

Full Length Research Paper

# Analysis of human activities in and around protected areas (PAs): Case of Kakum conservation area in Ghana

Joseph K. Binlinla<sup>1\*</sup>, Alexey Voinov<sup>2</sup> and William Oduro<sup>3</sup>

<sup>1</sup>Wildlife Division of Forestry Commission, Kyabobo National Park, P.O. BOX 65, Nkwanta, Ghana.

<sup>2</sup>Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente., The Netherlands.

<sup>3</sup>Faculty of Renewable Natural Resources, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

Received 7 February, 2014; Accepted 16 April, 2014

This study was conducted around Kakum Conservation Area (KCA) to investigate the effect of human activities in 5 km belt of KCA on the ecological functioning and conservation of the PA, as well as effect of KCA on local livelihood. Supervised classification of multi-spectral ASTER imagery was used to determine land-use/cover types in the study area. Open ended questionnaires, group discussions and key informant interviews were conducted among 120 respondents from 40 sampled communities. Classification of the ASTER imagery provided a description of the dominant human activities around KCA. Regression analysis showed that distance was 20% responsible for variance in illegal activities in the PA. Correlation analysis further showed a positive but insignificant relationship between the size of population in communities and illegal activities in KCA. The major impact was from elephant raiding, whereas loss of access to important natural resources was considered as the other significant stressor.

**Key words:** Ecological functioning, conservation, fringe communities, imagery, classification, illegal activities, land-use/cover types, livelihood.

## INTRODUCTION

Tropical landscapes are undergoing rapid anthropogenic changes, particularly in terms of deforestation, with general consequences for climate in the context of targets to reduced emissions from deforestation and degradation (REDD), biological diversity and maintenance of ecosystem services (Kufuor, 2004; Guild et al., 2004; Lauren et al., 2008). Globally, rainforest cover is estimated to be shrinking by about 0.8% per year

(Gunatilleke and Chakravorty, 2003; Primack and Corlett, 2005). In the course of the last 8,000 years, the Earth's tropical forest cover was almost halved, from 62 million km<sup>2</sup> to 33 million km<sup>2</sup> with most of the loss occurring in the last three decades (Achard *et al.*, 2002; Dudley et al., 2002). One major strategy adopted globally to curb the decline in tropical forest is the establishment of a Protected Areas (PAs) network (Myers et al., 2000;

\*Corresponding author. E-mail: josephbinlinla@yahoo.com. Tel: +233(0244)960685.

Lawton, 2001). The International Union for Conservation of Nature (IUCN) defines a PA as a geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature, with associated ecosystem services and cultural values (Gaston et al., 2008; Chape et al., 2008).

The world's hundred thousand PAs at present cover over 12% of the earth's land surface, and are known to be the greatest strongholds of biodiversity and landscape conservation (Chape et al., 2008). The establishment of PAs has therefore assumed high priority as the impact of modern industrial society and its expanding demand for resources continues to spread even into the remotest parts of the world (Chape et al., 2008). The World Conservation Monitoring Centre (WCMC, 2008) opined that the establishment of a network of PAs is increasingly important because PAs:

1. Safeguard many of the world's outstanding areas of living richness, natural beauty and cultural significance.
2. Help to maintain the diversity of ecosystems, species, genetic varieties and ecological processes which are vital for the support of all forms of life on earth, and for the improvement of socioeconomic conditions of humans.
3. Protect genetic varieties and species which are vital in meeting human needs, for instance in agriculture and medicine, and are the basis for human socio-cultural adaptation in an uncertain and changing world.
4. Have significant scientific, educational, cultural, recreational and spiritual values.
5. Provide major direct and indirect benefits to local and national economies at large.

Unfortunately, these natural assets are under increasing pressure and threats mainly because of expansion in human demands on the environment, exponential population growth and excessive consumptions (Wittemyer et al., 2008; De Fries et al., 2009; Laurance et al., 2012). Human get attracted to PAs because their surroundings abound in ecosystem services and favourable conditions for agriculture in comparison with outlying areas which remain degraded and less productive.

The main objective of this study was to investigate the effects of human activities on landscapes around Kakum Conservation Area (KCA) on the ecological functioning and conservation of the reserve, as well as effect of the reserve on local livelihood.

## MATERIALS AND METHODS

### Study area

This study was conducted in and around KCA which is a tropical rainforest PA in the southern part of Ghana in West Africa. It is comprised of two contiguous reserves, established in 1991 and managed as Kakum Conservation Area. Figure 1 shows a map of

the study area including the KCA and a 5 km buffer of the adjoining landscape with inset ASTER bands 321 imagery. Portions of the ASTER imagery, marked in red on the map were covered by clouds and could not be analyzed.

KCA covers a total area of 360 km<sup>2</sup> located between latitudes 5°20' and 5°40' N and longitudes -1°51' and -1°30' W (Hawthorne and Abu-Juam, 1995). The PA forms part of the Upper Guinean Forest in West Africa described among the world's biodiversity hotspots (Myers et al., 2000). KCA experiences two rainy seasons annually (from May to June and September to October). The average annual rainfall is between 1,500 and 1,750 mm (Barnes et al., 2003).

Average relative humidity is about 85% while average temperature ranges between 20.2 and 31.6°C (Barnes et al., 2003). These very favourable climatic conditions work as an additional attractor for further population growth in this area. In particular, the two rainy seasons coupled with relatively high temperatures affords two cropping seasons with considerable farm yields in a year, quite different from other vegetation zones in the country.

Traditionally, the entire landscape belongs to Assin, Twifo Hemang, Denkyira and Abura-Asebu Kwaman-Kese states. Citizens of the various states have lived in the area since the beginning of the 20th century, mainly engaged in agriculture. Besides, the locals supplemented their livelihood needs with hunting and other non-timber forest products (NTFPs), which they collected without restrictions. This situation continued until 1991 when KCA was established as a PA and as such access to resources within its confines became restricted (Eggert et al., 2003). However the locals continued to engage in small scale farming on the fringes of the PA. Around the late 1980s onwards, the cocoa industry in Ghana received a boost from the government through control of diseases, increased producer prices and other incentives for production (Kees Van and Vrieling, 2010). These conditions facilitated movements of people from regions with small patches of remaining forests to regions with relatively large stock of forest with favourable ecological conditions for cocoa cultivation. Landscapes surrounding KCA experienced influx of migrant cocoa farmers from other regions of the country and this culminated in rendering the PA an island in the "sea" of cultivated landscapes.

