academicJournals

Vol. 10(4), pp. 172-184, April 2018
DOI: 10.5897/IJBC2017.1161
Article Number: 9220D6856286
ISSN 2141-243X

http://www.academicjournals.org/IJBC

International Journal of Biodiversity and Conservation

Full Length Research Paper

Effect of forest management approach on household economy and community participation in conservation: A case of Aberdare Forest Ecosystem, Kenya

Elizabeth W. Wambugu[1*], Gilbert O. Obwoyere[2] and Bernard K. Kirui[2]

[1]Kenya Forest Service, P. O. Box 30513 – 00100 Nairobi, Kenya.
[2]Department of Natural Resources, Faculty of Environment and Resources Development, Egerton University, P. O. Box 536, 20115 Egerton, Kenya.

Received 24 October, 2017; Accepted 25 January, 2018

Forest ecosystems are important for ecological and socio-economic wellbeing, particularly for diversification of the livelihoods of adjacent communities. The forest management approach applied in an ecosystem influences availability, access and utilisation of forest products, and community participation in conservation. This study examined the effect of forest management approach on households' economy and participation in forest management. A random sample of 202 households adjacent to Aberdare forest ecosystem was selected for characterisation and interviews using semi-structured questionnaires. Data collected were analysed using Chi-square test, Spearman's rho correlation and multinomial logistic regression. Although the benefits varied with management approach, the majority of the households indicated the forest was beneficial as only 6% reported no benefits. There was a significant association between forest management approach and households' sources of food ($\chi^2 = 27.704$, $p < 0.001$), socio-economic status ($\chi^2 = 20.194$, $p < 0.001$) importance of forest ($\chi^2 = 11.863$, $p < 0.001$), forest dependence ($\chi^2 = 53.580$, $p < 0.001$) and participation in forest management ($\chi^2 = 17.551$, $p < 0.001$) at $\alpha = 0.05$. The factors that significantly influenced the regression model included households' dependence on the forest, socio-economic status and participation in forest management where R^2 was 0.797. These findings depicted that when ecosystems made no substantial contributions to livelihoods, their value and the level of community participation in conservation was lower.

Key words: Conservation management approach, economic importance, forest dependence, household economy, participatory forest management, protection management approach.

INTRODUCTION

Forests are multi-functional ecosystems which provide diverse goods and services, including intrinsic, economic, cultural and aesthetic values essential for socio-economic well-being, particularly to the forest adjacent community (de Groot et al., 2016; Costa et al., 2017). Although forest contribute significantly towards the diversification of

livelihoods of communities adjacent to forest ecosystems, inadequate community involvement in the management and governance of the forest resources, has been identified as a major cause of the escalation of ecosystem destruction (Agrawal, 2009; Biedenweg, 2012; Mogoi et al., 2012; Tesfaye, 2017).

Failure to recognise and account for the multiple uses and users has led to patterns of global forest degradation and losses with many detrimental environmental consequences (Lise, 2000; Kipkoech et al., 2011; Langat et al., 2016). This calls for methods of managing forests in a way that preserves ecological integrity and human well-being while addressing the diverse demands (Mbairamadji, 2009; Tesfaye, 2017). This has given rise to development of forest management approaches (FMA) over the past decades based on the sustainable forest management (SFM) concept that recognises the need to balance the ecological, socio-cultural, and economic objectives in management (Costanza, 2014; Rita et al., 2017).

A study of forests and livelihoods in the context of sustainable management requires that we understand the links and interactions between the resource, users, and institutions that mediate between them (Ongugo et al., 2008; Fisher et al., 2011). Mogoi et al. (2012) and Engida and Mengistu (2013) observed that there were two opposite perspectives to the cause of deforestation. Firstly, increased demand for fuel wood, timber, land for agricultural expansion and settlements leads to deforestation. Proponents pinpoint growth in population and the resultant forest dependence and poverty as the main causes. Secondly, the drivers of deforestation lie in the failure of the forest bureaucracy to adequately involve forest adjacent communities and other stakeholders in the management and governance of the forest resources (Mogoi et al., 2012; Musyoki et al., 2013).

The second perception has been gaining popularity and 10 to 12% of the world's natural forests are officially being managed using some degree of community participation. In sub-Saharan Africa, at least 21 countries have embraced various participatory approaches to natural resources management (Langat et al., 2016; Tesfaye, 2017). In some of these cases, the devolution of forest management appear to facilitate improved forest conservation (Lund and Treue, 2008; Costa et al. 2017), though the picture seems uncertain with respect to livelihood impacts (Lund and Treue, 2008; Mogoi et al., 2012; Matiku et al., 2013; Langat et al., 2016). In tropical countries, the diversity of stakeholders depending on forests with different interests makes sustainable forest management difficult to achieve. The concept of SFM therefore lays emphasis on integration of the ecological, economical and sociological issues (Salleh, 1997; Mbairamadji, 2009; Tesfaye, 2017).

SFM advocates for stakeholder participation, particularly the adjacent communities, in forest management and decision-making (Salleh, 1997; Langat et al., 2016). This has been a tendency that has occupied significantly development thinking and practice in the recent years (Ellis and Ramankutty, 2008; Mbairamadji, 2009; Kenter et al., 2015). Governments, funding agencies, civil society and multi-lateral agencies seem to all agree that development can be sustainable only if people's participation is made central to the development process (Agrawal and Gupta, 2005; Tesfaye, 2017). Putting these considerations into account reduces conflicts among stakeholders with respect to access to and use of forest resources as well as guiding the allocation of forest space amongst stakeholders for different purposes (Lund and Treue, 2008).

Consequently, many countries in Africa and Asia are promoting the participation of rural communities in the management and utilisation of state-owned forests and woodlands through some form of Participatory forest management (PFM) (Lund and Treue, 2008; Bush et al., 2011; Engida and Mengistu, 2013). Incorporation of PFM in FMA is considered a dynamic system differing from the traditional approach of forest management in its systemic approach and its integration of ecological, economic and social constraints of forest management (Costanza et al., 2014; de Groot et al., 2016).

