Forest cover of Kibonge Forest in Kenya between 1974 and 2016

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Abstract

This report outlines, describes and analyses the status of Kibonge forest for purposes of synthesizing and presenting information to be easily understood by policy makers and forest conservators. Data on national cover change and drivers is scarce thus constraining design and regional approach to policies and practices for sustainable forest management and use. This study aims at giving the forest cover using Landsat imageries. Data was collected between, July 2013 and July 2014. The status of the forest was established by taking, eight multi temporal Land sat imageries at intervals of 4 years from 1978 – 2016. The mappings were prepared while following six major steps: pre-processing satellite images, visual image interpretation, field data collection (ground truth), field data analysis, digital image classification and map accuracy assessment. Measurements were given as percentage cover. There was a general decrease ($n=7$, $r = 0.956$, $p< 0.001$) in the size of Kibonge forest especially between 1989 and 2010, forest area decreased by 5.9 % similar to a decrease of Mt. Kenya forest during the same period. There was increase in cropland and grassland area by 11.08%, a strong indicator of human encroachment to the forest. There is need for forest protection to allow regeneration of indigenous species, reforestation and establishment of buffer zones made of exotic species between human settlement and the forest. Improved law enforcement of illegal logging, proper forest management, sufficient funding and the promotion of alternative human resources are the best measures to restore the forest canopy cover.

Keywords: Canopy cover, Landsat imageries, forest loss, Reforestation

INTRODUCTION

This report gives clarity to status and type of pressures of forests in Kenya, for purposes of responding to the need for policy making and resource utilization while basing on current reliable information. Forest covers 6.99% of total land area of Kenya (MENR 2016).

Kenya's has four forest cover types: western rainforest (western plateau/Guinea-Congolian rainforest), Afro-Montane undifferentiated, dry land and coastal forests (MENR 2016), as well as plantation and farm forests. Montane forests (1.14 million ha), and mangroves and bush lands (2.13 million ha) are dominant. Western Kenya's Kakamega and Nandi Hills rainforests are representative of Guinea-Congolian rainforests stretching from the Congo Basin to the West African coast. Bamboo and mixed indigenous afro-Montane forests are found on Kenya's major 'water towers' - Mount Nyiro, Mount Elgon, Mount Kenya, Mount Kulal, Mount Marsabit, Mau Forest Complex, Cherangani Hills, the Aberdares and the Mathews range. Coastal forests consist of mangroves and coastal natural forests, while dry land forests can be found in the Taita Hills, northern Kenya's hills and eastern and north-eastern regions; these occur in low-lying sandy alluvial soils and are both riverine forests in floodplains and along rivers and tributaries, and dry savannah forests (MENR 2016).

Kenyan forests are highly valued for they contribute to socio-economic development. It boosts local and national economies by 0.7 % annually (KNBS, 2016) through sales of forest products, food and energy, employment and ecosystem services. The ecosystem provides habitats to wildlife and tourist activities (MENR 2016). However, these forests are widely endangered by deforestation. LULC analysis revealed Kenya's deforestation rate was 0.05 % in 1990-2000 (Ministry of Forestry and Wildlife 2013). Although forest declined by 0.199% from 1990 to 2000, it has been increasing at a rate of 0.109 % annually due to improved afforestation efforts (Ministry of Forestry and Wildlife 2013). This study aimed to determine the forest size using landsat imageries and to identify the human activities affecting forest land.

METHODOLOGY

Kibonge forest is located at $0^{o}10^{/}47$–$0^{o}26^{/}37$N and $35^{o}27^{/}12$-$35^{o}41^{/}43$E *in* the Rift Valley e of Kenya covers an area of 8.7Ha. The study area is divided into three main agro-ecological zones which run parallel to each other in a North-South direction; highland, the Elgeyo escarpment and the Kerio Valley basin. The highland lies at an altitude of approximately 3000m above the sea level and extends across the constituency from North to South. The land falls precipitously in a series of steep uplands Kapchebelel ranges to the South of Nyaru town, which comprise the Elgeyo escarpment. The Kerio Valley basin is 1000m above the sea level.

The climate of the place is relatively wet with an annual rainfall of 1400mm. The long rains occur between March to August with the wettest and coldest months being July and August. Short rains are between October and December. Temperatures vary from, 4^{0}C during the wet season and 18^{0}C during the dry season. Soils are majorly volcanic loam. The steep slope has thin layers of soil due to increased erodibility of soil though with a higher concentration of indigenous forest of a typical rainforest while the gentle sloping area, has plantations of *Cyprus spp and Pinus spp.* The forest has greatly been excised due to increased need for more land for grazing livestock and crop farming thus invoking the need for documenting the forest cover of the place. Inhabitants engage in agriculture, flouspar mining and trade (Muchemi et.al.2008).