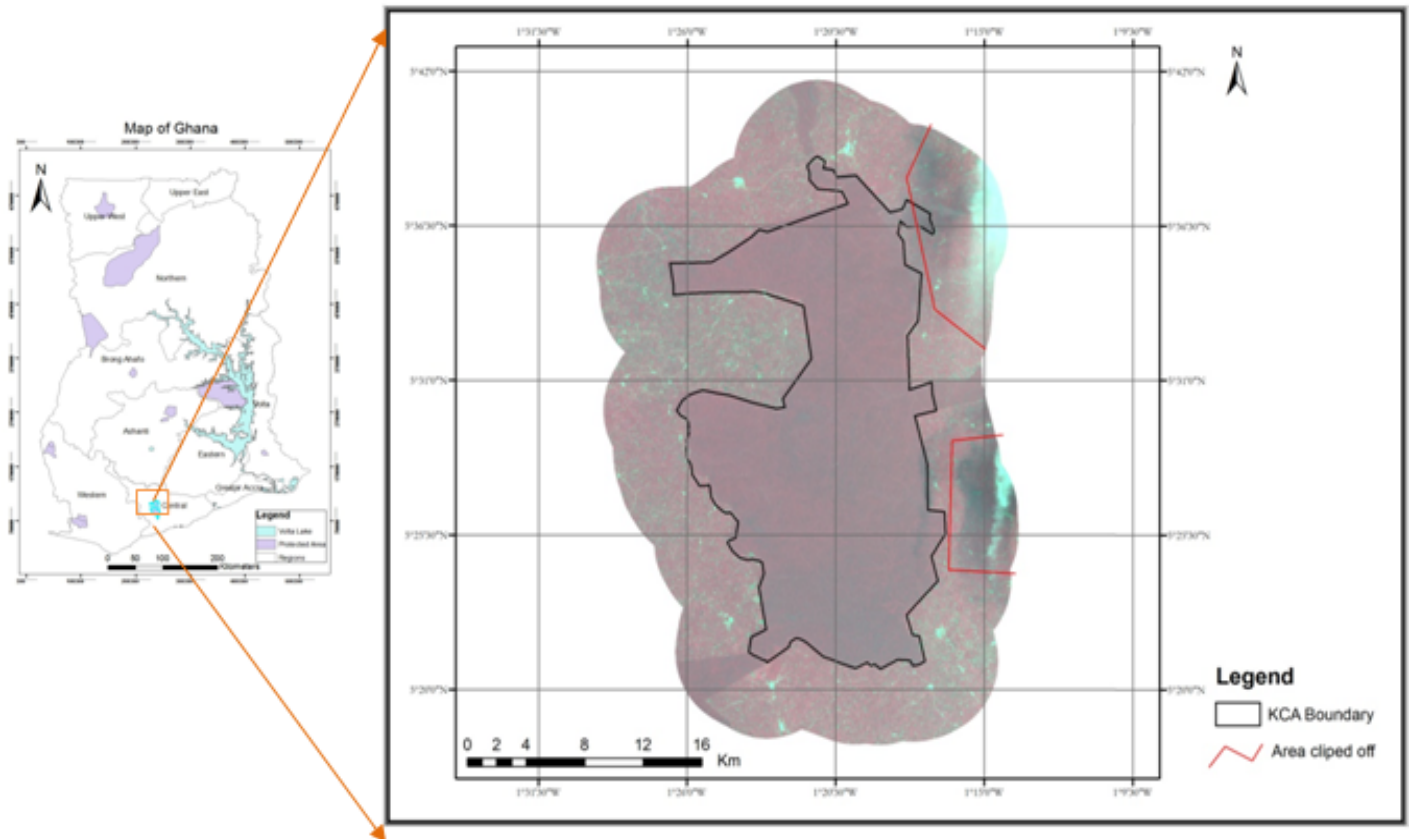
### Field work

Field work was carried out in September-October 2010. Data was collected through random sampling method. Sample of the communities, poachers' arrest and poaching trails, data on elephant crop raiding in farms on adjoining landscapes and demographic and socioeconomic data for sampled communities were collected through questionnaire survey. Ground truth data and illegal human activities were collected through line transects in KCA.

The landscape was divided into 10 rectangular sampling plots of 5 x 5 km<sup>2</sup>, based on geographic coordinates in the area. This was in order to ensure equal representation for the different communities in the sampling scheme. The scheme was particularly to take care of minority groups as well as people of varied ethnic and cultural background in the area. This scheme was also used in collecting ground truth points. A list of all communities within each of the plots was generated and 4 randomly selected from each plot. This generated a sample size of 40 communities from which respondents were further sampled for administration of questionnaire.

### Questionnaire surveys

Semi-structured, open ended questionnaires were designed and field surveys conducted in 40 sampled communities. In all 120 respondents (3 from each of the 40 communities) were interviewed,



**Figure 1.** Study area: Kakum conservation area (KCA).

109 males and 11 females. The interviews were conducted in the local dialect of respondents (Twi). Focused group discussions and key informant interviews were held in some communities to clarify specific responses. Respondents were identified through simple random sampling procedure by means of a ballot.

#### **Illegal activities encountered along transects in KCA**

Signs of illegal activities were recorded along forty transects into the PA. Geographic locations of sampled communities and their mean distances in relation to the PA were determined. A one kilometre transect was laid in the PA perpendicular to the location of each sampled community, and all signs of illegal activities encountered along transects were geo-referenced with the help of a hand held GPS device. The procedure was the same for all 40 transects along the 40 sampled communities. Because of the relatively large area to be covered and because of time constraints, it was decided not to cut straight-line transects through the PA. Instead transects of least resistance were employed (Sam, 1996). Rangers and patrol staff of KCA assisted in the collection of these data, mostly because of their technical knowledge in identifying and distinguishing between types of illegal activities, as well as serving as field guards during the forest hike. In all 233 different incidents of illegal activities were encountered, ranging from hunters' trails, cartridge shells to cutting of raphia palms (*Raphia farinifera*). Mean distances of communities from the PA and number of illegal activities encountered along each corresponding transects were analyzed statistically in order to determine their correlation.

#### **Satellite image classification**

Within the scope of this study, image classification is defined as the extraction of distinct themes, from ASTER 2007 imagery based on image pixels. Because of the researcher's familiarity with the study area, supervised classification method with Maximum Likelihood classifier algorithm (Hubert-Moy et al., 2001) was used, providing high classification accuracy. Whereas image classification produced a land cover map of the study area for determination of land use cover types in place, the purpose for field data was to understand the socio-economic and cultural dynamics of the sampled communities.