Kenya has different types of forests, ranging from the dry forests to the high montane forests, with each type necessitating a different management approach to provide a varied set of benefits to diverse stakeholders (Wass, 1995; KFS, 2010). This was the scenario exhibited in Aberdare forest ecosystem which consists of Aberdare Forest Reserve and Aberdare National Park which were managed through conservation and protection FMA respectively. It borders human inhabited farmlands with a growing population that exerts great pressure on the ecosystem due to the increased demand for forest goods and services. The ecosystem contributed to hydroelectric power generation, agriculture, horticulture and tourism industry that were key economic sectors in Kenya.

According to Bush et al. (2011) and Mogoi et al. (2012), institutional factors are important determinants of socio-economic values of forest ecosystems to local communities. Evidence from several studies carried out globally indicates that issues determining use of resources in protected forests are often related to FMA

*Corresponding author. E-mail: wambugu_ew@yahoo.com.

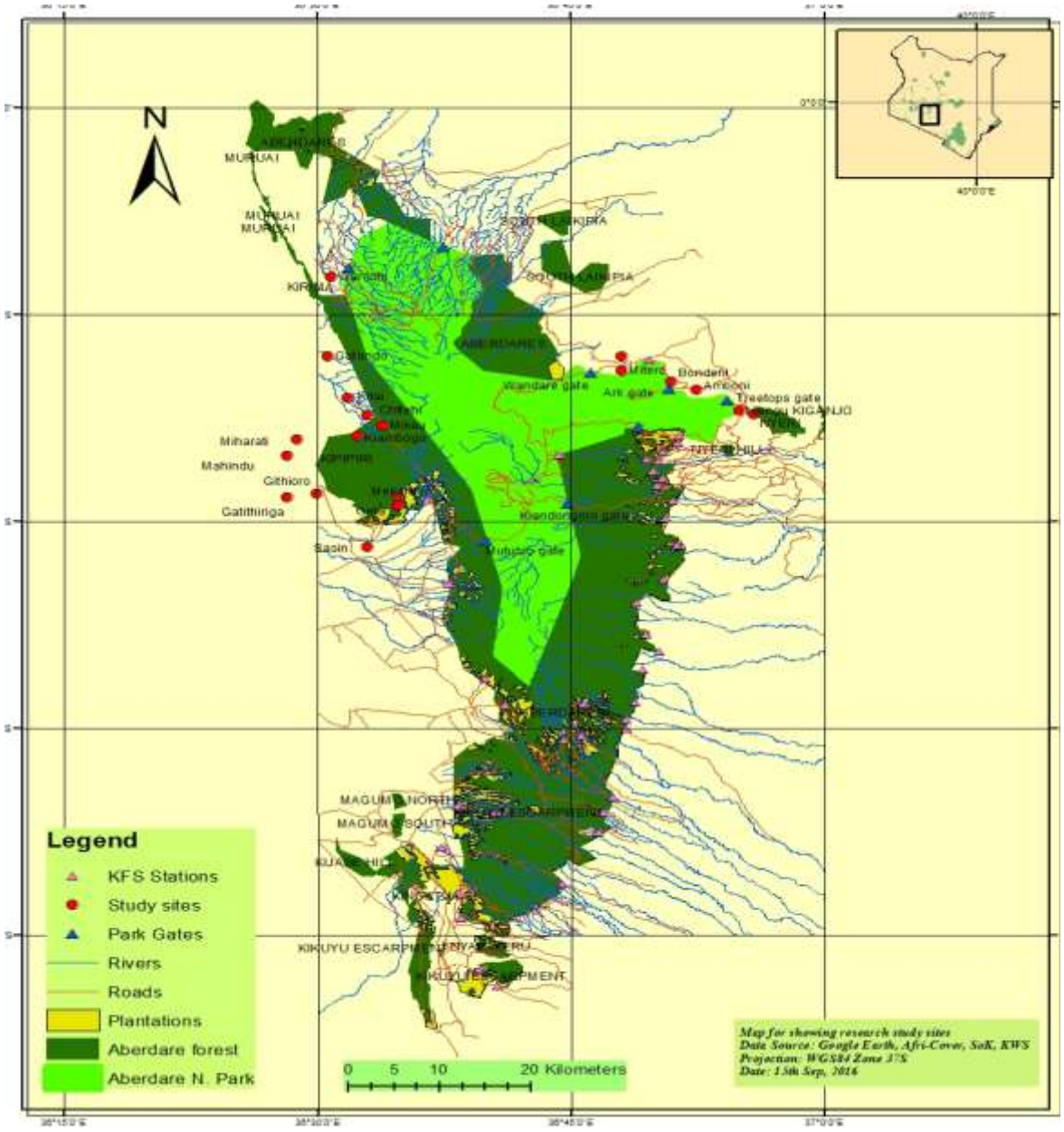

Figure 1. Map showing study sites within Aberdare Forest Ecosystem in Kenya.

and thus are area specific (Cavendish, 1999; Gaveau et al., 2009; Costa et al. 2017).

The study aimed at providing insights into the effect of forest ecosystems FMA on household economy of adjacent community and their involvement in PFM. Thus, the study examined the household dependence on to Aberdare forest ecosystem and their level of involvement in PFM based on FMA. The significance of the study was to recommend ways to promote community involvement in PFM to enhance conservation of forest ecosystems while addressing livelihood improvement.

METHODOLOGY

The study area

The study focused on Aberdare Forest which was a unique ecosystem as a Forest Reserve and a National Park extend and directly border with farmlands (Figure 1). The ecosystem was one of the five major water towers in Kenya. The forest ecosystem as used in this study comprised of Aberdare Forest Reserve, Aberdare National Park and an area of about 5 km of farmlands. It is located between longitude 36°30'E and 36°55'E and latitude 0°05'S and 0°45'S. The forest ecosystem was approximately 226,522 ha, whereby the Forest Reserve covers an area of 149,822 ha and the

Table 1. Community demographic profile.

