats. Chi-square (X^2) test was used to test for overall significant difference between incentives obtained from the forest conservation in the Transects.

A pair wise analysis using the Man Whitney U Test was used to separate individual significant difference between incentives obtained from the forest in the study sites. Significant test levels were expressed at $P < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Threats to Forest in South West Mau Forest Complex at Different Distances (0 – 2 km, 2 -5 km and >5 km) from the Forest Edge

Threats were identified as encroachment, logging, charcoal production, grazing, arsonist, cultivation, insecurity, poaching, fire, inadequate management, poor agricultural practices, and quarrying (Table 1).

The results of the study were also subjected Kruskal Wallis Test to test the overall significant differences between the threats at different distances from the forest edge. The test demonstrated that there was significant difference ($P < 0.001$) between Transects at different distances away from the forest edge and threats to forest conservation.

A pair wise analysis using the Man Whitney U Test further demonstrated that there were more significant ($P < 0.05$). Threats to forests at transect 0-2 Km were more than at beyond 5 Km from the edge of the forest with respect to encroachment, logging, charcoal production, grazing, poaching, and poor agricultural practices. At 2-5 Km and beyond 5 Km there were no significant differences ($P < 0.05$) in threats. The test demonstrated that there was a significant ($P < 0.05$) threat only in grazing, and charcoal extraction at 2-5 Km than beyond 5 Km transect. Arsony, cultivation, insecurity, fires, and inadequate management were not significantly different ($P > 0.05$) at different distance levels (Table 2).

Results indicated that arsony (16%), cultivation (27%), insecurity (20%), fires (28%), and inadequate management (24%) were not related to distance because they were being carried out by individuals living both within and without the forest. The ranking of fire was the same across distances because it can be caused by anyone regardless of distance from the forest, in case of fire breakout from the forest, everyone is required to take part in putting it out, and its effects have been seen and felt by many people regardless of distances from the forest. Effects to forest conservation by arsonists, insecurity and inadequate management, were rare and a large percentage (<50%) of people regardless of the distance from the forest edge disagreed that they were a threat to forest conservation.

Table 1. Summary of threats to South West Mau Forest complex at different transects 0-2 Km, 2-5 Km and beyond 5 Km from the forest edge

Threat	Percentage (%) response												Mean Total %	RANK
	0-2 Km				2-5 Km				5-10 Km					
	B_1	C_1	K_1	Mean	B_2	C_2	K_2	Mean	B_3	C_3	K_3	Mean		
Encroachment	56	48	36	**47**	48	40	44	**44**	72	64	60	**65**	**52**	**1**
Logging	64	52	48	**55**	40	36	36	**37**	52	40	36	**47**	**49**	**2**
Charcoal production	28	56	48	**44**	16	36	32	**28**	12	8	20	**13**	**28**	**5**
Grazing	44	60	64	**56**	24	36	36	**32**	12	16	24	**17**	**35**	**4**
Arsonists	20	32	24	**25**	8	12	16	**12**	0	20	20	**13**	**16**	**11**
Cultivation	44	36	40	**48**	16	32	36	**28**	8	12	20	**13**	**27**	**7**
Insecurity	24	24	24	**24**	8	22	36	**22**	4	12	22	**13**	**20**	**10**
Poaching of forest products	60	44	56	**53**	36	32	36	**35**	24	36	32	**31**	**40**	**3**
Fire	44	40	48	**44**	24	20	12	**19**	16	24	22	**21**	**28**	**5**
No management plan	20	11	32	**21**	16	8	24	**16**	36	36	36	**36**	**24**	**9**
Poor Agro forestry in neighbouring farms	22	28	32	**27**	24	32	28	**25**	16	28	32	**25**	**27**	**7**

Note: B1, B2, B3 - Mt Brackett study sites in transects 1, 2 and 3; C1, C2, C3 – Chebewor study sites in transects 3, 4 and 5, and K1, K2, K3- Kedowa study sites in transects 6, 7 and 8, respectively

Encroachment, logging), charcoal production, grazing, excision, poaching, and poor agricultural practices were more intensive at 0-2 Km than beyond 5 Km from the forest edge.