## **RESULTS**

#### **The existing land-use/cover types around KCA**

Supervised classification of multi-spectral ASTER 2007 imagery categorized the study area into five major land-use/cover types, namely: forest, oil palm plantation, mixed crops, cocoa farm and built-up/bare. Forest refers to the protected area and small patches of fallow lands around. The four remaining classes are the dominant land-use and cover types around the fringes of KCA. However portions within KCA showed the other four cover types, other than forest, after classification. Based

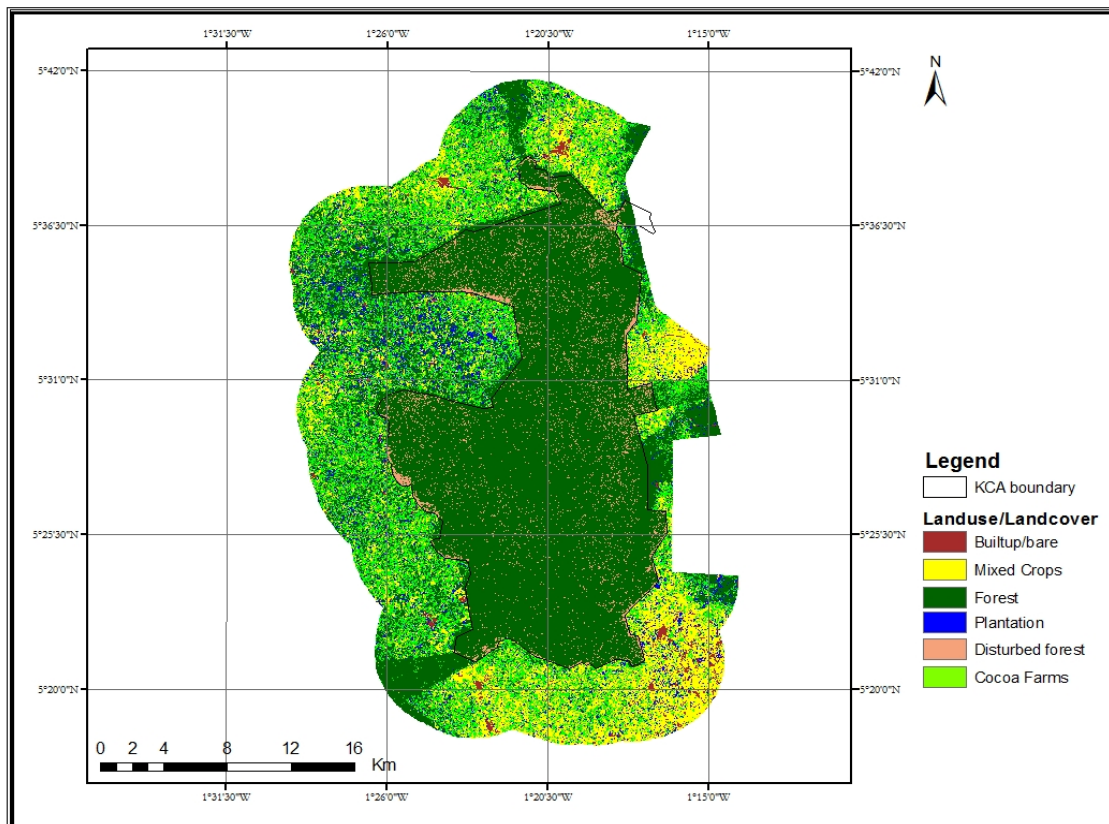


Figure 2. Land cover map of study area.

Table 1. Description of land-use/cover types in the study area.

Land cover type (class name)	Descriptions
Forest	Forested areas predominantly covered by trees with or without close canopy. It includes KCA and fallow lands in the surrounding landscape.
Oil palm plantations	Areas predominantly covered with oil palm plantations ( <i>Elaeis guineensis</i> ) on the fringes of KCA
Mixed crops	Areas covered with a mixture of crops that include maize, plantain, cocoyam and cassava on a single plot of land on the fringes of KCA.
Cocoa farms	Areas predominantly covered with matured cocoa ( <i>Theobroma cacao</i> ) trees along the fringes of KCA
Built-up/bare	Areas dominated with buildings, roads and other human infrastructure, as well as exposed soils resulting from human activity or natural cause.
Disturbed forest	Areas of forest inside KCA that classified other forest and are likely results of disturbances by humans, including tree removal, clearing, fire or cocoa farms.

on expert knowledge these non-forested land-uses inside the PA were grouped and labelled disturbed forest, (Figure 2). These include human induced disturbances such as illegal cocoa farms and illegally felled trees among others.

The categories are elaborated in Tables 1 and 2. The resulting land cover map specified dominant use of the landscape and a basis for analyzing effects of human activities on biodiversity in and around KCA. The map

shows the extent to which habitats in the neighbouring landscapes have been converted from forested ecosystems into varied land-use/cover types, and thus demonstrating the negative effects of human activities on biodiversity in and around the PA.

Clearly, the intention of most farmers on the fringes of KCA is to grow cocoa as observed from analyses of land cover types, (22% of land under cocoa in relation to other crops). Partly, this is because of government interventions

**Table 2.** Land-use/cover types and size covered in the study area (ha).

Land cover type (Class name)	Land use	Description	Percentage
		Area covered (ha)	
Forest	Conservation area/fallow patches	43,764.8	49.5%
Cocoa farms	Farm land	19,570.43	22.1%
Mixed crops	Farm land	14,686.18	16.7%
Oil palm plantation	Farm land	4,505.06	5.2%
Built-up/bare	Settlement/bare areas	1,440.88	1.6%
Disturbed forest	Farms and other illegal activities	4,263.72	4.9%
Total area		88,231.69	100%

**Table 3.** Accuracy assessment report.

Class name	Reference total	Classified total	Number correct	Producer's Accuracy (%)	User's Accuracy (%)	Kappa
Forest	89	89	79	88.76	88.76	0.82
Plantation	21	22	16	76.19	72.73	0.70
Cocoa farms	70	72	60	85.71	83.33	0.77
Mixed crops	57	55	45	78.95	81.82	0.76
Built-up/bare	18	17	13	72.22	76.47	0.74
Total	255	255	213			

Overall accuracy = 83.53%; overall Kappa statistic = 0.77.

that have boosted production of the crop in the country, and perhaps also because perhaps cocoa in Ghana is widely considered among farmers as an important security at old age. The average size of a cocoa farm ranges between 7 and 8 ha. Cocoa farms are generally difficult to distinguish and accurately classify when located within a forest because of similarity in their spectral reflectance with pristine forest (Rice, 2000). However, in the case of this study, cocoa farms had relatively high classification accuracy (Table 3) as a result of the fact that they are located entirely outside the borders of the PA, invariably with no forest trees found in them.