Demographic factors	Units	N	Minimum	Maximum	Mean
Age of respondent	Years	202	21.00	101.0	54.0
Duration of settlement	Years	202	1.00	50.0	32.0
Household size	No.	202	1.00	30.0	6.7
Household members working in the farm	No.	202	1.00	14.0	2.8
Household members formally employed	No.	44	1.00	6.0	1.5
Distance to Forest Reserve	km	115	1.00	6.0	2.9
Distance to National Park	km	87	1.00	5.0	1.6

National Park covers 76,700 ha (KFS, 2010). Aberdare forest cuts across four local administrative counties, which were Nyandarua, Nyeri, Murang'a and Kiambu. The study was undertaken within the first two counties, based on the fact that Nyeri was the only county where the National Park shares a common boundary with farmlands and giving way to the Forest Reserve which was in Nyandarua County. Nyandarua was selected as it had site where PFM was piloted. Thus, this provided populations that were similar in many aspects, main difference being FMA based on the policies of the managing institutions. The Kenya Forest Service (KFS) managed the Forest Reserve using conservation FMA (allows sustainable extractive use) whereas Kenya Wildlife Service (KWS) managed the National Park using protection FMA (allows mainly non-extractive use). The forest adjacent community depended heavily on the ecosystem and they also played a significant role in conservation either as agents of destruction or catalysts of conservation (Ehrlich et al., 2012).

Data collection methods and analysis

A three level sampling procedure was employed. First, the forest adjacent area was stratified on the basis of being adjacent to Forest Reserve or National Park. Secondly, the area was stratified on the basis of sub-locations directly adjacent to the forest ecosystem. Thirdly, through systematic random sampling, the sample frame (households) was identified within the selected sub-locations. Household selection involved having a transect walk in the farmlands and selecting the eighth household alternately on either side of the route.

On the understanding that the forest adjacent populations in the area were similar in many aspects, the survey was undertaken within a distance of 5km radius. It drew a sample size of 202 households out of 27,070 where 87 were adjacent to the protection area and 115 were adjacent to the conservation area. The decision over the total number of respondents selected was influenced by availability of time, financial and physical resources. It was also guided by World Agroforestry Centre procedural guidelines (Nyariki et al., 2005; Ongugo, 2008) for characterisation of studies at household level. They suggest that a sample size of 40 to 80 households spread over two or three communities which have populations with similar characteristics and attitudes is adequate to make inferences about the larger population.

Socioeconomic data was collected using semi-structured and non-scheduled-structured questionnaires which were administered to the selected households. Some of the key issues raised included demographic variables (household size, age, gender, educational level, gender of household head, farm size), dependent variable (FMA) and independent variables such as sources of household food and income, perception on the economic importance of the forest ecosystem, utilisation of forest products and participation in forest conservation activities.

Based on the annual income levels, socio-economic statuses of households were categorised as very poor (USD 0 to 250), poor (USD 250 to 500), average (USD 500 to 750), rich (USD 750 to 1000) and very rich (USD >1000). To obtain the local communities' dependence on the forest resources, variables that showed household's sources of forest products and interaction with the forest ecosystem were redefined and weighted to obtain dependence levels that showed very low, low, moderate, high and very high. It was considered for example, that those who depend mostly on the forest for various products have a higher value than those who meet their forest products needs from elsewhere.

The quantitative data from the survey was sorted, coded and analysed using the Statistical Package from Social Sciences (SPSS) version 21 and Microsoft Excel 2013. Data were displayed using frequency distribution tables and graphs so as to establish various patterns that characterise the phenomena in the study area. Chi Square was used to test the association and Spearman's correlation was used to establish the relationships between FMA and household socio-economic attributes as well as PFM. Logistic regression was used to determine the influence of FMA on these attributes and level of community involvement in PFM.

RESULTS

Socio-economic characteristics

Out of the whole sample size of 202 respondents, 57% were adjacent to the Forest Reserve whereas 43% were adjacent to the National Park. Males comprised 61%, where 78% were male-headed and the mean household size was 7 members. The average distances were 2.9 km and 1.6 km to the Forest Reserve and to the National Park respectively. The distribution of other demographic factors was shown in Table 1. Results from this study portrayed that the socio-economic statuses of many (27%) households were in the very poor category. That notwithstanding, there were 32% within the very rich category (Table 2).

Sources of household food and income

Majority (85%) of the surveyed households depended on

Table 2. Household socio-economic status.

Social status	Frequency	Percentage
Very poor	54	26.5
Poor	35	17.3
Average	36	17.9
Rich	14	6.8
Very rich	64	31.5
Total	202	100.0

food production from own or rented plots while 14% benefited from cultivation of forest land under the plantation establishment for livelihood improvement scheme (PELIS). The results also showed that 45% of the households depended on sale of agricultural crops as the most important source of income followed by 31% who relied on livestock and livestock products (Table 3). The common livestock kept were mainly cattle, sheep and poultry with a few farmers rearing pigs. Since majority (61%) of the respondents had small land parcels, 23 and 16% depended on forest grazing for cattle and sheep respectively.

Sources of forest products and household utilisation

Survey results showed that the most important forest products derived from the ecosystem were water (98%), firewood (70%) and grazing (67%). Additionally, other products like charcoal, wild game and cedar posts which were not available in the farmlands were illegally extracted from the ecosystem as they were prohibited. However, survey results illustrate that many forest products were predominantly derived from farmlands (Figure 2).

FMA and sources of household food and socio-economic status

The main source of household food for the majority (85%) of the households in the area was from their own or rented private farms. However, 14% of those adjacent to the conservation area obtained household food from forest cultivation under the PELIS. There was a significant association between FMA and household source of food (Table 4). In that very poor category, more (23%) lived adjacent to the conservation area as only 4% were adjacent to protected area. Additionally, more households (17%) within the very rich category lived adjacent to the protected area compared to 14% who lived adjacent to the conservation area. There was a significant association between the management approach and household socio-economic status (Table 5).

FMA and community perception of the importance of the ecosystem

Survey results showed that majority (83%) of respondents adjacent to the forest under both FMAs regarded the forest ecosystem as important mainly for non-economic benefits. However, most (96%) of those who had high regard for economic benefits were mainly adjacent to the conservation area. The results also indicated that there was a strong and significant association between FMA and community perception on the importance of the forest (Table 6).

FMA and households' dependence on the forest and level of involvement in PFM

Results showed that the majority (94%) of the households derived benefits from the ecosystem as only 6% indicated low benefits. However, more (9%) of those living adjacent to the conservation area rated the benefits as very high compared to 2% of those living adjacent to protection area. Additionally, the survey findings portrayed that fewer (1%) respondents adjacent to the protection area were involved fully in PFM compared to 7% of those adjacent to the conservation area (Table 7).

