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## Land Use Land Cover Change Analysis and Its Effects on Wildlife Protected Areas: A Case of Rimoi National Reserve

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### **Abstract**

*Land use land cover (LULC) change dynamics have been among the observable changes that have taken place in many of the Kenyas' landscape. These changes have severely affected ecosystem health including degradation of wildlife protected areas (WPAs) and declining biodiversity populations. Changes in land use land cover between 1986, 2000 and 2006 of Rimoi National Reserve and the adjacent areas in Elgeyo Marakwet County was studied. The county host the wildlife protected area of Rimoi National Reserve where incidents of human Wildlife Conflicts (HWCs) between the protected area and the adjacent communities has been on an upward trend. The objective of the study was to assess the rate and spatial patterns of wildlife habitat distribution and disturbance within and adjacent to Rimoi National Reserve. The study was carried out mainly by use of Geographical Information Systems (GIS) technology which revealed that the overall wildlife habitats (bush land, shrubs & acacia trees and forested woodlands) has undergone drastic transformation over the three study periods (1986, 2000 and 2006). Bush land and forested land covers declined by 29.0% and 61.4% respectively while shrubs and acacia trees increased by 24.2%. The main contributor of land use land cover change in the study area was agriculture which increased by 245.4% over the 20 years period. These change has resulted in high frequencies of Human Wildlife Conflicts (HWCs) being experienced with declining populations of biodiversity being observed.*

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**Key Words:** *Biodiversity, Dynamics, GIS Technology, Land use, Land cover change*

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### **Introduction**

The main factors driving land use land cover (LULC) change on a world wide scale are the human activities. Human settlement and agriculture are some of the many agents of land use land cover changes that have been identified as the drivers of global environmental change (Vink, 2012). As land use is the backbone of agricultural economies in many countries of the World, land also provides a substantial economic and social benefits to thousands of communities. Also it has been observed that land use land cover changes is a character reflection of modern human society interacting with physical environment (foreman *et al.*, 2003). Marian (2006) defined land use as an expression of man's management of ecosystem in order to produce some of his needs. Mather (1986) referred land use as human action and is formed by choice made by the individual land users operating within broad environmental limitations under governmental influences. According to Lubowski *et al.*, (2006), land use change is necessary and essential for economic development, growth and social progress, but land use land cover change, however, does not come without costs implications and other associated effects. Land use land cover (LULC) change is arguably the most pervasive socio economic and environmental force driving changes and causing degradation of

ecosystems. According to Schneider *et al.*, (2001) land use land cover change are mostly caused through the conversion of forest lands into residential areas and farm lands. Deforestation, Urban development, agriculture and other human activities have substantially altered Earth's landscapes. Such disturbances of the land affect important ecosystem processes and services which have wide-ranging and long term consequences (Lubowski *et al.*, 2006)

Over the last three decades Kenya's savanna wildlife rangelands have been experiencing significant changes in land use and land cover patterns due to the increasing anthropogenic activities arising from the rapid human population growth (Kioko *et al.*, 2006). The rapidly increasing land use activities in these wildlife ecosystems contribute to the degradation of historically known and available wildlife habitats outside wildlife protected areas (Campbell, 2000). Wildlife conservation and management systems in Kenya are dependent on savanna ecosystems outside the established wildlife protected areas, but the sustainability of these ecosystems are threatened by the expanding human activities. Kenya's wildlife protected areas (WPAs) are under threat from human population pressure and immigration, land use changes, over harvesting of natural resources and climate changes (Olukoye *et al.*, 2004). Human population growth and wildlife numbers are inversely related (Kamande, 2008). In her study in Taita Taveta district with communities residing adjacent to Tsavo National park, Kamande (2008) showed that wildlife numbers decreased with an increase in human population. A downward trend in wildlife numbers between 1990s and 2010s in Tsavo west national park indicated that the increase in human-wildlife conflicts experienced by the local communities was not triggered by increase in wildlife, but by change in land use to one that is incompatible with wildlife conservation.

Savanna rangelands outside wildlife protected areas (WPAs) are critical wildlife dispersal habitats which have been on decline over time. Their decline have been attributed to land fragmentation due to human population immigration and the expansion of agriculture and urbanization to the marginal areas (Okello and Kioko, 2010). Land use land cover change around wildlife protected areas has had far implications for the conservation of wildlife. Wildlife protected adjacent areas are critical in providing seasonal foraging and watering points for many species of species of wildlife. Also such adjacent habitats are breeding grounds and act as migratory corridors for wild animal residing in the protected areas (Okello and Wishtemi, 2006). Despite the importance of wildlife adjacent areas, their existence has been exposed to land use land cover change due to the increasing livelihood needs of the adjacent communities, a situation that retards the viability of wildlife protected areas (WPAs) as sustainable wildlife conservational areas.