The results of the study indicated saw millers from outside the locality obtain licences from government agency to permit them to do logging within the forest. The respondents observed that it was very discouraging for them to see outsiders extract resources which they have been engaged in conserving. In addition, it was stated that most people living very close to the forest and engaging in activities like encroachment, illegal logging were mostly people residing beyond 5 Km away from the forest, who were looking for timber, agricultural and settlement lands. However, charcoal extraction was carried out by those living close to the forest.

The results showed that anthropogenic activities mainly: encroachment, logging, grazing, cultivation and poaching posed threats to the conservation of South West Mau forest complex especially at 0-2 km transect, despite its importance to humanity and other biotic lives. These threats were mostly posed by individuals who were not indigenous. [7] and [16] noted that the forest threats majorly originate from the non-indigineous communities residing in and around the forest. This was because while the indigenous communities have local based sustainable management strategies, non-indigenous communities are always driven by greed to destroy the forest for personal gains. This fact was well demonstrated by little forest cover in Chebewor and Kedowa study sites, where the communites living there migrated from elsewhere compared to Mt Brackett study site. In Kedowa study site extraction of forest resources was mainly contributed by commercial and quarrying activities at Kedowa shopping centre. [17] found that surface mining operations leads to clearance of large tracts of forest lands, causing serious forest degradation.

Table 2 (a). Test Statistics for threats' intensities pair wise analysis

Encroachment and squatting	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	355.500	151.000	182.500
Wilcoxon W	851.500	404.000	435.500
Z	-1.267	-3.310	-2.983
Asymp. Sig. (2-tailed)	.205	.001	.003
Exact Sig. (2-tailed)	.211	.001	.003
Logging	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5)Km**
Mann-Whitney U	326.000	185.000	141.000
Wilcoxon W	732.000	438.000	394.000
Z	-1.757	-2.682	-3.844
Asymp. Sig. (2-tailed)	.079	.007	.000
Exact Sig. (2-tailed)	.078	.007	.000
Charcoal Production	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	413.000	186.000	230.000
Wilcoxon W	909.000	439.000	483.000
Z	-.332	-2.524	-2.123
Asymp. Sig. (2-tailed)	.740	.012	.034
Exact Sig. (2-tailed)	.747	.011	.033
Grazing	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	367.500	185.500	245.500
Wilcoxon W	863.500	438.500	498.500
Z	-1.093	-2.560	-1.886
Asymp. Sig. (2-tailed)	.275	.010	.059
Exact Sig. (2-tailed)	.278	.010	.058
Arsonist	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	377.500	232.000	285.500
Wilcoxon W	873.500	485.000	538.500
Z	-.894	-1.590	-1.077
Asymp. Sig. (2-tailed)	.371	.112	.282
Exact Sig. (2-tailed)	.373	.116	.288

Table 2 (b). Test statistics for threats' intensities pair wise analysis

Cultivation	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	400.500	246.500	293.000
Wilcoxon W	896.500	499.500	546.000
Z	-.567	-1.270	-.930
Asymp. Sig. (2-tailed)	.571	.204	.352
Exact Sig. (2-tailed)	.585	.211	.361
Insecurity	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	399.500	162.500	203.500
Wilcoxon W	895.500	415.500	456.500
Z	-.553	-3.123	-2.736
Asymp. Sig. (2-tailed)	.580	.062	.056
Exact Sig. (2-tailed)	.591	.071	.056
Excision	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	381.000	159.500	189.500
Wilcoxon W	877.000	412.500	442.500
Z	-.909	-3.119	-3.195
Asymp. Sig. (2-tailed)	.363	.002	.001
Exact Sig. (2-tailed)	.378	.001	.001
Poaching of forest products	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	406.500	200.500	273.000
Wilcoxon W	902.500	453.500	526.000
Z	-.468	-2.416	-1.516
Asymp. Sig. (2-tailed)	.640	.016	.130
Exact Sig. (2-tailed)	.643	.016	.138
Fires	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	365.000	183.500	207.500
Wilcoxon W	771.000	436.500	467.500
Z	-1.090	-2.774	-2.766
Asymp. Sig. (2-tailed)	.276	.006	.086
Exact Sig. (2-tailed)	.274	.006	.086
No management plan	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	321.500	217.000	381.000
Wilcoxon W	727.500	470.000	877.000
Z	-1.807	-1.869	-.909
Asymp. Sig. (2-tailed)	.071	.062	.363
Exact Sig. (2-tailed)	.072	.063	.378