An actual field assessment was done in May 2013 to identify sampling stations, for purposes of determining the type of vegetation of the place. Two belt- transects of 3km long were determined using the government topographic maps and were marked to best fit inside the forest habitat. The coordinates of the peripheries of the study area, were established using a Garmin Plus Global Positioning System (GPS). Also using the determined distance as reference and GPS, the sampling points for status of the forest were marked at an interval of 100m along the transects.

Status of forest covers in Kibonge forest

The status of the forest was established by taking, eight multi temporal Land sat imageries at intervals of 4 years from 1978 - 2016 were purchased from the Regional Centre for Mapping Resources for Development (RCMRD) in Nairobi, Kenya. The maps were compared for identification of any change in forest size. The mappings were carried out based on a method described by Janssen and

Huurneman (2001) which involves six major steps: pre-processing satellite images, visual image interpretation, field data collection (ground truth), field data analysis, digital image classification and map accuracy assessment. Estimation was given in terms of percentage cover (Enquist, 2002).

Coverage % = Area covered by a species(Basal area) in a line transect divided by the total area

covered by all the species multiplied by 100.

Relative coverage = [Coverage (Dominance of a particular species) / the total coverage (Dominance) for all the species in a stand] x 100.

RESULT AND DISCUSSION

Kibonge landsat imageries were analyzed and the results showed a great decrease in the size of the forest over the years 1978 to 2016 as shown by the figure 1.0

These maps are showing a general decrease ($n=7$, $r = 0.956$, $p< 0.001$) in the size of Kibonge forest.The obvious evidence is between the years 1989 and 2010 (Fig 1). In all the years, the size of cropland, bare soil, grassland and low open grassland kept increasing while that of closed wood land, tall dense grassland and water body decreased (Fig 2). Analysis showed that between 1989 and 2010, forest area in Kibonge decreased by 5.9% as well as tall dense grassed shrub land by 8.15% and water body (0.05%) while open grassland and cropland increased by (11.08%) and (1.4%) respectively. A Pearson's correlation showed a significant difference in Kibonge forest size (Pearson correlation; $n=7$, $r = 0.956$, $p< 0.001$) (Table 1).

Table 1: Correlation between land use land cover sizes compared over years 1978-2016

		Forest	**Cropland**	**Grassland**	**Bare soil**	**Water body**
Forest	Pearson Correlation	1	-.328	-.767	.062	.913
	Sig(2-tailed)		.787	.443	.961	.267
	N	3	3	3	3	3