The escalation of human wildlife conflicts (HWCs) is one of the main issue of concern associated with land use land cover change around wildlife protected areas (FAO, 2009). Human wildlife conflicts have been on the rise and are becoming a major challenge to adjacent communities' sustainable livelihoods and wildlife management authorities in many countries Kenya included (Kenya Wildlife Service, 2012 & FAO, 2009). Elgeyo Marakwet County in which it host Rimoi National Reserve (RNR) has been experiencing challenges associated with human wildlife conflicts and competition over the natural resources which the local community consider valuable and important towards the achievement of livelihoods needs (Kenya wildlife service, 2012). Rimoi National Reserve adjacent areas are communal lands which are undergoing demarcation and adjudication for freehold ownership, and the demand for land and other associated resources is certainly on the rise. Land use land cover (LULC) change has certainly contributed to the

increasing HWCs and considering the fact that the demand for land in this region for settlement and crop production is increasing in the face of Kenya's population growth rate of 2.6% p.a (KNBS, 2009). The dominant communities within Rimoi National Reserve adjacent areas are the Marakwets and Keiyos who are the sub ethnic tribes of the main Kalenjin community in Kenya whose pastoral life styles are changing in favour of sedentary farming, a land use land cover change which has continued to challenge wildlife conservation in the area. Therefore, the study sought to analyze trends in land use land cover change and human immigration as some of the known causes of conflicts to establish their possible contribution to human wildlife conflicts experienced in Rimoi National Reserve adjacent areas and other implications to the protected area. Land use land cover changes were analyzed from multi-temporal images and ground truthing data with a view to understanding the dynamics of land use and land cover changes from 1986 to 2006 of Rimoi National Reserve and the adjacent areas

## **Materials and Methodology**

### **Conceptual Framework**

The study adopted political ecology framework where it emphasize that land use land cover (LULC) change are the resultant product of interactions between societal reflections on economic, social and political processes, and the physical environment. These interactions further occur in different scales over time and space. The society-environmental interaction conceptual frame work was further guided by the following principles:- i) Societal processes and the physical environment are the active components of land use change systems ii) Analysis of temporal dimension of land use land cover change pattern interaction is important in understanding their causes and time period and iii) appreciating the fact that different societal processes such as population growth or changes in government policies have different impacts on land use and land cover change which are temporal in nature.