At 2-5 km the major threats to forest conservation were as a result of encroachment, grazing, and cultivation resulting from land clearance for agricultural purposes and illegal settlements. These results concurred with [6], [11] and [18] that the major cause of forest destruction in developing countries attributes to high rates of population increase, and inadequate land for agricultural purposes; thus forcing people to clear forests for additional land. This was clearly indicated in Chebewor study site, where the main economic activity was farming producing maize, millet and sorghum.

At over 5 Km from the forest edge, grazing, cultivation, charcoal production, arsonists, and insecurity posed least threats to forest conservation. This was mainly because the locals at this distance especially at Nukiat study site were rarely participating in grazing in forest lands due to distance. Majority were practising zero grazing and engaged in intensive farming with mechanized operations. These results agreed with other studies which indicated that adopting zero grazing can be used in dealing with the increasing forest degradation [19].

Households closest to the forest derive the most benefits from the forest compared to households further away from the forest. The findings are in line with previous studies such as [20,21], who found that forest-adjacent communities within the 5 Km buffer zone depend on the forest for their livelihoods. However, threats like arsonist, insecurity, fires, and inadequate management neither decrease nor increase with the distance from the forest edge as was also noted by [22].

3.2 Incentives Obtained in South West Mau Forest Complex at 0-2 Km from the Forest Edge

The study found that the community living within South West Mau conserve the forest because of various products and services they derive from it. Notable of which were; rain water, firewood, timber, charcoal, medicine, grazing grounds, vegetables, fruits, bush meat and thatching grass (Table 3).

Chi square of association showed that the incentives derived from the forest products are significantly different ($P < 0.001$) from one transect to another Man Whitney U Test further indicated that there was significant difference ($P < 0.05$) on incentives derived by local people from firewood and vegetables only. People within 0-2 Km from the edge of the forest derive firewood and vegetable more than those who are 2-5 Km away from the forest. However, the test did not as show any significant difference ($P > 0.05$) within the 2 transects for incentives that included timber, medicine, building materials, grazing, honey, rain, fruits, thatching grass and bush meat. Comparing transects 0-2 Km and over 5 Km from the edge of the forest Man Whitney U Test indicated that there was significant difference ($P < 0.05$) on incentives derived by local people from firewood, medicine and vegetables only. People near (within 0-2 Km) the edge of the forest derives firewood, medicine and vegetable more than those who are 2-5 Km away from the forest. However, the Test did not show as any significant difference ($P > 0.05$) within the 2 transects for other incentives that included timber, building materials, grazing, honey, rain, fruits, thatching grass and bush meat. At transects 2-5 Km and over 5 Km from the edge of the forest Man Whitney U Test indicated that there was no significant difference ($P > 0.05$) on any incentives derived by local people (Table 4).

The study clearly identified an array of reasons for conserving the forest by the local people and especially within a distance of 2 Km from the edge of the forest. These reasons included timber, medicine, building materials, grazing, honey, rain, fruits, thatching grass and bush meat. The observation can be attributed to the fact that respondents near forests have the opportunity of depending on the forest more frequently because of short distances. As a result, they never get tired to obtain such products on a daily basis. However, this did not mean that respondents beyond 2 Km from the forest does not obtain these products, especially firewood. The study demonstrated similar findings with [4] which indicated that firewood is the heavily demanded forest product in developing nations. In Kenya, this is attributed to the fact that over 70% of household primary energy country wide and 90% of the same in rural households is derived from firewood [23].

