Institutions, livelihoods and forest dynamics: The case of Ramogi and Mau forests In Kenya.

Corresponding Author: George M.Okwaro[1] (kalamukenya@yahoo.com),

Co- Authors: Bernard J.M. Ngoda[2] (ngoda5@yahoo.com),

[1] Kenya Forestry Research Institute IFRI- CRC-K. P. O. Box 20412-00200 Nairobi.
[2] Egerton University. P. O. Box 536 –20115 Egerton

Abstract

The study investigates the forest condition changes, the spatial patterns of forest dynamics and the roles played by institutions and livelihoods in the forest cover dynamics. Landsat satellite imagery of 1986, 1996, and 2006 was used to create single data classifications and a Forest cover change image depicting the sequence of changes in forest cover between 1986-1996-2006. The spatial relationships between observed changes in the forested areas livelihoods and institutional factors are then determined.

The results show the rate of forest degradation in Mau forest (transition from close forest to open forest rose dramatically from 3 % in 1986-1996 period to 12 % 1996-2006 period. Fragmentation and excisions were more pronounced in the second period. It is observed that rampant forest change occurred in areas located close to road, near the village, at lower elevations and on more gradual slopes. Ironically relatively low levels of degradation was recorded in Ramogi forest, which is a semi government forest (legally government forest but with a *de facto* control and claim of ownership by local community and / county council.) The findings are further compared with results from an International Forestry Resources and Institutions (IFRI) - Sustainable Agriculture and Natural Resources Management (SANREM) based study on the forest adjacent households, association and effects on the forest condition. When compared the mentioned factors relate very closely and are very much similar.

Key words: Landsat, remote sensing, spatial and dynamism.

[1] Kenya Forestry Research Institute IFRI- CRC-K. P. O. Box 20412-00200 Nairobi.
[2] Egerton University. P. O. Box 536 –20115 Egerton

Introduction

Forest destruction and degradation has increased drastically over the last quarter of the century. This has been propelled primarily by activities of rural households seeking to improve their livelihoods. These activities have resulted in loss of biodiversity, degradation of water catchments and increase in greenhouse gases which have far reaching effects. This is has been blamed on poor monitoring and rule enforcement embedded in the institutions of management. It follows that sustaining these resources in the face of demographic and economic pressure is pegged on the success of the institution and cooperation of the forest adjacent communities. The last quarter of the previous century has seen increase in population and poverty levels especially among the rural communities coupled with diminishing options of means to livelihood. These developments exerted more pressure on the forest and institutions governing their utilization leading to degradation. This fuelled the need to have a better understanding of institutions in natural resource management.

In recent times, there has been a growing realization of the roles of institutions in the management of the forests and allied natural resources. These institutions just like in economic, political and cultural realm are crucial in shaping the practice management of forests such that slight changes in these institutions always result in major changes in composition and diversity of forests. In Kenya, gazetted forests have been under formal management since the passing of forest ordinances by the colonialists in 1901. Substantial amendments were made on this ordinance graduating it to forest Act 385 upon independence and later on, it was replaced by the Forest Act 2005. Despite these changes, other forests have been held sacred by some communities and thus managed differently by local institutions such as the Kayas of the Kenya's coast. It's interesting to note that these forests differ even in condition as they differ in institutional management.

The forest landscape in Kenya is characterised by big changes both in forest cover and management. These changes received considerable attention from the civil society organization and NGOs which propelled players in the field to craft new forest laws to replace the old archaic, mutilated and no-responsive forest policies that were in force earlier on. Studies by KFWG, FAN and MEN, 2007 have contributed to the understanding of deforestation and environmental degradation in forests of Kenya. Despite this, only a few studies have their base on qualitative evaluation of forest dynamics. Most of these studies examined causes, and results of deforestation. More over there have been very few attempts to analyze forest cover changes in the context of policy and institutional changes (Gautum etal 2002).

In order to understand the forces and processes of forest cover changes, integrated synthesis of socioeconomic and institutional data is essential. This study incorporates remote sensing for mapping change but also integrates biophysical, livelihoods and institutional data to interpret the forest change trends revealed by digital image analysis. Focus was on a section (Kedowa block) of the larger Mau forest in the Southern rift valley and Ramogi hill forest in the western region of Kenya. The two offer a good comparative study as one is a gazetted forest managed by the Kenya forest service and the other (Ramogi hill forest) a semi-government forest under de-facto control i.e. ownership is claimed by the local community. . We begin by discussing institutions and livelihoods in the context of forest management, then finalize by exploring and summarising the contribution of institutions and livelihoods in shaping the condition of the forests over a period of Fourteen years.