### **Aims of the study and Justification**

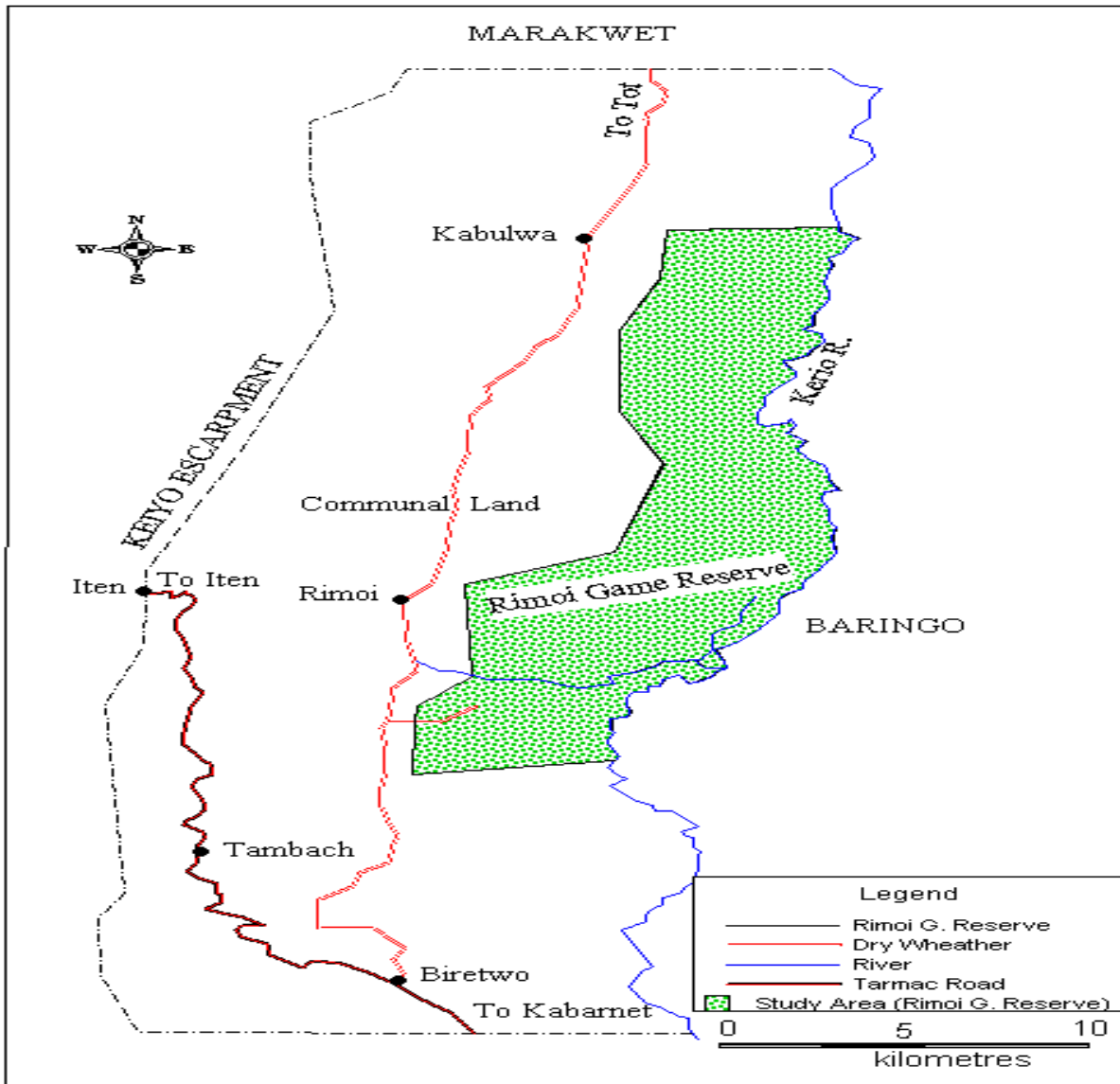
The choice of Rimoi National Reserve and adjacent areas as the basic unit of analysis was considered appropriate for several reasons. First, the area contains a major protected wildlife conservation area within the Kerio Valley Conservation Area (KVCA) which relies heavily on the surrounding adjacent areas for wildlife dispersal (Mizutani *et al.*, 2005). Second, any potential to experience serious land use conflicts in this area will invariably involve wildlife as a key factor. Thirdly, Kerio Valley Conservational Areas (KVCA) like many other savanna rangelands in Kenya, has been undergoing major land tenure reforms since 1989. This is following a government directive to shift the tenure system from communal/group ownership to privately (fee hold system) owned individual system through land subdivisions. Fourth, KVCA has the potential for wildlife conservation in a multiple land use system. This recognizes the fact that wildlife conservation is not the only legitimate form of land use in this area. Hence the study focused on assessment of the rate and spatial patterns of wildlife habitat distribution and disturbances within and adjacent to Rimoi National Reserve.

### **Description of the Study Area**

The Kerio Valley Conservation Area (KVCA) figure 1 lies in the Northern part of Kenya and comprise approximately 1485 km<sup>2</sup> of which less than 7% represent Rimoi NR and the adjacent areas, while the rest are communal land inhabited by the Keiyos and Marakwets pastoral communities. Rimoi National Reserve lies at the bottom of the Kerio Valley along the spectacular

Kabarnet - Iten road. The area is a migratory corridor for the savanna elephants and other wild animals and the entire region is prone to cattle rustling, a contributory factor to the perennial poaching problems being witnessed within the area. It is probably also one of the least frequented Reserves in terms of visitor visitation in Kenya where determined efforts are required to increase visitation. The national reserve borders Kerio River in Elgeyo marakwet County, which flows northwards to Lake Turkana. Rimoi National Reserve is located at an altitude of 1,000-1,600 M. A. S (SARDEP, 2000b) and receives an average of 700-1000 mm of rainfall p.a. It is warm for most part of the year with temperatures ranging between 22<sup>0</sup> and 31 °C. The Iten- Kabarnet tarmac road that traverses the Location in an East-West direction is fed by several small roads. Rimoi location is spanned by three agro ecological zones. The highland which is between 2,500-3,000 m A.S.L. which lies in the west, the Kerio escarpment which lies between 1,300-2,500 m A.S.L on the intermediate, and the lowland (the Valley floor) in the east which is situated between 1,000-1,300 m A.S.L (Muchemi, Mwangi and Greijn 2002a; 2002b). In the past, Keiyo escarpment has always been inaccessible due to the poor availability of service facilities and roads, and people have settled sparsely along springs or streams. Traditional extensive shifting cultivation for subsistent crops, such as sorghum and finger millet, has been long practiced in the escarpment (Mizutani *et al*, 2005)