Again the high accuracy could be attributed to the large number of ground control points collected for validation during field work. Whereas outside the PA most of the impacted forest is indeed replaced by cocoa, it is pretty difficult to conclude that the situation is the same inside KCA. Again, the overall classification accuracy was quite high as observed in Table 3. However, classification errors are likely to be caused by misclassification of some pixels

The cultivation of mixed crops mainly maize, cassava, plantain, cocoyam, vegetables, usually planted together on a single plot, is common among farmers, meant for subsistence and occasionally for commercial purposes. Mixed crop fields are smaller in sizes as compared to cocoa, they range between 0.2-3.0 ha on average and

are located in between cocoa farms and palm plantations.

Cultivation of oil palm plantation has recently gained popularity in the area as a commercial crop mainly for palm oil extraction, even though not much of the landscape is committed to it as to the cultivation of cocoa. Settlements in the area constitute various types ranging from hamlets, cottages, small towns to sizeable communities mostly built with local materials. The landscape was also covered with very small fallow lands and patches of uncultivated lands.

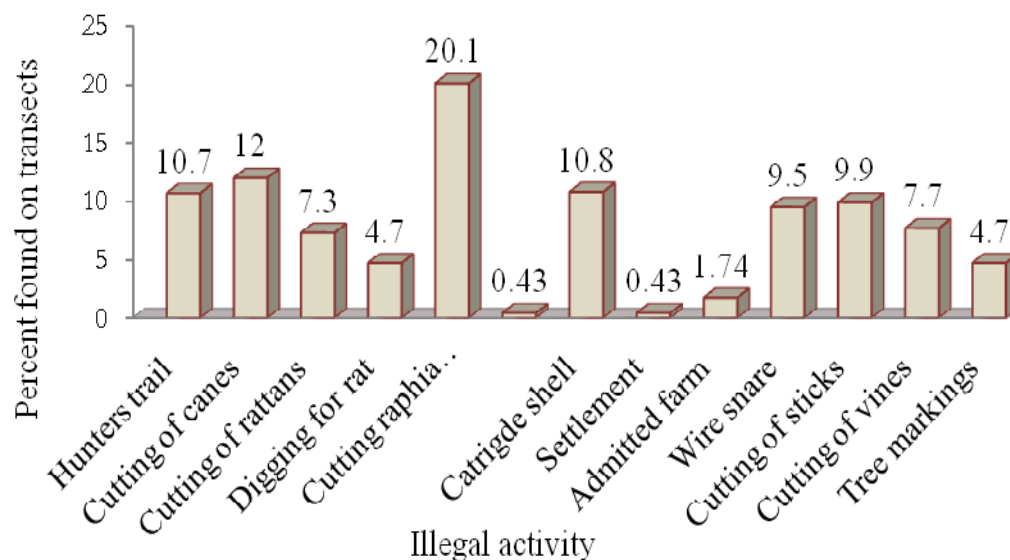
Some of these landscapes were left uncultivated because elephants from the PA habitually raided crops on them. Other fallow lands in the area remained uncultivated as a result of petty land disputes between some farmers. These small patches of fallow landscapes were classified as forest.

### Demographic characteristics of the study area

Demographic data for the study communities for 1970, 1984 and 2000, was obtained from the Ghana Statistical Services (GSS 2000) and growth rates were calculated to analyse population growth trends. Table 4 shows population growth trends in Ghana and in the study communities. Population growth rates were derived using the population growth rate formula,  $r =$

**Table 4.** Comparison of population growth trends (1970 - 2000).

Year	Population in Ghana (million)	Average growth rate in Ghana (%)	Population in study communities (thousand)	Average growth rate in study communities (%)
1970	8,559	2.2	5,461	3.2
1984	10,736	2.5	10,524	3.4
2000	18,412	2.3	21,749	4.8

**Figure 3.** Percentage of types of illegal activities along transects in KCA.

$(\frac{P^1 - P^0}{P^0} \times 100 / t)$  where,  $r$  = average annual rate of growth,  $P^1$  = current population totals,  $P^0$  = previous population totals,  $t$  = the number of years between censuses (Witmeier et al., 2008).

Comparison of population growth trends between 1984 and 2000 showed that the environment of KCA had more people during the period after its creation in 1991 than before, growth rates increased by 0.8% after creation of the PA.

There was no such increase in population growth rates for the country as a whole. Growth rates for KCA were higher than the 2.4% average for the nation (2.1% for the Central Region and 3.6% for other rural areas during the same period).

#### Effect of land-use types on the ecological functioning and biodiversity conservation in KCA

Accelerated growth in human populations around KCA has been identified as a major threat to the PA (IUCN/PACO, 2010). As observed from the land cover map, increased human population on the fringes of KCA

resulted in habitat conversion of the bordering landscape as well as human disturbances within KCA. Apart from disturbed spots within the PA, a number of other illegal activities were encountered along transects into the PA.

A total of 233 signs of illegal activities were recorded along the forty transects in KCA. Of these activities harvesting of raphia palm (*Raphia farinifera*) was most frequent with 20.1% occurrence (Figure 3).

This is probably because of its extensive use by the locals as building material for their mud houses. Land clearing for agriculture coupled with competition for the harvest of raphia on the fringing landscape is reported to have completely wiped-out the resource outside of the PA. Therefore illegal harvest of raphia and other building materials within the confines of the PA is a common practice among locals in the study area.

Cane cutting constitutes the next highest finding with 12% occurrence, followed by cartridge shells with 10.8%. Communities around PAs often engage in bushmeat hunting for both commercial and subsistence purposes. Other illegal activities encountered include cutting of sticks, vines (*Berchimia scandens*), and rattans constituting 9.9, 7.7 and 7.3%, respectively. Canes and rattans are harvested and used in weaving baskets for

**Table 5.** Comparison of mean distance and illegal activities in KCA.

Community	Population in 2000	No. of illegal activities along transects	Percentage	Mean distance from KCA (km)
Aboabo	532	17	7.2	0.20
Adianum	299	15	6.4	0.80
Antwikwaa	479	5	5.1	0.50
Nkwantanaan	398	12	5.1	0.80
Gyahadzi	76	7	3.0	0.30
Apokwaa	184	8	3.4	0.80
Briscoe I	389	6	2.6	0.10
Mpentemboa	56	5	2.1	0.10
Nsabaa	108	10	4.3	0.90
Obengkrom	156	8	3.4	0.70
Adwe krom	543	7	3.0	0.40
Essuman	243	7	3.0	0.20
Fa Asem Kye	421	9	3.8	0.30
Mesomagor	395	7	3.0	0.70
Adwe-krom	543	7	3.0	0.40
Akosua Doma	432	5	2.1	0.50
Asem Asa	593	5	2.1	0.50
Boafo Yena	718	6	2.6	0.20
Nyarko	203	6	2.6	0.20

carrying cocoa pods and other foodstuffs from farm.