Forests and institutions

Institutions may be defined as a system of rules, decision making process and programmes that give rise to social practices and guide interactions among the occupants of relevant roles. They exist as formal and informal, sometimes fluid and ambiguous, and usually subject to multiple interpretations by different players thus making them dynamic continually being shaped and reshaped over time (Somanatha et al 2002). In the context of forest the ability to adjust institutions to changing environmental conditions is likely to become increasingly significant in a world of growing uncertainty and surprise (Gunderson 1999) but this ability is dependent on acquisition of forest knowledge and understanding of forest cover changes.

According to (Davies 1997:24), institutions are the social cement which links stakeholders access to capital of different kinds to the means of exercising power and so define the gateways through which they pass on the route to positive or negative (livelihood) adaptation. Institutions are thus very crucial in the policy and practice of sustainable management of forests and livelihoods. First understanding of institutional process allows the identification of barriers and gateways to sustainable livelihoods. Since formal and informal institutions mediate access to livelihood resources and in turn affect the composition of portfolios of livelihood strategies, an understanding of institutions and organization is therefore key to designing interventions which improve sustainable livelihood incomes visa avis resource conservation.

Forestry management in Kenya has undergone many changes that date back during the pre colonial era. During that time forests were managed in a decentralised manner with clans belonging to same communities managing what could be now a forest block independently. By 1908, the colonial government had gazetted major forests under the auspice of the first forest ordinances of 1901. By 1932, a total of 43 forests were defined as government forests. The colonial government was emphatic on serving the public good through protection of forests and water resources even if it led to displacement of the local communities (Kamugisha et al, 1997). At that time, the population was still small and forest use was still confined to hunting and gathering (provision of food) and market of forest products was very small or in some cases non-existent. By 1990, the total forest area gazetted was about 1,930,000 ha. The Kenya forest service (KFS) under the ministry of forestry and wildlife is responsible for management of all gazetted forests. Management of these resources is guided by the National forest policy supported by the Forest Act 2005. Activities of KFS include; establishment and management of plantation forests, law enforcement to control illegal extraction, licensing of extraction of forest products and fire protection.

The increased population densities, high demand of forest products and change of forest uses has caused conflict between the forest adjacent communities and KFS. There are existing conflicts between the objectives of the conservation programmes and those of the local communities. The sense of traditional ownership, responsibility and control of forests and their benefits by local communities have largely been ignored. In return, most communities view government control and management negatively, thus making them indifferent to conservation initiatives led by the government (Ongugo,Njuguna 2002).

To sustain long-term use of forests, collective action is needed to limit resource use and to undertake various forms of active management. Condition of the forest itself, characteristics of the resource users, and relations between the forest users and the forest affect the degree of difficulty associated with establishing restrictions on entry or extraction. It's clear that homogeneity or heterogeneity of the forest users and their size have an effect on trust and divergent of interest and thus influence prospects of collective action. Homogeneity may also have a bearing on collective action, for example sharing important social cultural and economic characteristics may increase the predictability of interactions (Fearon and Laitin 1996) generally common traits suggests common interest. Other than promoting trust and common interests homogeneity fosters collective action. One of the study sites Ramogi hill forest a community forest under de-facto control i.e owned by government but managed by locals through tradition and culture, explicit a high level of homogeneity. It is because of this ethnic homogeneity and the common social and cultural life and respect to tradition that has abated forest degradation for such a longer time. As compared to Mau kedowa government forest under formal institution where the associations are highly heterogeneous there lacks trust in members and high levels of rivalry resulting into poor levels of collective action. This has seen the condition of the forest deteriorate over time.

Forest and Livelihoods

Livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living (Elis, 2000). The forest adjacent communities are very rural and characterised by subsistence agrarian economy, supported heavily by sale of charcoal and fuel wood in the nearby urban settlements. With the growing rural urban migration, the urban market driven economy with its ever growing population provides a twist in the supply and demand forces of the provision of fuel wood and charcoal. Because of the inability of the locals to afford electricity or cooking gas they rely heavily on fuel wood and this brings an imbalance and elasticity of supply and demand of charcoal prompting the Forest adjacent people to thrive to supply more which in return leads to more destruction of the forest. It is this huge and ever growing demand of charcoal, fuel wood, poles and short cycle agricultural foods that contribute heavily to degradation of the forest. In spite of this there are several factors influencing the extent to which a household depends or even exploits forest resources. Such factors include: the distance from the forest, wellbeing of the household, household size, level of education of household members. In some cases distance and slope of the forest dictated the level of exploitation.