**Figure 1: Map of the study area**



*Source: Prepared from Topographic sheet, 2013*

#### **Data used**

Changes in land use land cover was mapped by use of IRS-P5 LISS IV satellite image of 1986, 2000 and 2006 procured from the Regional Centre for Mapping of Resources for Development (RCMRD), Nairobi (Kenya). The procured images were geometrically corrected using scale 1: 250,000 survey of Kenya toposheets for Rimoi National Reserve and adjacent areas and was referenced to geographic coordinate systems, WGS64 datum. The three time period satellite data (1986, 2000 & 2006) were then subsetted to obtain the study area. Digital Elevation Model (DEM) of the Rimoi National Reserve and the adjacent areas were downloaded from the advance space borne thermal emission and reflection (ASTER) Global DEM website (<http://gdem.ersdac.jspacesystems.or.jp/>) on 14 June 2013. Moi University department of Geography reference maps and survey of Kenya (SOK) toposheet were used to generate ancillary database on human settlement, agriculture, bare grounds, shrubs and forests. Three software's were

used in data processing which included ArcGIS (ESRI 2007) for paper digitization, data overlay and map preparation. ERDAs imaging for satellite image processing and IDRISI for land use and land cover change analysis

### **Data Analysis**

The processed satellite imageries of 1986, 2000 and 2006 were virtually interpreted and classified using unsupervised classification (Survey of Kenya (SoK) Data techniques). The produced maps were compared with the respective satellite images and cleaned by re-coding. The built up areas and water masses were captured separately using area of interest (AoI) tools and subsequently re-coded (Areen dra *et al.*, 2013). Land use and land cover (LULC) data sets were re-casted to UTM coordinates system (Zone 2 WGS 64) datum after classification for calculation for area of change statistics. Field truthing verification of the final output were carried out to calculate and ascertain the accuracy of 2006 land use land cover change. Field truthing was done in the month of March when the local community were preparing their farms for next planting season and August when the area is experiencing a lot of socio economic activities. Random points were selected and Global Positioning System (GPS) was used to map the coordinates of the selected land use land cover points for further analysis.

Satellite image interpretation was adopted as the appropriate analytical tool for the acquired data. The use of remotely sensed data information to describe and analyze wildlife habitat relationships and the general ecosystem changes has been increasingly applied in the monitoring of land use and land cover changes (Sperduto & Congalton, 1996). Odenyo (1979) used Landsat imagery to analyze land cover type condition in the savanna ecosystem of Narok in Kenya while Mushove (1994) used multi temporal satellite image analysis in monitoring human encroachment on to Mzola forest reserve in Zimbabwe. Results of these studies has shown that the application of this technology to analyze land use land cover changes in savanna ecosystem can yield quality results.

### **Establishment of land use/Land cover Change**

Multi-temporal landsat data processing and classification was done using the procedures outlined by Yang and Lo (2002). Five land use classes; - agricultural land, shrub & acacia trees, Bush land, bare ground and forested wood land were delineated as the major land use and land cover types existing in the study area. Satellite imageries were overlaid in ArcGIS<sup>®</sup> (ESRI, 2007) to determine the area covered by each land use cover type. Additional information on community perception on wildlife rangeland health status was obtained. These information was gathered from households (N=248) residing within the wildlife protected adjacent areas, and were asked their information regarding their socio economic programmes and the magnitude of human wildlife conflicts