### Illegal activities in KCA related to location of fringe communities

What drives illegal activities in the protected area? Our hypothesis was that it is related to the human population residing in the area. Therefore, the next step was to explore the relationship between the number of illegal activities in KCA and the size of human settlements and their location.

First, we looked at the correlation between the mean distances of communities from KCA and the number of illegal activities encountered along transects.

Correlation yielded  $R = -0.446$ ,  $p < 0.004$  implying a negative correlation between the two variables, the farther communities are from KCA the less illegal activities observed. A regression statistics (ANOVA, single factor) of  $R^2 = 0.20$  at  $p < 0.05$ , implied 20% of the total variance in dependent variables (illegal activities) could be explained by the independent variables (mean distances). From analyses, communities located close to KCA (between mean distances of 0.10 and 0.90 km) recorded high numbers of illegal activities in KCA. Aboabo community has a mean distance of 0.20 km from the boundary of KCA and recorded 17 or 7.2% of illegal

activities in comparison with Kruwa with a mean distance of 1.9 from the PA boundary and recorded only 3 or 1.3% of illegal activities.

Illegal activities were again correlated with the number of people in each community. Population data for the 2000 population and housing census were used for this analysis. Projection ratios for the 2000 population could have been used to represent population figures in 2010 for these analyses. However, demographers often criticize projection ratios for their validity (Voss and Balkrishna, 1992). Hence, we used the 2000 data and produced a positive but very insignificant correlation  $R = 0.068$ ,  $p > 0.698$ . A regression statistics of  $R^2 = 0.04$ , at  $p < 0.05$  (Table 5).

Communities with relatively high population figures recorded marginally low levels of illegal activities, and at the same time these communities are located between mean distances of 1.0-2.0 km from the borders of KCA (Table 6).

The following inferences could therefore be drawn in relation to fringe communities and encroachments within KCA by comparing Tables 5 and 6:

1. Communities that are located closer than 1 km to the borders of KCA are relatively smaller and tend to encroach more in the PA although distance was found to be only 20% accountable for the variance in illegal

**Table 6.** Comparison of population and illegal activities in KCA.

Community	Population in 2000 (000)	No. of illegal activities along transects	Percentage	Mean distance from KCA (km)
Adiembra	1,987	3	1.3%	1.5
Ahenbrom	1,988	4	1.7%	1.0
Abodweseso	976	2	0.9%	1.3
Nyamebekyere	945	1	0.4%	2.0
Homaho	1,182	3	1.3%	1.0
Mfoum	2,910	5	2.1%	1.8
Kruwa	1,972	3	1.3%	1.9

activities;

2. Communities with relatively high human populations also encroach more in the PA but at a marginally low rate (only 4% responsible for the variance in illegal activities), and invariably located more than 1 km from the PA;

3. Communities located farther than 1 km from KCA generally encroach less on the PA perhaps as a result of their mean distances from the PA.

Therefore, distance at which a community is located from KCA was found to be more accountable in explaining levels of human encroachment in KCA than size of population. Figure 4 illustrates location of illegal activities and sizes of sample communities in a population density map of the study area. Apparently, it is the smaller but closely located communities that have the largest impact on the KCA. One possible explanation is that the bigger the community the more economic fortunes it attains and therefore the less it depends on NTFPs and other resources directly provided by the PA.

### Population levels and impact on KCA

Analysis of human populations showed that communities around KCA before its creation experienced average growth rate of 3.3% as compared to a higher average growth rate of 4.1% after its creation in 1989. Average growth rate for the same period for the entire country remained at 2.4 and 3.6% for other rural areas. This study has demonstrated that land-use and habitat conversion around KCA is driven mainly by population growth. Growth in population resulted in varied uses of the landscape including conversion to agriculture and settlements with diverse impacts on ecological processes in and around KCA.

### Analysis of encroachers arrested in KCA

To enhance PA security, the staffs employ conventional law enforcement in the form of armed foot patrols within KCA. Invariably, the essence is to safeguard the ecological integrity of the PA through regular day, night, short, long and in some cases, emergency foot patrols,

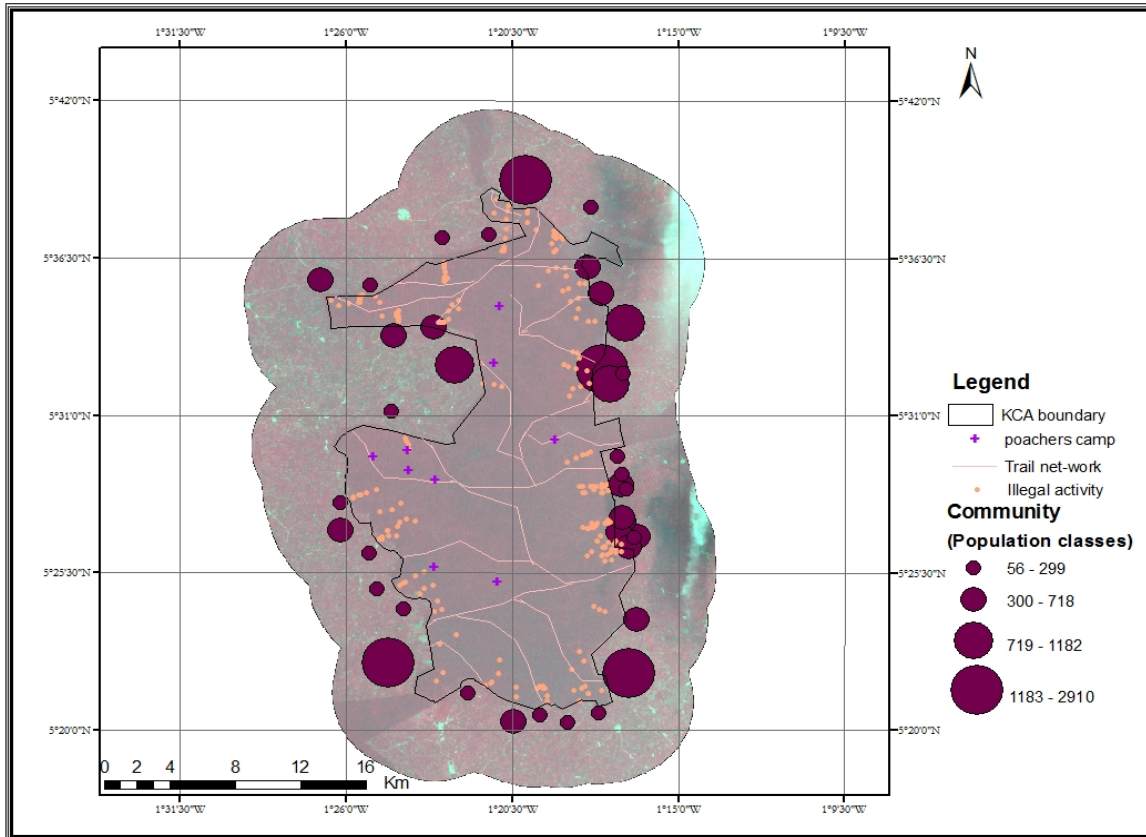
surveillance and monitoring operations against any illegal activity. In order to compare encounter rates of illegal activities within PAs a standardized measure of patrol effort is used (Hood and Parker, 2001). A measure of efforts for comparing areas with each other as applied in the case of KCA is effective patrol man days (EPMDs) per unit time (Jachmann, 2008). While on patrol, staff records geographic location of patrol areas with the aid of GPS and compass devices. With the same devices they also record illegal activities by encroachers, animal sightings and other events of interest. Figure 5 shows numbers and percentages of arrests made by field staff in KCA between 2002 and 2009, thus validating occurrence of illegal activities in KCA.