It's evident that the rural people are disproportionately dependent on forest resources in that higher proportion of their total income comes from the forest resource. This is so because there is greater access to non-forest income opportunities by those who are more powerful and resourceful and thus low returns forest activities serve as an employment of the last resort. To conceptualize the links between livelihoods, and forests, a wider spatial perspective has to be put into consideration. For instance demographic trends and other events outside the forest sector often have an influence on changes in modes of living and forest landscapes at local levels. For example, the forest transition theory, which relies on historical case studies, observes that forest resources tend to be abundant and healthy prior to economic development then diminish and degrade as development proceeds, and then re-emerge in high income countries (Mather and Fairbairn, 2000). This means that, when there is economic development worth providing employment to people sustainably, there will be a shift from over-dependence on forest, as forest related activities will be paying less and thus non-lucrative enough to attract people. In the Kenyan forest landscape, this is not likely to be achieved any soon and thus thriving for sustainable livelihood through non-consumptive forest utilization appears to be a more viable option. A livelihood is said to be sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets while not undermining the natural resource base. It's therefore arguable that local communities and the institutions governing utilization of the forests resources explore non consumptive means of livelihood such value added non-timber forest products, Forest tourism (garden wedding in forests etc) and if possible payment for environmental services.

Study area

Mau forest (Kedowa block)

Mau forest complex lies on longitude 35.33^0 E and Latitude 0.5^0 S. It covers an area of approximately 270,000 hectares and classified as a low montane lowland forest (Wass 1995). The forest reserve spans across six administrative districts: Narok, Nakuru, Bureti, Bomet, Kericho and Kipkeleon at an altitude between 1800-3000 meters above sea level. There are five main forest reserves: Eastern, Western, South western Mau, Trans-Mara and Olpusimoru approximately 66,000 ha, 22,700 ha, 84,000 ha, 34,400 ha, 17,000 ha respectively MENR 2007. A sixth large block, the Maasai Mau approximately 46,000 ha is still un-gazetted. Only a small portion of the South western Mau (Kedowa block) was sampled for this study to facilitate comprehensive" ground truth" data set. Although the entire water shade study would encounter large changes in forest condition the study site is representative of the current situation in the entire block of the watershed.

Ramogi hill forest

The forest is located in Yimbo location, Bondo, District, Nyanza province on the north-eastern shores of Lake Victoria in western Kenya. It is located at latitude 00° 06´23´´S and longitude 034° 04´10´´E. The hill lies at an altitude of 1240 m above sea level, and comprises two peaks namely Minyenjra (200 ha) and Nyaidi (83 ha) . It is surrounded by Lake Victoria and the associated Yala swamps in the west and North to the southwest it is bordered by Oraro, Usigu and Jusa settlements. The forest is in the eastern outpost of the Guineo-congolian block characterized by lowland dry forest (Bagine, 1998). The forest was gazetted in 1970 as a natural forest reserve to protect the flora and fauna uniquely associated with it. Before then, it was under the local community and county council management. During gazettement, the sacred groves institutions were not recognized by state. The forest is under the protection of state, but the sacred sites are still in the custody of the local elders, penalties and rule enforcement is very weak as there is no forester in charge of the station and forest guards operate from the district forest station which is a bit far from the forest.