### **Results**

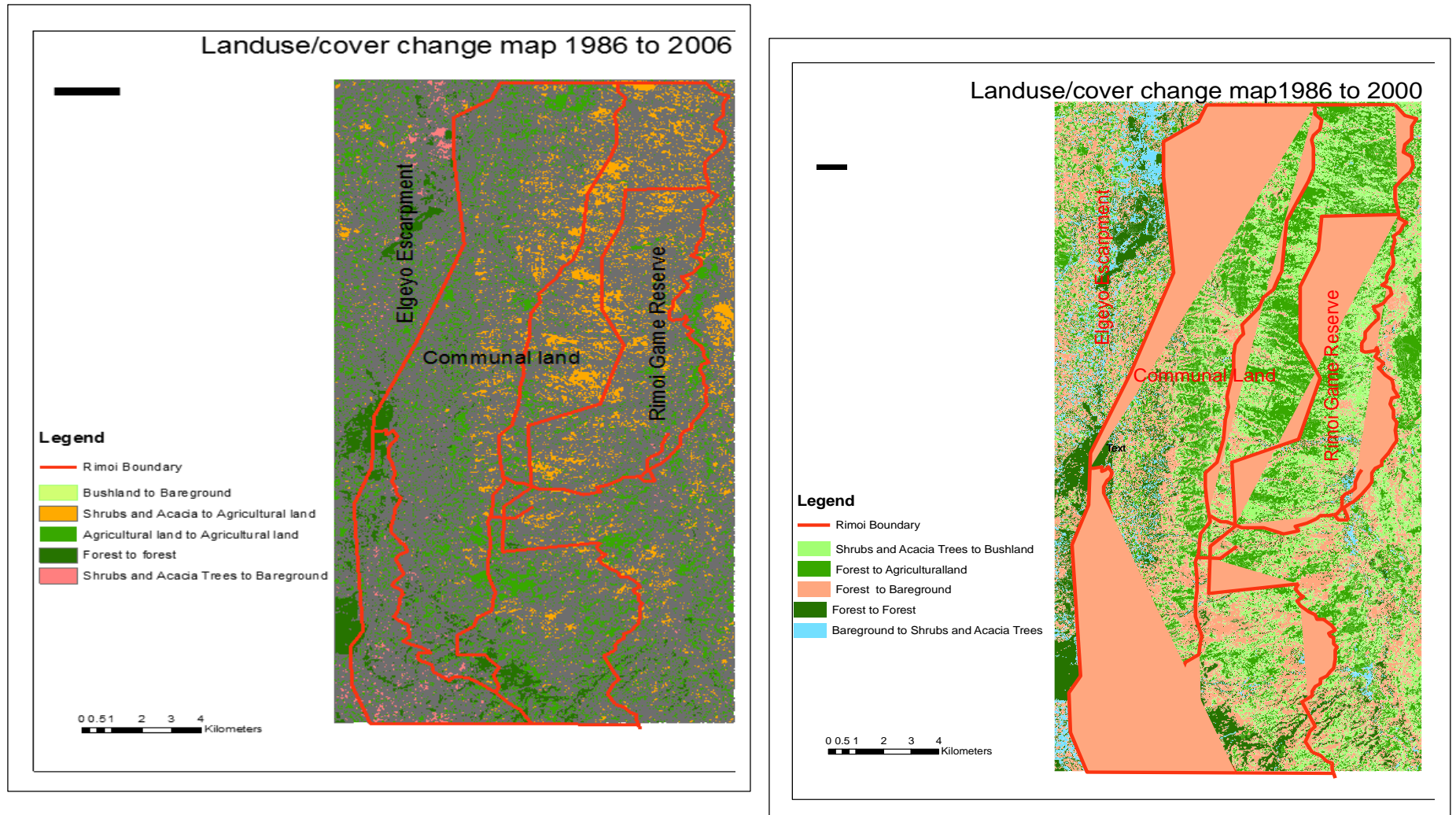
#### **Land use land cover changes**

The land use land cover interpretation yielded five (5) different land use land cover types which were considered useful and spatially significant for the current analysis. The five land use land cover types in Rimoi National Reserve and the adjacent areas are shrubs & acacia trees, bush land, bare ground, forested woodland and agriculture (farms and settlement) table 1. The use of the word “current” implies the latest available information from satellite images. For the purpose of this study “current” refers to 2006 which was the latest available satellite images of the study area. It is assumed that the extent and location of the major land use/cover types and changes have not

changed greatly at the map scale 1:250,000 between 1986, 2000 and 2006. Figure 2 shows the extent and location of the different land use/cover change types for 1986 - 2000 and 2000 - 2006 and 1986 – 2006 overlays respectively

**Table 1: General Physiognomic Description of the five land use/cover types in the habitat classification in Rimoi NR and adjacent areas**