Table 3. Summary of incentives obtained from South West Mau Forest complex at different transects 0-2 Km, 2-5 Km and over 5 Km from the forest edge

Threat	Percentage (%)												Mean Total %	Rank
	0-2 Km				2-5 Km				5-10 Km					
	B_1	C_1	K_1	Mean	B_2	C_2	K_2	Mean	B_3	C_3	K_3	Mean		
Firewood	80	60	44	**61**	80	96	52	**76**	0	12	56	**23**	**53**	**1**
Timber	12	0	16	**9**	0	0	32	**10**	0	0	0	**0**	**6**	**9**
Charcoal	0	12	0	**4**	0	0	4	**1**	0	0	24	**8**	**4**	**10**
Medicine	0	0	16	**16**	0	16	8	**8**	8	13	8	**9**	**11**	**7**
Building materials	24	0	12	**12**	0	12	8	**7**	0	4	16	**7**	**17**	**5**
Grazing	68	48	72	**63**	64	72	64	**67**	0	24	0	**8**	**46**	**3**
Honey	12	8	0	**7**	0	0	0	**0**	72	12	12	**34**	**14**	**6**
Rain water	76	84	44	**68**	64	44	36	**48**	0	32	36	**24**	**47**	**2**
Vegetables	56	16	20	**31**	72	20	8	**31**	0	0	8	**3**	**22**	**4**
Fruits	0	0	48	**5**	0	48	16	**21**	0	0	24	**8**	**11**	**8**
Thatching grass	0	8	0	**3**	0	0	0	**0**	0	0	0	**0**	**1**	**11**
Bush meat	0	0	0	**0**	0	0	4	**4**	0	0	0	**0**	**1**	**11**

Note: B1, B2, B3 - Mt Brackett study sites in transects 1, 2 and 3; C1, C2, C3 - Chebewor study sites in transects 3, 4 and 5, and K1, K2, K3 - Kedowa study sites in transects 6, 7 and 8, respectively

Table 4. Pair-wise analysis on forest incentives

Firewood	**(0-2)Km and (2-5)Km**	**(0-2) Km and (5-10) Km**	**(2-5) Km and >5 Km**
Mann-Whitney U	223.000	138.500	141.500
Wilcoxon W	476.000	544.500	637.500
Exact Sig. (2-tailed)	.025	.000	.000
Timber	**(0-2)Km and (2-5)Km**	**(0-2)Km and (5-10)Km**	**(2-5)Km and >5Km**
Mann-Whitney U	410.500	208.000	425.000
Wilcoxon W	816.500	461.000	921.000
Exact Sig. (2-tailed)	.711	.037	.904
Charcoal	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	376.500	281.000	324.500
Wilcoxon W	782.500	687.000	577.500
Exact Sig. (2-tailed)	.326	.551	.756
Medicine	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	407.500	132.500	321.500
Wilcoxon W	813.500	538.500	817.500
Exact Sig. (2-tailed)	.670	.000	.716
Building	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	412.500	292.000	338.500
Asymp. Sig. (2-tailed)	.719	.731	.961
Exact Sig. (2-tailed)	.750	.735	.957
Grazing	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	341.000	284.000	402.000
Wilcoxon W	747.000	690.000	808.000
Exact Sig. (2-tailed)	.052	.646	.614
Honey	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	340.000	297.000	296.500
Wilcoxon W	746.000	703.000	549.500
Exact Sig. (2-tailed)	.131	.826	.408
Water	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	413.500	285.000	331.000
Asymp. Sig. (2-tailed)	.695	.575	.827
Exact Sig. (2-tailed)	.717	.578	.913
Vegetables	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	178.000	158.000	192.500
Wilcoxon W	674.000	564.000	688.500
Exact Sig. (2-tailed)	.001	.002	.004
Fruits	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	419.500	163.500	593.500
Wilcoxon W	915.500	569.500	689.500
Exact Sig. (2-tailed)	.827	.220	.064
Bush meat	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	429.500	227.500	260.500
Wilcoxon W	835.500	633.500	756.500
Exact Sig. (2-tailed)	.946	.428	.087
Thatching grass	**(0-2)Km and (2-5)Km**	**(0-2)Km and >5Km**	**(2-5)Km and >5Km**
Mann-Whitney U	361.500	301.000	269.500
Wilcoxon W	767.500	554.000	522.500
Exact Sig. (2-tailed)	.207	.885	.147