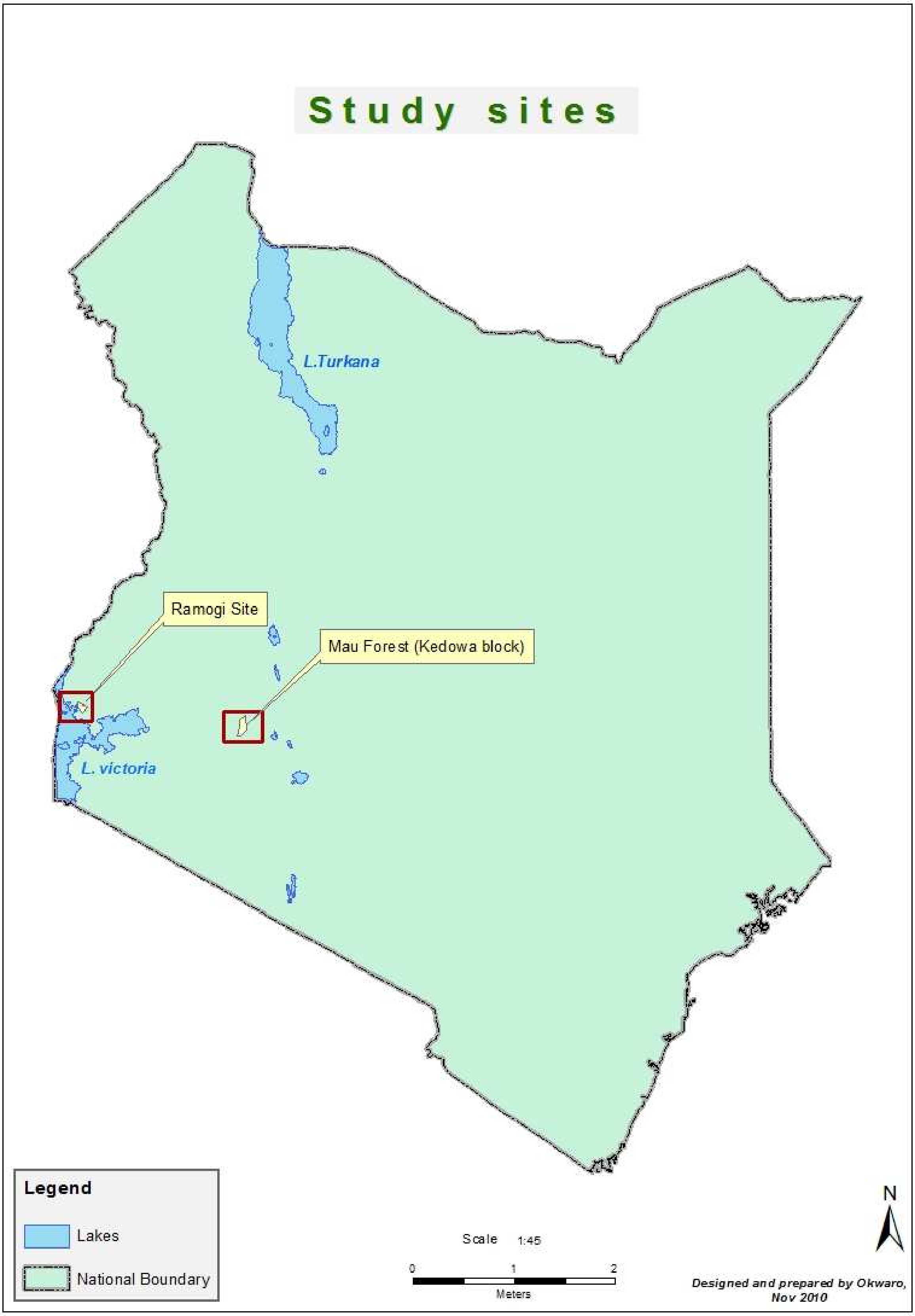

Figure 1: Study sites.

Methods

Hybrid methodological approach with sequence of methods designed to explore different questions post by different elements of the research were used.

Investigating forest cover change using remote sensing and GIS

Determination of the state of forest cover between 1986, 1996 and 2006 was done. This incorporated the use of remotely sensed data LANDSAT (TM) satellite image for 1986 (Land sat 5TM 1986 Land sat 7ETM 1996 and Land sat 7ETM 2006. Image Vegetation cover was determined by the colour tone, the distribution form and texture of plant covered areas. Forest cover change was determined by comparing two images at a time.

Image processing

The Land sat data sets were obtained in separate files. In order to consolidate the different bands into one single file layer stack function in Image analysis for ArcGIS) was used (Booth-Lamirand 2003). The greyscale single bands 5,4, and3 were combined together to obtain a multiband data set. Image classification was performed with three target classes (Closed canopy forest, bare ground,and secondary vegetation(open forest) or re-growth).The purpose was to provide a framework for organising and categorizing information that could be extracted from the data (Jensen et al.1996). The classification scheme included classes that were both important to the study and discernible from the data at hand. This was designed to be hierarchical in structure providing an avenue to describe the study area in several levels of detail. Unsupervised classification was used since the ground truthing data was collected in 2010 yet the images data were of later years hence could increase errors in identification and assignment of training samples for supervised classification. Furthermore supervised approach is subjective in the sense that the analyst tries to classify information categories, which are often composed of several spectral classes whereas spectrally distinguishable classes were revealed by the unsupervised approach hence greatly reduce ground data collection requirements (Kumar 2004). The classification was based on the Iterative Self Organising Data Analysis Technique (ISODATA) (Tou and Gonzalez 1974) a clustering method that uses spectral distance as in the sequential method, but iteratively classifies pixels, redefines the criteria for each class and repeats the classification, so that the spectral distance pattern in the data gradually emerge. The method utilizes minimum spectral distance to assign a cluster for each candidate pixel. The process begins with a specified number of arbitrary cluster means or the means of existing signatures, and then processes repetitively, so that those means shift to the mean of the clusters in the data.(Booth-Lamirand 2003; Kumar 2004)

Forest cover change detection

Change detection involved the comparison of 2006, 1996 images with that of 1986. The Image change analysis (GIs matrix method) function of ERDERS IMAGINE has the ability to conveniently perform change detection by comparing two images of the same place from different times. Image difference resulted in a greyscale continuous image. The image generated represented the difference created by subtracting the before image from the after image. The resulting image was further analysed using the Recode method of GIS where post classification was done giving out an image of change within the classes at accuracy of 75%. Area of change was then tabulated from the resulting histogram.

Quantifying livelihoods

To determine dependency on the forest by locals, income accounting approach was employed. This focussed on consumptive forest products that household's source from the forest such as fuel wood, wild food, herbs, and the like. In measuring the value of use of forest goods and setting this in the context of the overall household portfolio, an appropriate measure of the household's economic status has to be measured. The total net income (monetary or cash income and income in-kind), approach was used as it has a broad measure of household's economic welfare status (Cavendish 2002). This relied on households self reported physical quantities and value estimates and the prevailing local market prices. Respondents reported the weekly, monthly, or annual amount of each product gathered, the amount consumed, amount exchanged, amount given out as gift and amount sold and cash received from sales of theses product if they were bartered rather than sold.