Relationship between FMA and level of dependence on forest ecosystems and involvement in PFM

The relationship between FMA and community perception on the importance of the ecosystem, sources of household food, household socio-economic status, forest dependence and level of PFM involvement were found to be both strong and significant at $\alpha = 0.05$ as shown earlier. Further analysis revealed that on one hand, there was a negative and significant relationship between FMA and importance of the ecosystem ($r = -0.29$, $p < 0.001$), household source of food ($r = -0.32$, $p < 0.001$) and income ($r = -0.35$, $p < 0.001$). On the other hand, the relationship between FMA and community dependence on the forest ($r = 0.44$, $p < 0.001$) as well as level of involvement in PFM ($r = 0.19$, $p = 0.007$), was positive and significant as shown in Table 8.

Influence of FMA on households' economy and PFM involvement level

Results of the multinomial logistic regression analysis showed that FMA significantly influenced various factors such as forest dependence, level of PFM involvement,

Table 3. Sources of household food and income.

Variable	Frequency	Percentage
Sources of household food		
Forest PELIS plot	29	14.4
Own /rented private land	171	84.6
Purchase from market	2	1.0
Total	202	100.0
Sources of household income		
Agricultural crops	91.0	45.0
Livestock and livestock products	62	30.7
Both crops and livestock	41	20.3
Forest products/ecotourism	3	1.5
Casual labour	3	1.5
Salary/remittance/others	2	1.0
Total	202	100.0
Livestock grazing		
No. of households grazing cattle in forest	47	23.3
No. of households grazing sheep in forest	33	16.3

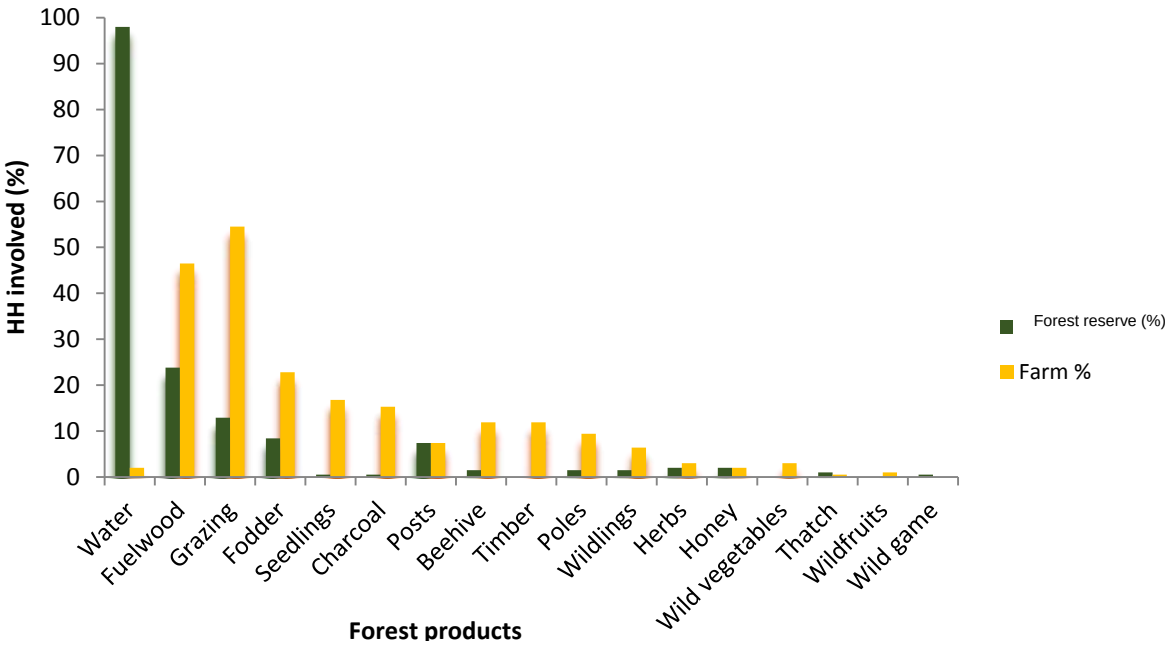

Figure 2. Distribution of household relative utilisation of diverse forest products derived from Aberdare forest ecosystem and farmland sources.

importance, household social status and source of food as shown in Table 9 below. The Cox and Snell pseudo R^2 was 0.797 showing that the regression model was a good fit for the data ($\alpha = 0.05$, $p < 0.05$) as it predicted about 80% of the variance. A significant and positive influence was found between FMA and household sources of food. Conversely, FMA significantly and inversely influenced forest dependence, level of PFM involvement, importance

Table 4. FMA and household sources of food.

Household sources of food	Frequency (f)	Forest management approach		Total
		Protection	Conservation	
Forest cultivation through PELIS	F	0	29	29
	Percentage	0.0	14.4	14.4
Own or rented private land	F	87	84	171
	Percentage	43.1	41.6	84.7
Purchased from Market	F	0	2	2
	Percentage	0.0	1.0	1.0
Total	F	87	115	202
	Percentage	43.1	56.9	100

$\chi^2 = 27.704$, df = 2, α = 0.05, $p < 0.001$, n = 202.

Table 5. FMA and household socio-economic status.

FMA	Frequency (f)	Household socio-economic status					Total
		Very poor	Poor	Average	Rich	Very rich	
Protected	F	6	6	12	4	28	56
	Percentage	3.7	3.7	7.4	2.5	17.3	34.6
Conservation	F	37	22	17	7	23	106
	Percentage	22.8	13.6	10.5	4.3	14.2	65.4
Total	F	43	28	29	11	51	162
	Percentage	26.5	17.3	17.9	6.8	31.5	100

$\chi^2 = 20.194$, df = 4, α = 0.05, $p < 0.001$, n = 162.

Table 6. FMA and community perception of the importance of the ecosystem.