2004 recorded the highest numbers of arrests of 45 poachers. This was reportedly because of the introduction of a new measure of patrol efforts at the start of 2004 known as the effective patrol man-days per unit time (Jackmann, 2008). Arrests declined sharply to 6 the following year probably because the locals may have gotten wind of the new system and arrests made the previous year, and so decided to temporary withdraw. Otherwise new poaching tactics might have been devised, through which poachers could outwit patrol staff. Arrest rose again to 24 in 2006, 32 in 2007 and again fell to 30 in 2008. Wildlife poaching in particular has been identified as a persistent illegal activity in forest reserves (Jackmann, 2008). In particular, commercial poachers are noted for making use of a network of trails they create, often walking long distances into the PA. Others are described as "hit and run" poachers who hunt in the PA without necessarily using the trails net-work. The second group of poachers are those who hunt purposely for subsistence. They usually sneak in to the PA and once inside begin to mark trees and saplings as signs to enable them determine their way out, and on shooting an animal quickly move out with the booty without staying long in the PA.

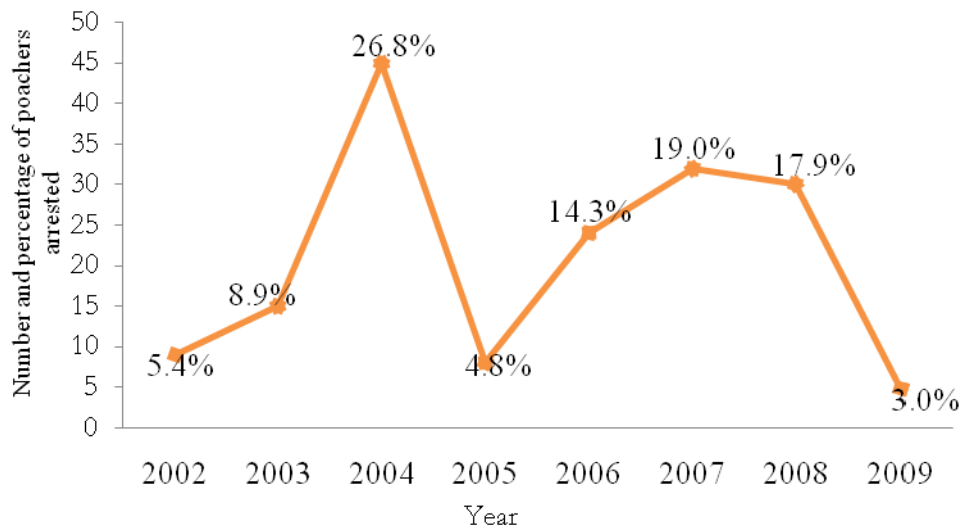
### Effects of KCA on local livelihood

Reponses from questionnaires revealed that the settler





**Figure 4.** Distribution of population and illegal activities along transects in KCA.



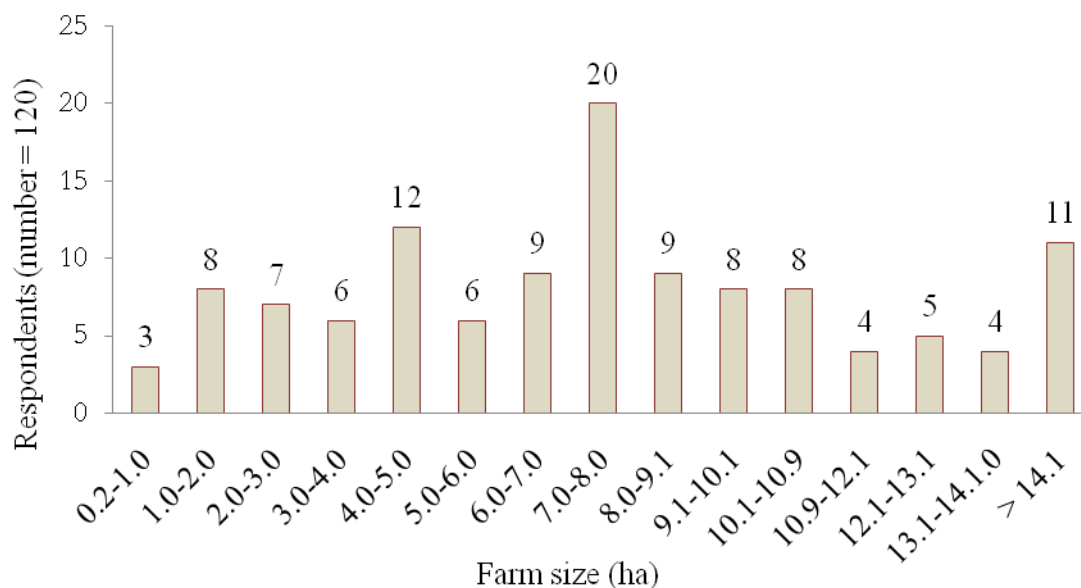
**Figure 5.** Percentage of poachers arrested in KCA (2002 to 2009). Source: (Poachers arrest record in 2010, offices of KCA).