Valuing forest resource used by rural households enables us to assess its quantitative contribution to rural livelihoods and extend of dependency of rural people on forest products.

Biophysical data

Biophysical data was collected in 2000 and 2005; using IFRI protocol Ostrom 1992 From the IFRI database data on saplings, seedlings, trees, and forest users was extracted using a SQL query. This primary data has been used to study location specific relationships between forest condition and some economic and institutional factors.

Results

GIS based detection of forest cover dynamics

Forest cover status 1986, 1996, 2006

From the unsupervised classification of Landsat 5TM 1986 1996 and Land sat 2006, three forest cover categories (closed canopy forest, bare ground, and secondary re-growth(open forest)) in the landscape were recognized and evaluated. From the relative pixel values and counts of the various categories it was evident that the area under closed canopy increased from 1986 in the Mau forest complex (Kedowa block) to 1996, however there was a significant decrease between 1996 and2006. Area under bare ground was least in 2006 and highest in 1986. Areas under regenerating vegetation (open forest) have also considerably increased over the study period. The various land cover categories are shown and illustrated below (Figures 2, 3, and 5)

In Ramogi forest using the same characterization (Though mistakably bare represented open forest as bare rocks has been there for ages and do not increase) there was very significant change in closed canopy forest on the side of the swamp between 1996 and 2006 as opposed to between 1986 and 1996. The area under secondary re-growth increased drastically between 1996 and 2006 but the area bare remained constant during the period of study (Figure: 6).

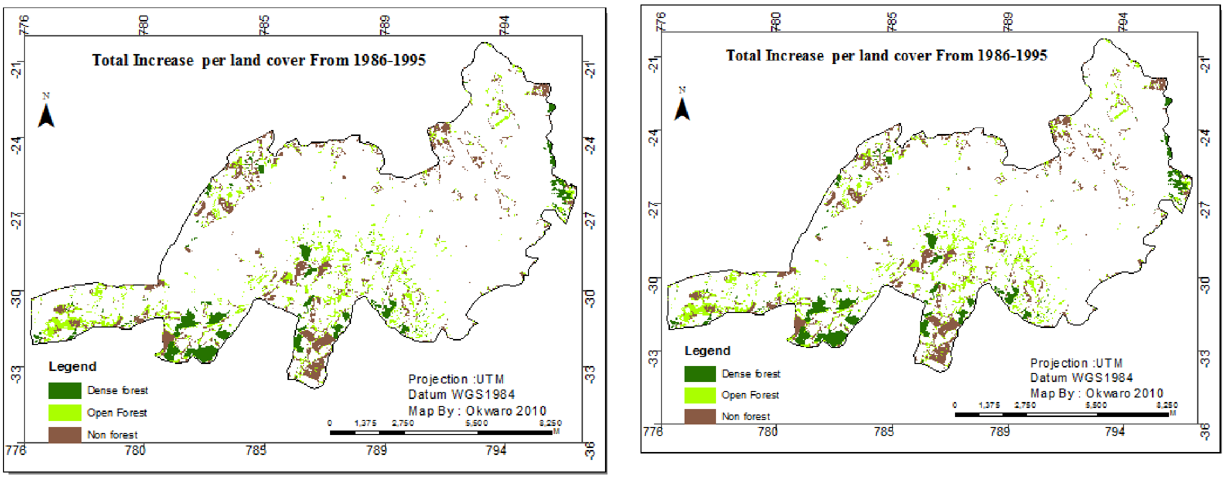

Figure (2): Forest cover change 1986-1996 Kedowa forest (Mau).