FMA	Frequency (f)	Importance of forest ecosystem		Total
		Economic	Non-economic	
Protection	F	1	49	50
	Percentage	4.2	40.8	34.7
Conservation	F	23	71	94
	Percentage	95.8	59.2	65.3
Total	F	24	120	144
	Percentage	16.7	83.3	100

$\chi^2 = 11.863$, df = 1, α = 0.05, $p = 0.001$, n = 144.

of the ecosystem and household social status. The results further depict that household annual income and sources of income did not contribute significantly to the final model (Table 9). The regression model obtained was:

FMA = -32.092 + 17.551(source of food) –7.747(forest dependence) – 2.51 (PFM involvement level) – 4.528 (importance of ecosystem) – 2.159 (socio-economic

Table 7. FMA and households' forest dependence and level of involvement in PFM.

FMA	Frequency (f)	Forest dependence				Total
		V. High	High	Moderate	Low	
Protected	F	2	20	62	3	87
	Percentage (%)	2.3	23.0	71.3	3.4	100
Conservation	F	10	73	23	9	115
	Percentage (%)	8.7	63.5	20	7.8	100
Total	F	12	93	85	12	202
	Percentage (%)	5.9	46	42.1	5.9	100
		PFM involvement level				
		Low	Moderate	High	Fully involved	Total
Protected	F	56	29	0	2	87
	Percentage (%)	27.7	14.4	0.0	1.0	43.1
Conservation	F	59	30	12	14	115
	Percentage (%)	29.2	14.9	5.9	6.9	56.9
Total	F	115	59	12	16	202
	Percentage (%)	56.9	29.2	5.9	7.9	100

status)

DISCUSSION

FMA and household sources of food and socio-economic status

Forest-adjacent communities operate behind a background of limited economic opportunities. Farmers are faced with multiple problems which include scarcity of land, food, fodder, fuelwood, biomass and increased land degradation (Figure 2 and Table 3). As reported by Langat et al. (2016) and Tesfaye (2017), most of the rural population maintain diversified livelihood strategies because they cannot obtain sufficient income from any single strategy and secondly to distribute risks. The study observed that over 85% of the households depend on food production from own or rented plots as also reported in Mau forests (Langat and Cheboiwo, 2010; Mutune et al. 2015). However, due to the high population and small land parcels, some households looked upon the forest ecosystem as an alternative source of fodder and food as illustrated by the 14% who depended on food from cultivation of forest land under PELIS (Table 4).

According to the survey findings, the majority of the forest adjacent community were within the very poor and poor category (Table 5). Similar findings were also obtained from communities living in various PFM sites in Kenya like Iveti, Museve, Nthangu and Makongo (Musyoki et al., 2013; Thenya, 2014). Those classified as rich or very rich in the area reportedly owned large pieces of land, reliable water for irrigation or more livestock. Subsequently, only about 3% of the households recorded sources of income other than agriculture, livestock or protected area related activities.

Although there was no restriction in increasing income from conservation areas as long as one followed the laid down regulations like applying and paying for licenses and permits (Mbuvi et al., 2009; Thenya, 2014; Mutune et al. 2015), the local community involvement in the forest resources for cash income was also found to be only from sale of horticultural crops from PELIS plots (Table 3). The reasons for this could be; firstly, many products in high demand could be acquired legally, and hence, households acquired them directly from the forest on their own (Figure 2).

Secondly, for products that could not be obtained legally, only a small proportion of the community especially the youth were procuring them for sale to the few people who could afford. The findings revealed that posts, charcoal, poles and game meat were procured from the forest illegally for mainly cash income (Figure 2). These findings portray that, if there are no alternative sources of products, the pressure on the ecosystem would continue unabated, efforts of ecosystem

Table 8. Relationship between FMA between household interaction with the forest ecosystem and level of involvement in PFM.

Variable		FMA
FMA	r	1.000
	Sig	0.000
Sources of household food	r	-0.322
	Sig	0.000
Household annual income	r	-0.345
	Sig	0.000
Forest dependence	r	0.440
	Sig	0.000
PFM involvement level	r	0.191
	Sig	0.007
Perception on the importance of forest ecosystem	r	-0.287
	Sig	0.000

Table 9. Influence of FMA on households' economy and PFM involvement level.

Variable	β	Model fitting criteria	Likelihood ratio tests		
		-2 Log likelihood of reduced model	Chi-Square	Degrees of freedom (df)	P-value
Intercept	-32.092	84.103[a]	0.000	0	.
Household annual income	0.000	84.111	0.008	1	0.929
Forest dependence	-7.747	96.651	12.548	3	0.006
PFM involvement level	-2.510.	88.388	4.285	1	0.038
Importance of ecosystem	-4.528	102.795	18.693	1	0.000
Sources of Food	17.551	94.595	10.492	2	0.005
Sources of income	15.607	100.259	16.156	9	0.064
Socio-economic status	-2.159	115.923	31.820	4	0.000

R^2 = 0.797.

managers notwithstanding.

This study further depicted that many (27%) of the households within the poor livelihood category lived adjacent to the conservation area (Table 5). These findings concur with Vedeld et al. (2004), Ellis and Ramankutty (2008) and Musyoki et al. (2013) that poor people live in remote, forested and fragile areas. In many studies, poverty was linked to increased pressure on forests which leads to forest degradation and destruction (World Bank, 2005; Costa et al., 2017; Rita et al., 2017). This was found to be happening in the study area and thus, it necessitated erection of the electric fence around the ecosystem (Ark, 2011) to curb forest destruction as well as human-wildlife conflicts.

Similarly, a study on households adjacent to Sururu and Eburru forests found that poor community members were engaged in diverse livelihood strategies with crop, livestock, forest and casual labour being the major sources of household incomes which they sought to extend into the adjacent forest (Mutune et al., 2015). This possibly reflects the difference between household dependence for low income households who have few alternatives to forest income versus use as a livelihood alternative for high income households. This calls for attention on addressing poverty reduction, a major factor cited variously as key driver of forest destruction (Fischer et al., 2008; Ongugo et al., 2008; Bush et al., 2011; Rita et al., 2017).

FMA and community perception on the importance of the ecosystem

Forest resources are important components of livelihoods and development opportunities in Africa (Cavendish, 1999; Springate et al., 2003). Therefore, obtaining access to, and control of forest resources was fundamental for alleviation of rural poverty (Coulibaly-Lingani, 2011; Costa et al. 2017). Access to forest goods and services is characterised by, and dependent on FMA (de Groot, 2006; Tesfaye, 2017). Therefore, a change in landuse or management approach leads to a change not only in supply of goods but also for the complete bundle of services provided by the ecosystem.