group comprises of 10 different tribes in the country who originate from 7 out of the 10 regions. These revelations are further evidence of movement of people from other

regions of the country into the study area. Ultimately, high population growth rates around KCA resulted in the following impacts, according to respondents: (1) widened

**Table 7.** Analysis of responses generated from community surveys.

Description	Frequency		Percent		Total (N)
	Yes	No	Yes	No	
Knowledge in wildlife and biodiversity conservation	102	18	85%	15%	120
Ever collected NTFPs from reserves	81	39	67.0%	33.0%	120
Ever suffered from wildlife crop raiding	110	10	92.0%	9.0%	120
Tangible benefits from PA	0	120	0	100%	120

**Figure 6.** Distribution of farm sizes around KCA.

'people-PA' frontier, the area where the interaction and conflict between people and the PA is pronounced; (2) increased competition for arable land and natural resources in the area; (3) loss of habitat due to land conversion; (4) increased human-wildlife conflicts and, (5) further encroachment in KCA (Barnes et al., 2003; Eggert et al., 2003). The analyses are shown in Table 7.

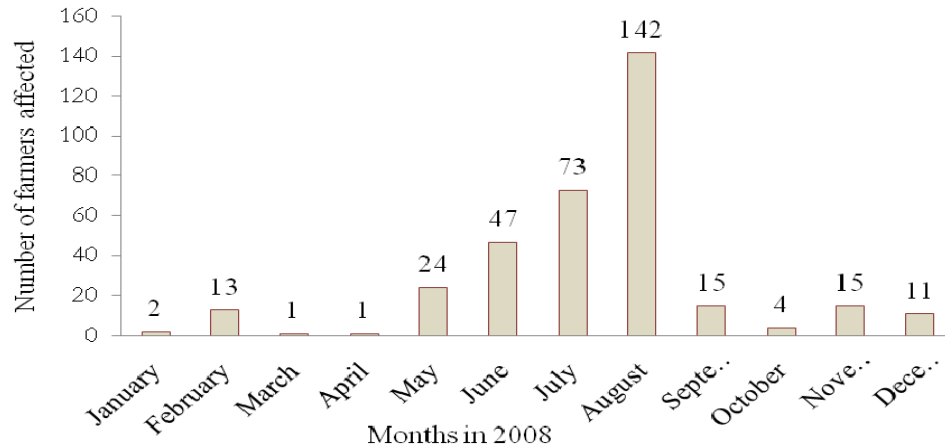
Until the later part of 1989, the areas that constitute KCA were forest reserves managed purposely for water catchment protection and timber production (Barnes et al., 2003). As forest reserves at that time, they were open for the locals to access and gather assorted NTFPs. Forest products such as bushmeat, fibres, berries and roots in particular served as food and dietary protein supplements, and other products as building materials for the construction of mud houses and medicinal plants for herbal health care needs. The source of such freely available ecosystem services ended from 1991 when KCA was established as a wildlife PA. 67% of respondents reported having gathered forest products from the PA in the past for direct household consumption and also as a

source of income and employment. 37% of respondents identified loss of NTFPs from KCA as a major concern in its establishment and according to respondents, as a reason to increase their farmlands in order to compensate for income previously derived from sales of NTFPs and other resources.

Both groups of respondents are engaged in commercial and subsistence farming, mainly on the landscapes around KCA. Reported farm sizes range between 0.2 ha - >14 ha (Figure 6), with the average farm size ranging between 7.0-8.0 ha for cocoa and 0.2-3.0 ha for mixed crops.

#### ***Incidence of elephant crop raiding on landscapes around KCA***

Respondents confirmed that farmers around KCA suffered elephant raids on farms during the period when the PA was not established. However, frequency of crop raiding, number of farms and crops affected increased



**Figure 7.** Incident of crop raiding around KCA in 2008. Source: (Crop raiding report 2008, offices of KCA).

after the creation of KCA (Eggert et al., (2003). Barnes et al. (2003) inferred that increased reports of crop raiding in the study area are evidence of widened human-elephant interface due to increased human population. This may also be a result of increased numbers of wildlife in PAs, which, supposedly, is a positive development, but not for the surrounding farmers.

As a result of the situation three international organizations; the Food and Agriculture Organization (FAO), the World Bank and the International Fund for Animal Welfare (IFAW) intervened in 2004, 2006 and 2008, respectively, to assist the farmers protect crops from elephant raids in particular (Addo-Boadu, 2010; Monney et al., 2010). Although farmers considered the interventions as a welcome relief, adoption rates are reportedly low among farmers mainly because of the cost involved in its application (Monney et al., 2010). As such, farmers in the area continue to experience elephant crop raiding (Figure 7).

A total of 348 farmers suffered crop raiding in 2008. Raiding is usually low at the start of the year then increases from the month of May. The peak raiding months are June to August, at times up to September depending on rainfall patterns experienced in the year. Raids involved food crops such as maize, cassava, plantain, cocoyam to tree crops including cocoa and citrus. Crop raiding impacts more on the locals because the state does not compensate for wildlife deprecations in the country. This is also because compensation scheme may end up attracting more migrants into the area to re-fuel the very cause of the problem.

## DISCUSSION

It appears that with no buffer zone established for the PA, such a 'fringe people-PA' frontier is developing by itself as a result of some on-going interaction between the

natural, Protected Area and the rapidly developing human landscapes.

Illegal activities are a major concern in biodiversity conservation. Their biological impacts range from declines in genetic diversity and species richness to changes in community composition and ecosystem services (Benjaminsen *et al.*, 2013). Illegal activities such as bushmeat hunting and land clearing in particular impact rainforest by wiping-out wildlife (in particular mammals and birds) that are important for dispersing tree species. The situation changes the structure of forest species by favouring small-seeded trees over large-seeded, leading invariably to lower tree diversity and hence degradation of forest landscapes (Holmerm *et al.*, 2007).

## Effects of habitat conversion on biodiversity conservation in KCA

Human disturbances on the surrounding landscape have impacted KCA negatively as shown by the land cover map. There is active poaching of animals as seen from the number of cartridge shells and wire snares found along transects. Such disturbances impact wildlife species within the PA by destroying their territorial areas and driving them into the converted adjoining landscapes. Landscapes that adjoin PAs could play important roles in sustaining ecological functioning in and around PAs (Hansen and De-Fries, 2007).

These landscapes invariably serve as source areas for populations of species in the PA; provide habitats for species with larger home range and migratory routes for particular species of fauna (Laurance et al., 2012). In this regard, the natural cross-boundary migration of flora and fauna species between KCA and the adjoining landscapes is adversely affected by conversion of landscape around PA to agricultural or residential uses.