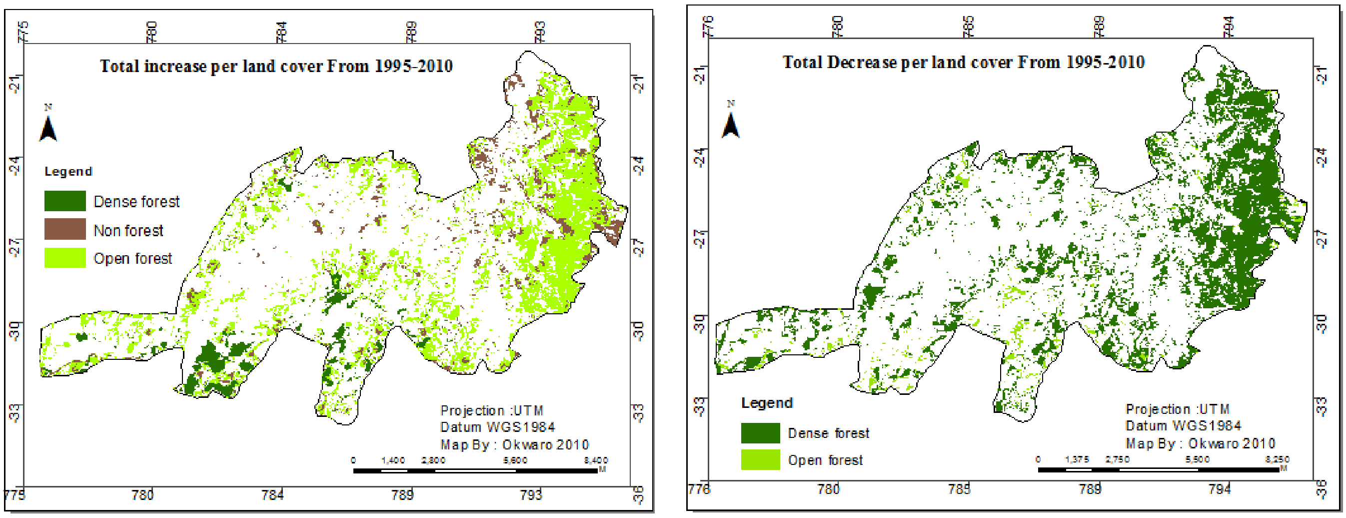

Figure (3): Forest cover change in Kedowa 1995-2006.