Although there has been widespread perception that local communities value forest ecosystems predominantly for extractive benefits (Costanza et al., 2014; Ndichu et al., 2015), the findings from this study showed that majority (83%) of the communities adjacent to Aberdare forest ecosystem irrespective of FMA valued the forest ecosystem mainly for non-economic benefits (Table 6). These included biodiversity, water catchment, protection against soil erosion and flooding as well as cultural values.

Comparable observations were made by Kipkoech et al. (2011) based in their study on total economic valuation of Mau forests in Kenya. That notwithstanding, majority (96%) of those who indicated the forest ecosystem was important to them for economic reasons were those adjacent to the conservation area.

The relationship between FMA and perception on the importance of the ecosystem was negative and significant. This can be explained by the fact that communities who derived more benefits from the conservation area regarded it as more important relative to those adjacent to protection area. These findings demonstrated that where a management approach did not allow provisioning benefits, there was a negative bearing on households' perception of value of forest This was elucidated by Mr Kagondu:

'*We value the ecosystem more for non-economic reasons because …… (pause) after all, where are those economic goods? We don't get them!*

Musyoki et al. (2013) obtained similar sentiments from focus group discussions (FGD) where community members' claimed the use of forest ecosystem products was theirs by *de facto* and they felt they should not be denied. Comparable observations were made by Mutune et al. (2015) in a related study based on Sururu and Eburru forests in Mau forest complex where KFS remained in control of the forest resources such as licensing of forest products and decision making whereas in practice the CFA were labour providers for forest rehabilitation and policing.

FMA and forest dependence

In the study area, forests contributed significantly towards the diversification of livelihoods of adjacent communities. The findings showed that the community derived moderate (42%) to high (46%) benefits from the forest ecosystem. The products that were viewed as most important were water (98%), fuelwood (25%) and grazing (13%) (Figure 2). Although the benefits varied between the two management approaches, the majority (94%) of all the households perceived the forest as beneficial to them as only 6% indicated low benefits (Table 7). This was an important finding as when ecosystems do not make substantial contributions to livelihood, this lowers the value placed on them (Engida and Mengistu, 2013; Langat et al., 2016). Hence, forest contribution to household economy and welfare cannot be ignored.

The findings also showed that the value of the ecosystem was low for communities adjacent to the protected area as the FMA did not allow resource exploitation. This was because the National Park was being managed for high biodiversity value and water catchment functions among other regulatory and supportive functions (Costanza et al., 2014; Rita et al., 2017). As also observed by Maingi (2014) and Ndichu (2016), it was evident from this study that forests played a critical role in rural livelihoods, yet given the rising competition over forestland for agricultural production, such information suggest there is dire need to make forest ecosystems economically more meaningful to the local people. This would necessitate total economic valuation of all ecosystem services to enable them to appreciate the importance of conservation particularly regulatory services like biodiversity.

Like recommended by Ark (2011) and Matiku et al. (2013), non-extractive uses can be enhanced like promoting the area as a tourism destination so that revenues from recreation can offset the high costs of maintaining the forest. Therefore, Kenya Forest Service and Kenya Wildlife Service should explore and exploit the full potential to provide more benefits to the community. Benefits to communities adjacent to the park could be improved by initiating income generating activities in the farmlands as well as supporting the community to participate in diverse non-extractive activities. As also suggested by Kipkoech et al. (2011) and Kenter et al. (2015), other avenues like payment for environment services should be explored to compensate the forest adjacent communities and Kenya in general for maintaining the forests because various non-use values accrue to global community and Kenya bears the costs of conservation (EMCA, 2015; KFS, 2016).

FMA and household involvement in PFM

The research findings showed that the community

adjacent to Aberdare forest ecosystem irrespective of FMA were all involved in PFM, albeit to various extents. Although the proposition that natural resources need protection from the destructive actions of people is widely accepted, this study showed that communities in the past and increasingly today collaborate with resource managers for long-term resource management as also observed by Engida and Mengistu (2013), Matiku et al. (2013) and Musyoki et al. (2013).

Nevertheless, the level of participation was higher for those adjacent to the conservation area as more (7%) adjacent to forest reserve were fully involved compared to only 1% adjacent to National Park (Table 7). Further, the findings showed that the association between FMA and level of community involvement in PFM was strong and significant (Table 8). This can be attributed to the fact that communities adjacent to the National Park were essentially benefiting from environmental services and few extractive products as FMA was predominantly preservationist (Bush et al., 2011).

This therefore suggests that the high interest in participating in forest management could be driven by some anticipated benefits as has been reported by other studies (Lise, 2000; Ongugo et al., 2008; Costa et al., 2017). Nonetheless, these findings disagreed with Bush et al. *(*2011) who found lower respondents' willingness to accept (WTA) for community adjacent to National Parks in Uganda. The anomaly of their findings was however attributed to the *de facto* access of forest resources from the national park. Like in Kenya, due to the strict national park protectionist management approach, the regulations prohibit extractive use by local communities, but then poor enforcement of the regulations by under resourced park management meant that a *de facto* open access arrangement existed. In the case where regulations are strictly enforced, the WTA is higher due to the foregone benefits.

Similarly, in Kenya, there was little community involvement in management of natural resources in the parks except for a few cases of revenue sharing in some national parks and consultation over government planned initiatives (Mogoi et al., 2012; Matiku et al., 2015). Following these findings, there is need to empower communities to overcome obstacles that may interfere with their efficiency, dynamism, openness and active participation in planning and decision making as observed by Costa et al. (2017). This will make them get a sense of ownership of the forest resources and partner with resource managers to enhance sustainable management of forest ecosystems.

This study therefore, advocates for substantial financial investment for capacity-building (Coulibaly-Lingani, 2011), joint management, income generating activities (Fisher, 2004), and adequate awareness creation, for forest resource managers to increase household support for forest conservation through alternative household livelihood improvement options (Tesfaye et al., 2017). The great interest in PFM involvement as shown by the community requires a strategy for harnessing to sustain it and have it contribute to sustainable forest management.