### Effects of KCA on community livelihood

Effects of KCA on local livelihoods could be discussed from two main points of view: 1) loss of access to land and forest products, 2) wildlife depredations on croplands.

Human Development Index (HDI), by the United Nations Development Programme (UNDP) estimates that 90% of the world's poor depend on forests for at least a portion of their income (World Bank, 2004; USAID, 2006). In Africa, about 600 million people have been estimated to rely solely on forests and woodlands for their livelihoods (WRI, 2005). Shackleton and Shackleton (2004) opined that depending on circumstances, forest products may offer both a "daily net" and a "safety net". The "daily net" describe everyday use, with product meeting current household needs as well as offering a reliable source of income. A 'safety net' on the other hand comes into play when other sources of household income, fail to meet dietary shortfalls, or whenever a quick cash option is required (McSweeney, 2003). To these end, loss of access to NTFPs in the case of KCA implies adverse effects on livelihoods of the locals, even though the net livelihood impacts are generally less easy to discern, mainly because of the lack of standardized assessment methodologies (Shackleton and Shackleton, 2004).

Wildlife challenges encountered by communities living close to PAs fall into two main categories: damage to resources such as crop raiding and livestock predations, and threats to human life by wild animals from the PA. In the case of KCA, the challenge is crop-raiding mainly by elephants migrating from the PA. This challenge was however, identified as a symptom of the ecological changes that have taken place on landscapes bordering KCA, resulting from increased human populations in recent decades. According to Sillero-Zubiri et al, (2004), larger animals such as forest elephants (*Loxodonta africana cyclotis*) typically require larger home ranges and more food resources to sustain a viable population. This pushes them to extend their range beyond the limits of PA boundaries into neighbouring lands, thereby entering into conflicts with local communities as in the scenario with resident elephants in KCA.

### Conclusion

Analysis of population growth around KCA showed that growth rate increased by 0.8% after the park's establishment. The increase in population was mainly a result of migration of people from other regions in the country into the study area to engage in agricultural activities. Human activities around the PA resulted in habitat conversion on the surrounding landscapes, which reduced the effective size of the ecosystem, produced edge effects, caused human encroachment and affected

the ecological processes in KCA. Indeed, statistical analyses showed negative correlation between mean distance of communities and number of illegal activities in KCA.

On the other hand, local livelihood are adversely affected by the PA because of unattainable forest products and raiding by wildlife from KCA. The magnitude of raiding effects on locals can be exemplified in the instance of a farmer who loses a whole season's produce to a herd of elephants overnight because he/she genuinely lacked the means to protect the crops from elephants. With no compensation for the loss and no access to products from KCA or alternative sources of livelihood, the farmer and his dependants are left impoverished for the period. In particular, the lack of access to forest products in KCA implies that source of direct household income, consumption and employment have been affected adversely due to creation of KCA. Also, traditional socio-cultural and religious ties with the forest as known for forest fringe communities are broken. Inaccessibility to bushmeat in particular results in reduced levels of dietary protein among families in the area or scarce cash will have to be spent to meet protein requirements. Consequently, the severity of these effects on the locals breeds apathy and community/park conflicts further make the PA unsustainable as biodiversity conservation area.

It may not be wise to establish PAs without a designated buffer zone, which would allow a softer transition between natural, wildlife dominated areas and developed human dominated ones. With no legally designated buffer zone, it still manifests itself, but with inevitably associated conflict: arrests in the PA, as well as wildlife raiding outside the PA. Establishing a buffer zone with restricted human activities, instead of total protection, could help avoid a good deal of conflict and make PAs more welcomed by local people.

It has been shown that system sustainability is a hierarchical feature, which has to be analyzed at a variety of scales (Voinov and Farley, 2007; Voinov, 2008). Gaining in sustainability in one scale may come at the expense of sustainability of sub- or supra-systems. Establishing PAs is crucial for regional and global biodiversity and conservation. Locally, PAs may however have adverse effects, especially when they are not planned and managed appropriately. We have shown that KCA has produced a "pull-effect" attracting even more human population and demand to an area where it is least desired. Lack of a buffer zone and repeated crop-raiding instigated by the park further impacts the human population, creating more unrest and hostility toward the idea of conservation. The promise of ecotourism also comes with big social and economic disparities, where the most impoverished groups of people are the least likely ones to get any benefits from it (Liu et al., 2012).

PAs have many forms of direct and indirect benefits at both local and global levels in the form of gains from the

opportunities for recreation and renewal from the genetic potential of wild species, as well as the environmental services provided by natural ecosystems. Biodiversity conservation should however not be at the expense of local communities whose livelihoods have depended to a very large extent, on forest and biological resources in terms of materials essential for basic life sustenance. As much as possible, some level of local community needs and aspiration ought to be integrated into PA management systems to enable local and fringe communities truly buy into the model of biodiversity conservation, particularly within African countries. In this regard, parks that generate revenue in the form of eco-tourism, sport hunting and more recently from unfolding carbon trade concept, should be made to support locals through creation of sustainable livelihood schemes and provision of basic infrastructure. The concept of Integrated Conservation and Development Projects (ICDPs Report, 2005) may well be acceptable means of reducing the “trade-offs” felt by local communities in terms of loss of access to resource.

Local communities should be integrated more into PA management and development programmes, thus for more impartial governance of “their” natural resources by devolving decision-making and resource control to local populations such as the Community Resource Management Area (CREMA) concept being introduced by the Wildlife Division in Ghana. It is clear that the future of wildlife and biodiversity conservation, will depend to a large extent on its capacity to deliver tangible incentives to local people, and the most effective way to deliver such incentives is to accord them the ownership right and the responsibility to manage biodiversity, and not purely on the strength of prohibitive rules and regulations.

Such conscious initiatives may go a long way to balance and enhance human welfare needs and ecological functioning.

### Conflict of Interests

The author(s) have not declared any conflict of interests.

### ACKNOWLEDGEMENTS

Many thanks and sincere appreciations go to the Faculty of Geo-Information Science and Earth Observation of the University of Twente (UT), the Netherlands, and the Faculty of Renewable Natural Resources of Kwame Nkrumah University of Science and Technology of Ghana.

We are thankful to Ms. Louise van Leeuwen (UT) and Professor Samuel Oppong (KNUST) for respectively, providing useful comments on earlier versions of the manuscript and coordinating the course. Finally we want to acknowledge staff of Kakum Conservation Area, Ghana for the support during field work.

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