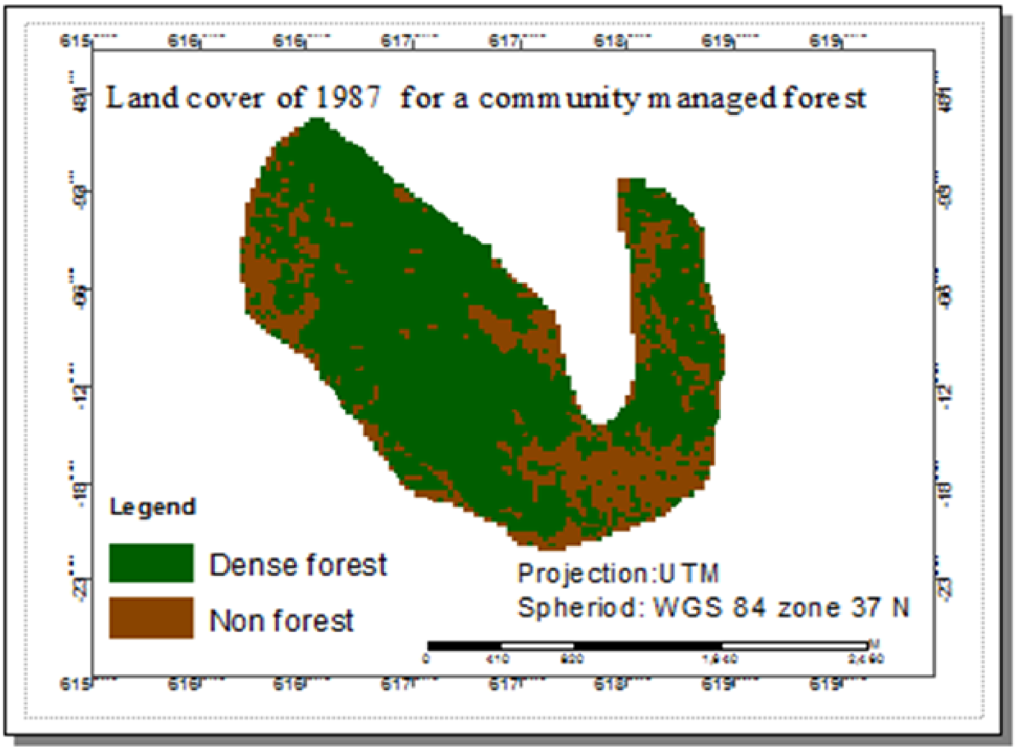

Figure (4): A classified image of Ramogi forest

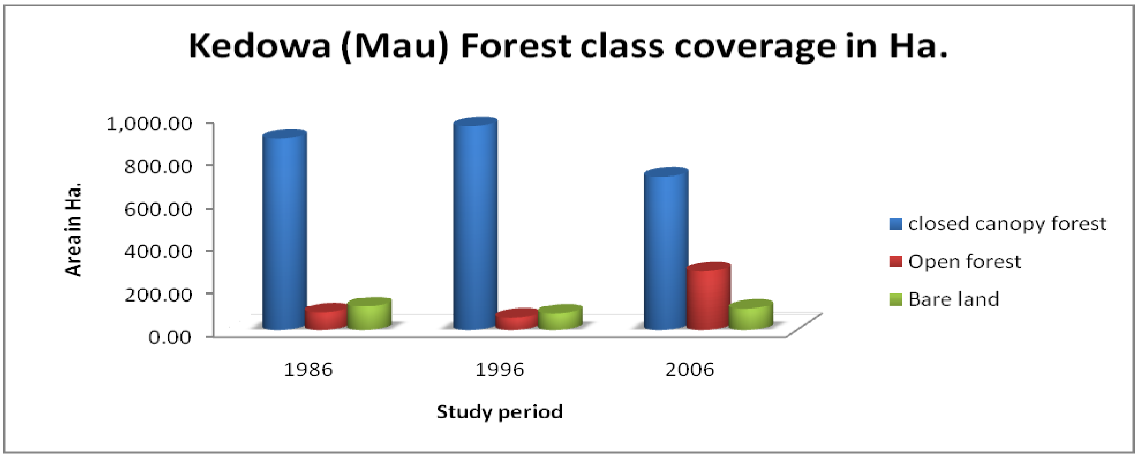

Figure (5): forest cover type in Kedowa Forest Block (Mau).

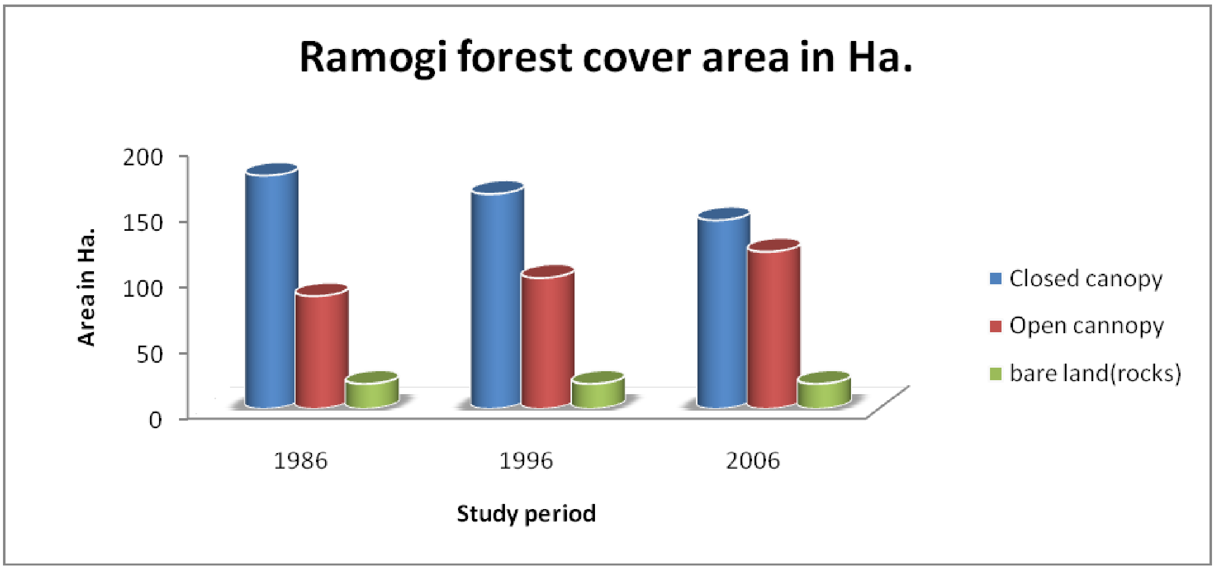

Figure (6): Forest cover types in Ramogi

Results from IFRI studies 2000 and 2005

From IFRI data base information on seedlings, saplings and trees from all the thirty sample plots was analysed to provide information of the structure of the forest on the ground. Figures 7 and 8 shows diameter distribution of the two forests between the last study period (1996-2006. This information is used to help check the consistency of the information provided by the GIs analysis and Remote sensing findings.

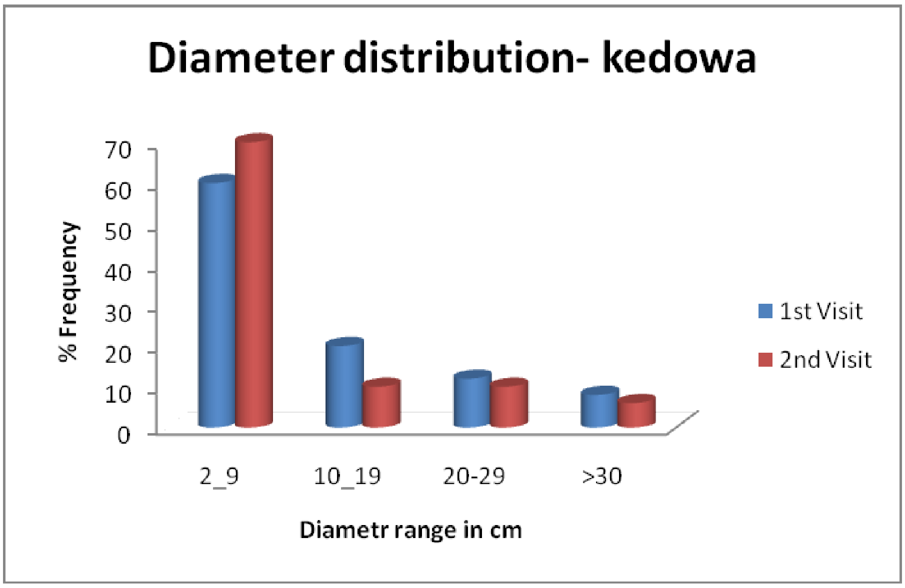

Fig (7): Diameter distribution of trees in Mau forest (Kedowa Block) by IFRI methodology for the two visits