Influence of FMA on household economy and PFM involvement level

Forest ecosystems provide a wide spectrum of goods and services that contribute to the socio-economic development of forest dependent communities. Since its early stages, the goals of PFM were manifold; to contribute to the socio-economic development of forest dependent communities (Agrawal and Gupta, 2005); reduce environmental degradation (Tesfaye, 2017), and alleviate poverty in developing countries (Engida and Mengiste, 2013; Langat et al. 2016).

In this research, FMA inversely and significantly influenced the level of forest dependence, economic importance and household socio-economic status and involvement in PFM (Table 9). This could be attributed to households' dependency on forest based livelihoods, particularly for those adjacent to the conservation area. Thus, there is need to reduce pressure on forest ecosystems through improved farming practices, as espoused by the "green revolution" in agriculture, technological development can increase productivity on intensively managed land, thereby decreasing pressure on other land for agricultural production (Fischer et al., 2008; Costanza et al., 2014).

Further, FMA negative influence on households' involvement in PFM can be explained by the fact that communities adjacent to protection area had lower access to economic opportunities. In view of the influence of economic benefits on community involvement in PFM, the implementation of PFM especially for those adjacent to the National Park may therefore not be smooth. This is because many issues remain unresolved, such as the transfer of power and resources between the official traditional bureaucracy to community institutions, and the sharing of costs and benefits between KWS and communities.

Further, the benefits that accrue from protected areas may not evident and might not be divided equitably among the different stakeholders. This study calls for broadening of economic benefits, particularly to communities adjacent to the park by supporting income generating activities in the farmlands as well as increasing community participation in non-extractive activities.

CONCLUSION AND RECOMMENDATIONS

Many rural households depend on natural resources for

their livelihoods. Therefore, their impacts on natural resource management in areas within and adjacent to forest ecosystems require a clear plan of how conservation goals can be balanced with their economic wellbeing.

Therefore, the main challenge in achieving sustainable forest management consist of finding a sound balance between the increasing pressure on forest resources from divergent community interests and sustainable forest conservation. Such a balance requires that an equilibrium be attained between the forest ecosystem, uses and users of forest resources as well as key institutional regulations taking into account all the ecological and socio-economic constraints. PFM was necessitated by the to create this equilibrium as high degradation of natural resources was caused by high discount rates of the local communities at the household level.

The findings of this study showed that many forest adjacent communities who derived some benefits from the forest ecosystem to supplement household sustenance contributed more in conservation. Therefore, sustainable FMA should contemplate on both the variety of local uses of forest resources and also the diverse views assigned locally to forest ecosystems. Based on these findings, this study therefore suggests that the government and development partners should support livelihood improvement schemes in the farmlands for the community to value and support conservation in the ecosystem. Therefore, Kenya Forest Service and Kenya Wildlife Service should explore and exploit the full potential to provide more benefits to the community. Benefits to communities adjacent to the park could be improved by initiating income generating activities in the farmlands as well as supporting the community to participate in non-extractive activities.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENTS

Authors thanked all participants in the interviews and focus group discussions for providing meaningful information to understand the socio-ecological system of the Aberdare forest ecosystem. We thank Kenya Forest Service for providing an enabling environment for the field work and support from staff. The authors are grateful for the assistance from Karatina University for partially financing the field work.

REFERENCES

Agrawal B (2009). Gender and forest conservation: The impact of women's participation in community forest governance. Ecol. Econ. 68:2785-2799.

Agrawal A, Gupta K (2005). Decentralisation and participation: The governance of common pool resources in Nepal's Terai. World Dev. 33(7):1101-1114.

Biedenweg K (2012). A framework for Evaluating Forest Conservation Implications of Community Based Capacity Building: Experiences from the Northern Bolivian Amazon. Conserv. Soc. 10(3):256.

Bush G, Hanley N, Rondeau D (2011). Comparing opportunity cost measures of forest conservation in Uganda; implications for assessing the distributional impacts of forest management approaches. University of Sterling. Sterling Economics Discussion Paper 2011-12.

Cavendish W (1999). Empirical regularities in the poverty environment relationship of African rural households. Imperial College, London: Working Paper Series No. 99.

Costa S, Casanova C, Sousa C, Lee P (2017). What Does Conservation Mean for Women? The Case of the Cantanhez Forest National Park. Cons. Soc. 15(2):168-178.

Costanza R, de Groot R, Sutton P, van der Ploeg S, Anderson SJ, Kubiszewski I, Farber S, Turner RK (2014). Changes in the global value of ecosystem services. Glob. Environ. Chang. 26:152-158.

Coulibaly-Lingani P, Savadogo P, Tigabu M, Oden PC (2011). Factors influencing people's participation in the forest management program in Burkina Faso, West Africa. For. Pol. Econ. 13(4):292-302.

de Groot R (2006). Function analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes. Land. Urb. Plan. 75:175-186.

de Groot R, Jax K, Harrison P (2016). Links between Biodiversity and Ecosystem Services. In: M. Potschin and K. Jax (Eds.), *Ecosystem Services Reference Book*. EC FP7 Grant Agreement no. 308428. Available via: http://www.openness-project.eu/library/reference-book

Ehrlich PR, Kareiva PM, Daily GC (2012). Securing natural capital and expanding equity to rescale civilisation. Nature 486(7401):68-73.

Ellis EC, Ramankutty N (2008). Putting people in the map: anthropogenic biomes of the world. Front. Ecol. Environ. 6(8):439-447.

Environmental Management and Coordination Amendment (EMCA) Act (2015). Nairobi: Government Printer.

Engida TE, Mengistu AT (2013). Explaining the Determinants of Community Based Forest Management: Evidence from Alamata, Ethiopia. Int. J. Comm. Dev. 1(2):63-70.

Fischer J, Brosi B, Daily GC, Ehrlich PR, Goldman R, Goldstein J, Lindenmayer DB, Manning AD, Mooney HA, Pejchar L, Ranganathan J (2008). Should agricultural policies encourage land sparing or wildlife-friendly farming?. Frontiers in Ecology and the Environment. 6(7):380-385.

Fisher B, Bateman I, Turner RK (2011). Valuing ecosystem services: benefits, values, space and time. Ecosystem Services Economics (ESE). UNEP. Nairobi: Working Paper Series No. 3.

Fisher M (2004). Household welfare and forest dependence in Southern Malawi. Environ. Dev. Econ. 10:135- 154.