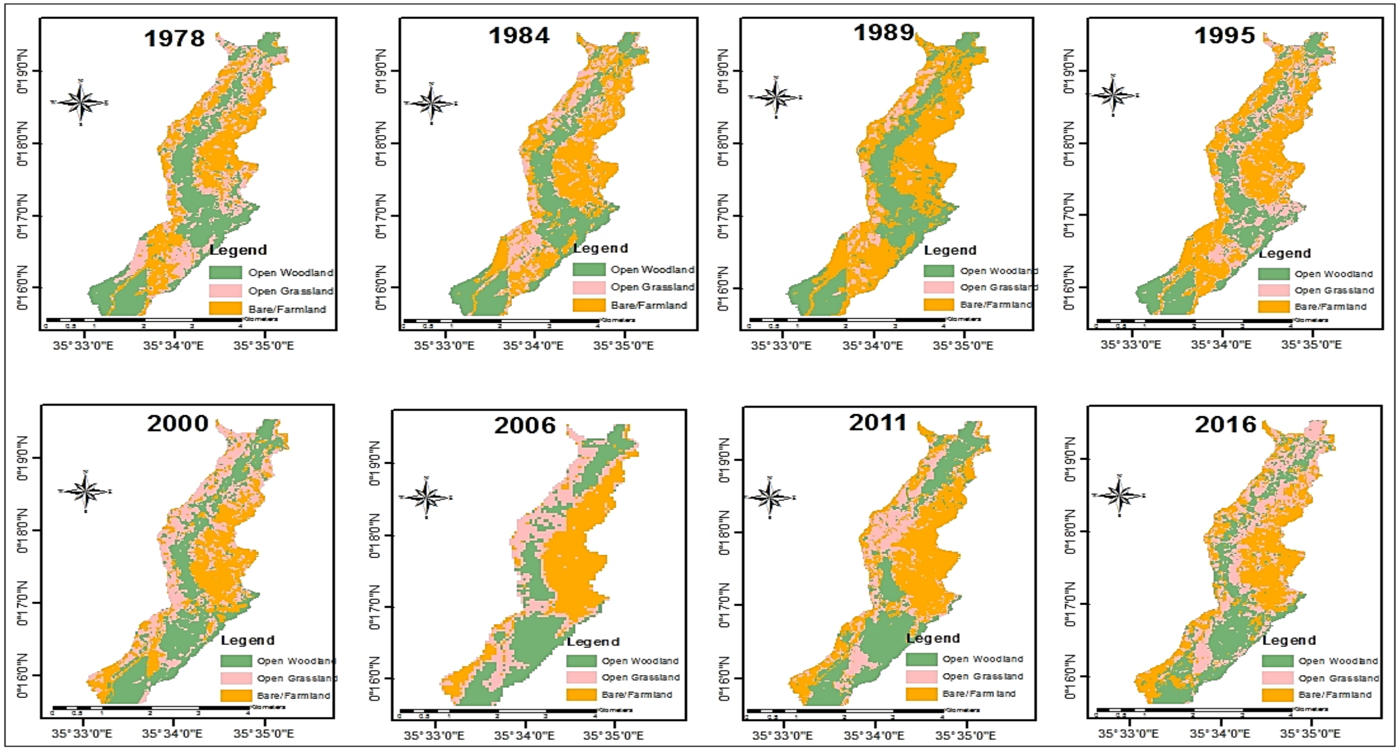

Figure 1: Land sat images of Kibonge forest showing changes in landuse landcover over the years 1978- 2016 respectively.Food trees were distributed in woodlands and in low open and tall densed shrubland

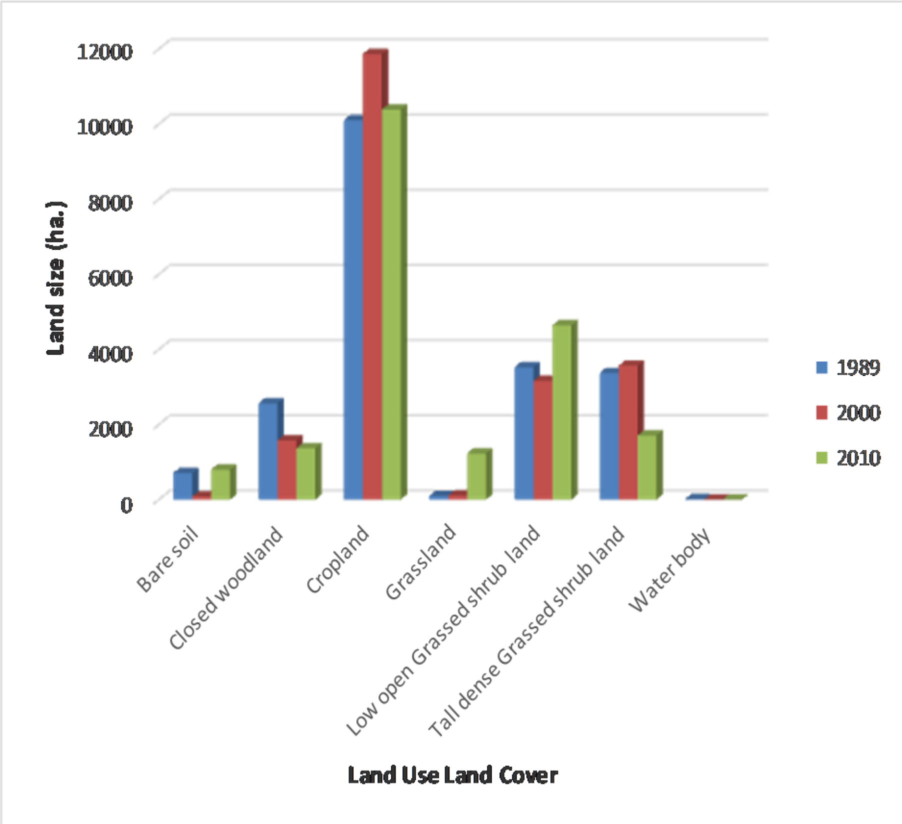

Figure 2: Land sizes (Ha) of LULC of Kibonge, compared over the years1978-2016

The overall resource abundance as measured by basal area (m^2/ha) for all trees in Kibonge forest was 23.7489m^2/ha.

Decrease in forest area subsequently increased the open grasslands and cropland. This study collaborates with the study done by (Ministry of Forestry and Wildlife., 2013) on analysis of drivers and underlying causes of forest cover change in the various forest types of Kenya and reported that, while the area under forest reduced from 46,450 ha in 1973 to 23,850 ha in 2009, cropland nearly doubled from 49,950 ha to 99,800ha over the same period (MEMR., 2012). For instance, using aerial Landsat images, the forest cover of Mau forest complex experienced a decline in forest cover from 4695 km^2 in 1985 to 4041 km^2 in 2010 against an increase in area under agriculture (MEMR, 2012). This was partly due to excision of about 35,000 ha of East Mau forest for conversion into settlements in 2010, conversion to small-scale agricultural lands (Baldyga et al., 2008) , logging and development of infrastructure (Lambin et al.,2001, Ayuyo and Sweta,2014). Forests in Upper parts of West Pokot and Kerio Valley characterized by nomadic pastoralism are also experiencing a reduction in forest cover while crop area is increasing (MEMR, 2012). For Mount Kenya forest, forest loss was about 12.7 % between 1980 and 2000 (MEMR, 2012), 10.3 % of forest decrease in Mount Kenya from 1978 to 1987 (Ndegwa, 2005) and 7.2 % from 1987 to 2002 (Ndegwa, 2005). Similarly, Landsat imagery of Kakamega -Nandi forest revealed a reduction of natural forest cover by 34.4% of the 1913Ha (Nkako et al. 2005).