<b>Land use/cover type</b>	<b>Vegetation Description</b>	<b>General Remarks</b>
<b>Shrub &amp; acacia trees</b>	<i>Acacia tortilis, Acacia nubila, Hyphaene Ventricosa, Salvadera Persica and Acacia Seyal</i>	Shrub savanna with dense layers of shrubs which offers opportunity for foraging and browsing
<b>Bush land</b>	<i>Acacia mellifera, Dodonea Viscodesa, Cynodon Plectostachyus and acacia commiphora</i>	Acacia commiphora and acacia mellifera combination forms good browsing for wildlife while understory provides grassy for wildlife to forage
<b>Forested Woodland</b>	<i>Uvaria scheffleri, Pittoporum Vilidiflorum, Acacia Xanthophlea, Acacia Elatior, commiphora africanus and Ficus Sycomorus</i>	Good and important for dry season grazing, browsing, shade and general cover for wildlife
<b>Bare Ground</b>	<i>Themeda Triandra, Digitaria Macrolephera, Sporobolus Fibriatus</i>	These are annually grasses and forbs which wildlife graze and dry out leaving the soils exposed and the vegetation cover has little or no forage during the dry season
<b>Agriculture (Farmland &amp; settlement)</b>	Maize, tomatoes, Irish potatoes, beans, bananas and fruit trees such as avocado and mangoes	Pastoralism, livestock husbandry, fallow land and settlement were considered part of this category



**Figure 2:** Land use land cover over lay changes for the years 1986-2000 and 2000-2006



### **Land use land cover changes between 1986 and 2006**

Five land use land cover (LULC) types and their dynamics were discriminated as bush land, shrubs & acacia trees, agriculture (farmlands and settlement), forested woodland and bare ground as shown in the classified land use land cover maps figure 2. In 1986, agriculture which constitute farmlands and human settlement occupied 8.3% of the total land area of Rimoi NR adjacent areas, however, over time it expanded to take 28.7% of the total land area in 2006 table 2. The most drastic expansion occurred between 2000 and 2006. Wildlife habitats especially bush land decreased throughout the period of the study in favour of agricultural development and human settlement by 29.0%, while shrubs and acacia trees increased by 24.2%. This increment of land use land cover was attributed to the increasing populations of elephants in the study area with their habitat damaging effects on bush land reducing it to shrubs and acacia trees cover.

The area of each land use land cover categories for the three time period (1986, 2000 and 2006) and their respective percentages are as shown in table 2. Between 1986 and 2000, major changes were observed mainly in bush land, shrubs & acacia trees, agriculture and bare ground. In the subsequent time period (2000-2006), bush land cover increased by 29.3% attributed to the decline of elephant populations associated with poaching by rustlers as during this period cattle rustling was rampant in the study area. While forest cover declined by 77.8% and agriculture constituting crop land and human settlement increased by 335.6% while bare ground land cover experienced no change over the study period. The overall change in forest woodland and bush land cover between the three time period were 61.4% and 29.0% decrease respectively, while agriculture constituting farmland and settlement had the greatest change of 245.2% increase in the study period table 2. Compared to all other land use and land cover changes, shrubs & acacia trees and bare ground showed the least changes at 24.2% and 32.3% increase respectively.

The area under bush land cover experienced a 45.0% decline by 2000 and a 74.3% gain (restoration) by 2006, but the overall change in bush land cover was however, a decrease by 29.0% table 2. The area under cultivation, human settlement and other human developments overall in the three time period increased by 245.4%. The decrease in bush land cover by 29.0% and forested woodland by 61.4% occurred between 1986 - 2000 for bush land cover and between 2000 - 2006 for forested woodland, a time during which there was agitation by community members for communal land subdivision for private ownership (freehold). This resulted in an increase in land sales which is attributed for an influx of migrants in search of farm lands and the emergence of new settlements in this wildlife rangelands. The most significant changes ( $P= 0.001$ ) were observed in shrubs & acacia trees, agriculture and forested woodland cover. This was also followed by bush land with significant increase ( $P = 0.006$ ). Increase in bare ground was not significant table 3.

**Table 2: land use land cover change (in Hectares) in Rimoi National Reserve and adjacent areas between 1986 and 2006**

Land use land cover	1986		2000		2006		Change 1986 - 2000		Change 2000 - 2006		Overall change 1986 - 2006	
	Area in Hec.	% change	Area in Hec.	% change	Area in Hec.	% change	Area in Hec.	% change	Area in Hec.	% change	Area in Hec.	% change
Bush land	36471	41.7	20028	22.9	25893	29.7	-16443	-45.0	5865	29.3	-10578	-29.0
Shrubs & acacia trees	21098	24.2	26207	30.0	26207	30.0	5109	24.2	-	-	5109	24.2
Agriculture	7245	8.3	5746	6.6	25027	28.7	-2099	-30.0	19281	335.6	17782	245.4
Forested Woodlands	14897	17.1	25894	29.7	5746	6.6	1102	7.4	-20148	-77.8	-9151	-61.4
Bare Ground	7552	8.7	9989	11.3	9989	11.4	2437	32.3	-	-	2437	32.3