Gaveau DLA, Epting J, Lyne O, Linkie M, Kumara I, Kanninen M, Leader-Williams N (2009). Evaluating whether protected areas reduce tropical deforestation in Sumatra J. Biogeo. 36:2165-2175.

Kenter JO, O'Brien L, Hockley N, Ravenscroft N, Fazey I, Irvine KN, Reed MS, Christie M, Brady E, Bryce R, Church A, Cooper N, Davies A, Evely A, Everard M, Fish R, Fisher JA, Jobstvogt N, Molloy C, Orchard-Webb J, Ranger S, Ryan M, Watson V, Williams S (2015). What are shared and social values of ecosystems? Ecol. Econ. 111:86-99.

Kenya Forest Service (KFS) (2010). Aberdare Forest Reserve Management Plan (2010-2019). Nairobi: Kenya.

KFS (Kenya Forest Service) (2016). The Forest Conservation and Management Act. Nairobi: Government Printer.

Kipkoech A, Mogaka H, Cheboiwo J, Kimaro D (2011). The Total Economic Value of Maasai Mau, Trans Mara and Eastern Mau Forest Blocks of the Mau Forest, Kenya. Environmental Research Basin Commission and Policy Analysis (K). Lake Victoria Basin Commission (LVBC), Kisumu, Kenya.

Langat D, Cheboiwo J (2010). To conserve or not to conserve: A case study of forest valuation in Kenya. J. Trop. For. Sci. 22(1):5-12.
Langat DK, Maranga EK, Aboud AA, Cheboiwo JK (2016). Role of Forest Resources to Local Livelihoods: The Case of East Mau Forest Ecosystem, Kenya. Int. J. For. Res. pp. 1-10.
Lise W (2000). Factors influencing people's participation in forest management in India. Ecol. Econ. 34:379-392.
Lund JF, Treue T (2008). Are We Getting There? Evidence of Decentralized Forest Management from the Tanzanian Miombo Woodlands. World Dev. 36(12):2780-2800.
Maingi D (2014). Equitable cost and benefit sharing – A key to success of Participatory Forest Management. Proceedings of the Second National PFM Conference: Enhancing participatory forest management under the devolved governance structure. Kenya Forestry Research Institute, Muguga, Kenya. pp. 119-123.
Matiku P, Caleb M, Callistus O (2013). The Impact of Participatory Forest Management on Local Community Livelihoods in the Arabuko-Sokoke Forest, Kenya. Cons. Soc. 11:112-29.
Mbairamadji J (2009). Ecosystemic forest management approach to ensure forest sustainability and socio-economic development of forest dependent communities: Evidence from Southeast Cameroon, Field Actions Science Reports [Online], Vol. 3 | 2009, Connection on 5 January 2017. URL: http://factsreports.revues.org/282
Mbuvi MTE, Maua JO, Ongugo PO, Koech CK, Othim RA, Musyoki JK (2009). Perceptions on participatory forest management impacts on poverty for selected forest adjacent communities in Kenya. ARPIP-KEFRI Project Report No. 1.
Mogoi J, Obonyo E, Ongugo P, Oeba V, Mwangi E (2012). Communities, property rights and forest decentralization in Kenya: Early lessons from participatory forestry management. Cons. Soc.10:182-194.
Musyoki JK, Mugwe J, Mutundu K, Muchiri M (2013). Factors influencing level of participation of community forest associations in management forests in Kenya. J. Sust. For. 35(3):205-216.
Mutune JM, Wahome RG, Mungai DN (2015). Local Participation in Community Forest Associations: A Case Study of Sururu and Eburu Forests, Kenya. Int. J. Afr. Asian Stud. 13:1-13.
Ndichu JM (2016). Assessing contribution of carbon markets in the enhancement of carbon sinks and community resilience to climate change: a case of Kasigau Redd+ Project, Kenya. M.Sc. thesis University of Nairobi, Kenya.
Nyariki DM, Kitalyi A, Wasonga VO, Isae I, Kyagaba E, Lugenja M. (2005). Indigenous Techniques for Assessing and Monitoring Range Resources in East Africa. Occasional Paper No. 2. Nairobi, Kenya: World Agroforestry Centre.
Ongugo PO, Mogoi JN, Obonyo E, Oeba VO (2008). Examining the roles of community forest associations in the decentralization process of Kenyan forests. Paper presented to the IASC conference 11-19th July 2008, England.
Rhino Ark (2011). Environmental, social and economic assessment of the fencing of the Aberdare Conservation Area. Nairobi, Kenya: Rhino Ark Ltd.
Rita E, Carla K, Thierry T, Adam AA, Errol V (2017). Indicators for Ecosystem Conservation and Protected Area Designation in the Mediterranean Context. Cons. Soc. 15(2):217-231.
Salleh M (1997). Sustainability: The panacea for our forestry ills? J. Sust. For. 4(4):33-43.
Springate BO, Yadav N, Dev OP, Soussan J (2003). Institutional development of forest user groups in Nepal: Processes and indicators. J. For. Live. 3(1):21-36.
Tesfaye SS (2017). Assessment of Local Community Perception of and Attitude Towards Participatory Forest Management (PFM) System and Its Implications for Sustainablity of Forest Condition and Livelihoods: The Case of Chilimo-Gaji Forest in Dendi District, West Shewa Zone, Oromia, Ethiopia. J. Earth Sci. Clim. Chang. 8(382):1-10.
Thenya T (2014). Forest Based Income Generating Potential (IGP) high community expectations amidst low community transformation; an analysis of PFM implementation between 2005 and 2013. Proceedings of the Second National PFM Conference: Enhancing participatory forest management under the devolved governance structure. Kenya Forestry Research Institute, Muguga, Kenya. pp. 104-110.
Vedeld P, Angelsen A, Sjaastad E, Berg G (2004). Counting on the environment; forest incomes and the rural poor. World Bank Environment Department Paper No 98. Washington, USA.
Wass P (1995). Kenya's Indigenous Forest Status, Management and Conservation. IUCN, Gland Switzerland and Cambridge, UK.
World Bank (2005). Livelihoods, Forests, and Conservation in Developing Countries: An Overview. World Dev. Rep. 33(9):1383-1402.