The pressure to produce enough food for the fast growing population has resulted to increased pressure on tropical forests, and has imposed irremediable harm to these ecosystems (Fashing et al., 2004). Forest-cover have undergone reduction from six billion hectare to four billion hectare of forest cover worldwide (Fao, 2012).In Kenya, loss in forest cover has been attributed to deforestation fuelled by intense human activities, and a rapid growth in population, Ministry of Forestry and Wildlife (2013).Therefore reduction of forests could affect hydrological cycles and habitats for wildlife ,which economically affects tourism (Mbugua 2003).

Basal Area and Canopy cover

Overall resource abundance as measured by basal area (m^2/ha) for all trees in Kibonge forest was 23.7489m^2/ha. Total basal area for Mt. Elgon forest (28.7m^2/ha) (Hitimana et al., 2004). The value obtained in the forest reserve is within findings reported by Kumar *et al*, (2002) for other tropical forests of the world. Equable tropical climate of the study area may have contributed to high tree growth rates and high tree basal area. The high basal area value obtained in this study is attributed to the high number of an exotic tree species, *Cuppressus lustanica* which had a large DBH and highest population.

CONCLUSION AND RECOMMENDATIONS

The study highlights negative correlation in forest size between the year 1989 and 2010, showing a drastic reduction in Kibonge forest in size and structure. The increase in cropland and grassland area by 11.08% is a strong indicator of human encroachment to the forest. There were more tree species concentrated on higher altitude (2400m) which was a steep slope where human activities could not take place. These points out the need for forest protection to allow regeneration of indigenous species, reforestation and establishment of buffer zones made of exotic species between human settlement and the forest. This will be achieved through improved law enforcement of illegal logging (Nkako et al. 2005), proper forest management, sufficient funding and the promotion of alternative human resources. In order to hasten recovery of the forest, further studies may be done to establish fast growing tree species suitable for the area to be planted on the bare grounds and increase canopy cover.

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REFERENCES

Ayuyo, I.O., and Sweta, L., (2014). Land cover and land use mapping and change detection of Mau complex in Kenya using geospatial technology. *International Journal of science and Research* (IJSR), ISSN (online): 2319-7064

Baldyga, T.J., Miller, S.N., Driese, K.L., Gichaba, C.M., (2008). Assessing land cover change in Kenya's Mau Forest region using remotely sensed data. *African Journal of Ecology* 46, 46-54.

Enquist B. J, Niklas K.J (2002). Global allocation rules for patterns of biomass partitioning for seed plants. *Science* 295(5559):1517–1520. doi: 10.1126/science. 1066360

Fao, F., 2012. Agriculture Organization (2009). State of the world's forests.

Hitimana, J., Kiyiapi, J.L., Njunge, J.T., 2004. Forest structure characteristics in disturbed and undisturbed sites of Mt. Elgon Moist Lower Montane Forest, western Kenya. *Forest Ecology and Management* 194, 269-291.

[KNBS] Kenya National Bureau of Statistics. 2016. Statistical Abstract 2016. Nairobi: KNBS

Lambin, E. F., Geist, H. J., & Lepers, E. (2003). Dynamics Of Land-Use And Land-Cover Change In Tropical Regions. *Annual Review of Environment and Resources*, 28(1), 205–241. doi: 10.1146/annurev.energy.28.050302.105459

Mbugua DK. 2003. The forest revenue system and government expenditure on forestry in Kenya. Rome: FAO.

MEMR, (2012). Master plan for the conservation and sustainable management of water catchment areas of Kenya. In Tropical forest conservation versus conversion trade-offs: Insights from analysis of ecosystem services provided by Kakamega rainforest in Kenya (Ministry of Environment and Natural Resources).

[MENR] Ministry of Environment and Natural Resources. 2016. National Forest Programme of Kenya. Nairobi: MENR.

[MFW] Ministry of Forestry and Wildlife. 2013. Analysis of drivers and underlying causes of forest cover change in the various forest types of Kenya. Nairobi: MFW

Ndegwa, L.W., (2005). Monitoring the Status of Mt. Kenya Forest Using Multi-Temporal Landsat Data. Unpublished MA thesis, Miami University