The lack of significant differences in grazing at different distances from the forest is as a result of the fact that most respondents takes livestock to the forest for grazing on a daily basis. This takes place regardless of the distance they live from the forest provided that monthly fees have been paid. On the other hand, there were no variations in the frequencies of obtaining timber, charcoal, building materials, thatching materials, and bush meat because of government rules and

regulations prohibiting people from obtaining such benefits from the forest regardless of the distances they live from the forest. The results therefore concurred with [24] who reports that communities within and far away from forest vicinity are also restricted from obtaining some products like charcoal and timber from gazetted forests frequently. In addition, some of the products like building materials and thatching grass are neither required on a daily, weekly nor monthly basis irrespective of the distance from the forest. This concurred with a study of [21] who have reported that some forest products and services serve not only the community living in the vicinity of forests, but also a larger community.

Communities neighbouring forests have been the main complainants, especially in regard to direct values, such as extraction of timber. Kenya Forest Act 2005 outlines sharing of benefits accruing from forest conservation but it is still a contentious issue in the area. Local communities have so far not benefited adequately from the timber industry, as most benefits go either to National Government or County. According to studies by [25], it was noted that there has been no clear concept on benefit sharing in PFM in Kenya. The already existing PFM plans on benefit sharing are rather weak. There have been conflicting views on where PFM should be applied on state forest plantations or indigenous forests or both. In the case of state plantations, KFS will have to deal with benefit sharing either in form of community management of plantations or by introducing "social contracts" in concessions and timber licensing. Another challenge has been on utilizing financial proceeds from the forest (especially from logging) with a view that proceed from the forest would be reinvested in the development of the area and a need for corporate social responsibility function of the government. Payment of farmers for carbon sequestration, through carbon credits or conservation efforts through payment of levies by those who benefit from services, would allow efficient and sustainable utilization of forest resources [25].

According to the studies of [25] and [26] it found that the CFAs need to be supported by the Government and natural resource management agencies and donors who support PFM. They need to be trained in conflict resolution, leadership and management skills, and financial management. Further, they will have to be sensitized and educated on environmental issues in order to change their attitude towards the forest from being a primary source of products and services to that of a resource that is necessary for survival. Communities need to be sensitized on other sources of livelihood to diversify their income bases and to participate in the wider economy of the country and allow efficient and sustainable utilization of forest resources.

4. CONCLUSIONS AND RECOMMENDA-TIONS

Activities of households adjacent to forests undermine South West Mau forest conservation objectives. Households' activities identified that threaten the forest conservation include: encroachment, logging, charcoal production, grazing, arsonist, cultivation, insecurity, poaching, fire, inadequate management, poor agricultural practices, and quarrying.

Though the Forest Act 2005 introduced empowerment of community in forest management and more equitable sharing of benefits, local communities have so far not benefited adequately from timber industry as most benefits go either to National Government or County Government.

It is therefore recommended that:

Government agencies such as the Kenya Forest Service (KFS), Kenya Wildlife, Ministry of Agriculture (MoA) and the Kenya Forest Research Institute through the support from the government and other development partners need to sensitize and educate households living adjacent to forests on forest conservation activities. This should be especially through Community Forest Associations (CFAs) as provided for in the Kenya Forest Act 2005, to effectively manage forests; a resource that is necessary for their survival. Further they need to be informed on other sources of livelihood to diversify their income base and to participate in the wider economy of the country and allow efficient and sustainable utilization of forest resources.

Kenya Forest Service should encourage the forest adjacent communities to form CFAs as spelt out on the Forest Act 2005 to assist in bargains on sharing benefits accruing from forest conservation. In addition the government through the KFS should develop mechanisms through which the proceeds from the forests can be

ploughed back to the local community. Such mechanisms may include Social Corporate Service (SCS), payments for environmental services etc. These will improve their livelihoods and thus contribute to sustainable forest conservation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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