**Key:** Hec. = Hectares

**Source:** *GIS Landsat imagery analysis, 2017*

**Table 3: Chi square goodness of fit test for the various land use land cover changes in Rimoi NR and adjacent areas between 1986 and 2006**

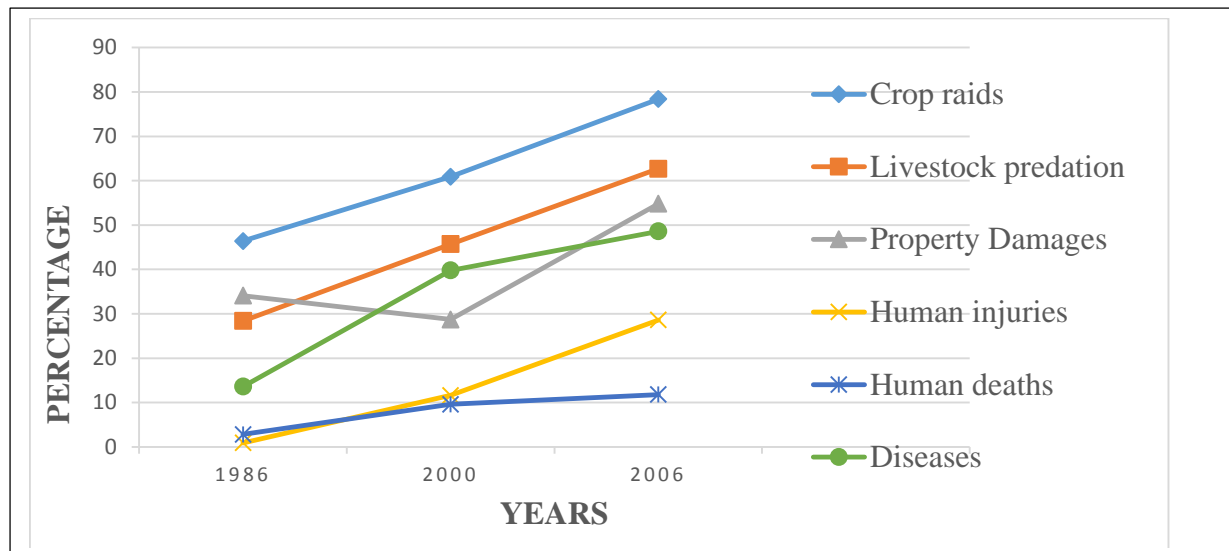
Land cover type	1986 (Hectares)	2000 (Hectares)	2006 (Hectares)	Change in land use cover	X <sup>2</sup> Goodness of fit test
Bush land	36471	20028	25893	-10578	X <sup>2</sup> = 3.479, df=3 P = 0.006
Shrub & Acacia trees	21098	26207	26207	5709	X <sup>2</sup> = 4.627, df=3, P = 0.001
Agriculture	7245	5746	25027	17782	X <sup>2</sup> = 2.964, df=3, P = 0.001
Forested Woodland	14897	25894	5746	-9151	X <sup>2</sup> = 9.752, df=3, P = 0.001
Bare Ground	7552	9989	9989	2437	X <sup>2</sup> = 5.496, df=3, P = 0.584

**Source:** *Author, 2017*

### Human Wildlife Conflicts

Human wildlife conflicts (HWCs) increase in the study area has been steady and strongly related to the time period of the study figure 3. Although HWCs menace increased throughout the three time period study (1986, 2000 and 2006), sharp increase between 2000 and 2006 was observed compared to other time periods. Overall, Rimoi NR adjacent areas have been experiencing socio-economic difficulties, losses and fatalities as a result of wildlife crop raids, livestock predation, and human injuries and deaths as a result of wildlife figure 3

**Figure 3: Human Wildlife Conflicts incidence in Rimoi NR adjacent areas**



Source: Author, 2017

### Environmental implications of land cover changes on Wildlife Conservation

Different studies in the Kerio Valley Conservation Area (KVCA) has reported that there has been a significant human intervention which has resulted in changes in land use land cover over the past decade (Maitima, 2009). These changes in turn has resulted in the loss of some wildlife in the protected area. According to Maitima (2009), Rimoi NR is one of the North Rift elephant migratory holding point whose biodiversity capability is being weakened by land use land cover change. Historically, Rimoi NR biodiversity abundance included Beisa Oryx, Kongoni Hartebeest, Buffalos, Black Rhino, Water bucks, Lions and Giraffes which have been exterminated and replaced by smaller wild species such as Colobus Monkeys, Grant Gazelles, Greater Kudu, Klipspringer and Hyenas (Kioko *et al.*, 2006). These species are rare nowadays and there are only exceptional sights if one ever spots them. There are also reports that the biodiversity are in constant decline

### Discussion and Conclusion

Landsat imagery analysis of the study area showed that the land use land cover (LULC) changes have taken place between 1986 and 2006. Rimoi NR adjacent area wildlife habitats especially the forested woodland, bush land covers were mainly converted to farm lands and settlement areas. , although shrubs & acacia trees cover did not show significant changes for the period under observation. It was also observed that agriculture which constituted farmlands and human settlement increased and expanded over the 20 year period. This was mainly because of the local community agitation for communal land subdivision for individual ownership (free hold) necessitating land sales which attracted land less migrants in search of farmlands and new settlements in the wildlife rangelands. This findings point out to similar

study of land use land cover done in Kenya by Kioko *et al.*, (2006). In their study of land use land cover change in Amboseli basin, they observed that concurrent changes over a period of 20 years (1984 – 2004) land cover changes was attributed to communal land sub division and government policy promoting agriculture in marginal wildlife rangelands. They also observed that the extend of land cover under cultivation and human settlement increased significantly while forested woodland and bush land declined significantly as well in the Amboseli wildlife basin.

Land use land cover in this wildlife conservation area has been occasioned by an increased demand for land resources for cultivation, human settlement, infrastructural improvements, urbanization and government policy on land privatization (Free hold ownership) with little deeds for faster economic liberation of the marginalized communities. The expansion and growth of cultivation and the emergence of new human settlements has been attributed to the immigration of human population in part attracted by land sales occasioned by communal land subdivision. Many studies have described agriculture and settlement as the major drivers of wildlife habitat loss. Murphee (2005), while studying the effectiveness of Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) conservation programme on land use and land cover changes in Zimbabwe observed that the major land conversion were from bush land to farm land cultivation and human settlement. Other studies by Campbell *et al.*, (2003), Okello and Mizutani (2005) indicated that agricultural expansion has been associated with deforestation in Kenya and the world over.

The expansion of agricultural activities and an increase in human settlement in the study area has been attributed to the fact that the preceding time period of 1986 to 2006 was characterized with the Keiyo sub ethnic community of the larger Kalenjin tribe contesting the establishment of Rimoi National Reserve in their ancestral land without adequate compensation for the loss of their land. The infrastructural development and improvement of Biretwo – Rimoi – Kabulwo – Chekilet road network in 2003 accelerated land use land cover change in the study area. This improvements facilitated easy access of farmlands across the Kerio River which hither to the opening up of the area was inaccessible. Furthermore, the infrastructural developments opened up livestock markets at Kabulwo and Cheptem trading centres to nearby large urban areas of Kabarnet, Iten and Eldoret, thus driving agricultural expansion in the study area. Similar observations were made by Mizutani *et al.*, (2005) in Rokocho, Keiyo South constituency where between 1994 and 2002 land use land cover change were found to be influenced by the existence of agricultural land, infrastructure and proximity to urban areas of Iten, Kabarnet and Eldoret.

Human wildlife conflicts (HWCs) was also observed to be on an upward trend in the study area with crop raids leading the pack of conflicts followed by livestock predation, property damages, human injuries & deaths and disease transmission in that order. This was attributed to the diminishing wildlife habitats (bush land, shrubs & acacia trees and forested woodland covers) as a result of agricultural expansion in the area over the study period. Therefore, land use land cover changes in this wildlife dispersal area could have far reaching implications in terms of wildlife conservation. Having reduced the extend of wildlife habitats, land use land cover changes will likely affect the wildlife species in Rimoi National Reserve especially the elephants and other browsers which require extensive home ranges

### **Conclusion**

The current state of affairs in Rimoi NR adjacent calls for quick and concerted efforts in order to overcome the problem of wildlife habitat destruction and other forces threatening the Kerio

Valley Conservation Area (KVCA). This is because the continued influx of migrants in search of new settlement and cultivation grounds will further encourage wildlife habitat fragmentation. A number of strategies could be employed in dealing with the negative land use land cover facing the study area to ensure conservation of wildlife successfully co-exist with local users. One such is to promote incentive to increase economic returns from wildlife for the local community to be motivated to conserve wildlife. Another best proposed strategy is to develop a comprehensive land use zoning plan that would be used in the management of agricultural expansion and human settlement, tourism programme development, mechanized farming and access to and impact on main natural resources such as water points/sources and wildlife migratory routes.

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### **Conflicts of interests**

The author declare no conflict of interest

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