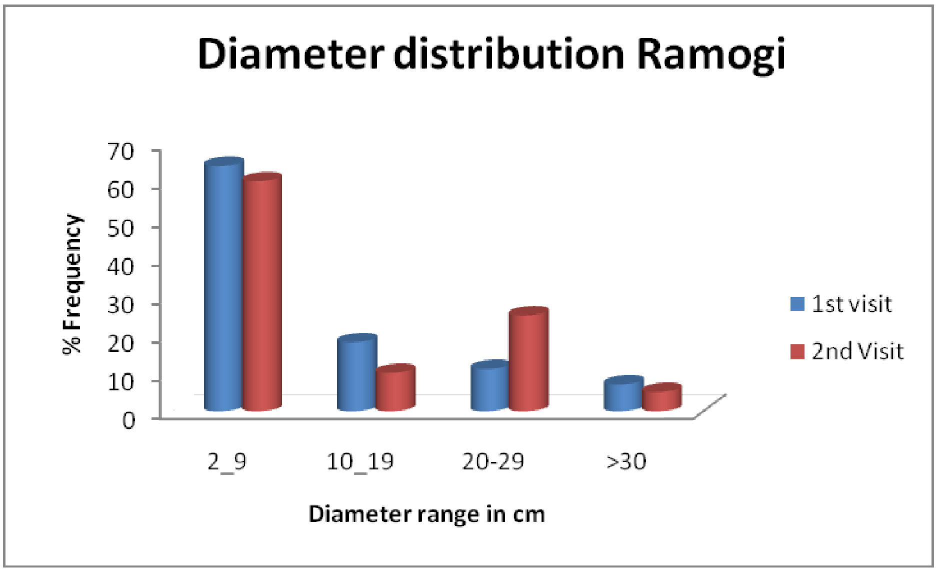

Fig (8): Diameter distribution of trees in Ramogi forest for the two visits

Forest product	Estimated amount in USD.
Fuel wood	293
Poles	250
Charcoal	375

Table (1): Estimated value of forest products sold and consumed domestically by a typical household in Kedowa. (Annual estimates using accounting method)

Household income	1-25%	26-50%	51-75%	75-100%	Total %
Forest products	38	42	10	10	100
Remittances	50	40	10	0	100
Wages	41	30	17	12	100

Table (2): Households approximated source of income (adapted from SANREM site report mau).

Discussions

Forest dynamism and institutions

Kedowa block of Mau forest is a gazetted forest and therefore under a formal institution of management. Being a section of the largest water catchment (Mau) in the country and hosting a forest dwelling indigenous community and lots of squatters, its management institution has evolved all the way from the colonial times to post independence. This is an institutional dynamism from local institutional arrangement where the indigenous community divided the forest amongst the clans each clan managing a section of the forest to a formal institution brought in by the colonialists. This formal institutions happened to favour national interest over local Forest adjacent communities interest, it stressed on industrial raw materials like round wood production over other forest uses and discouraged grazing and other forest uses, this often results in institutional failure and social injustice (Scott, 1998and Klooster 2000). This was because the centrally imposed regulations for monitoring compliance, meting out sanctions and distributing access were clumsy and poorly adapted to the local condition. More so the institutions that were to generate information on the state of the resources were lacking or not effective. This was further propelled by the limitedness of the ability of the centralised resource use control to adapt to changing social and environmental condition (Folker and Colding 1998). This institutional weakness coupled with laxity in general law enforcement opened up the forest for uncontrolled exploitation with the poor rural people burning charcoal and cutting poles competing with other outside alliances who were mainly interested in round wood timber using chain saws. Between the study period 1986 and 1996 there is an increase in closed canopy in Kedowa forest this was a result of the burn of the shamba system (a system where people are allocated portions of farms to cultivate within the forest during plantation establishment so that they can tend for the young growing trees) and Squatters were evicted from the forest and this reduced exploitation (figure 5). Later on the forest cultivation was introduced as Non-residential cultivation. This fuelled forest degradation as seen fig 2, 3, and 6 between the years 1986 and 2006; within this period of forest adjacent communities' activities in the forest peaked with cutting of trees of large diameter and posts for sale (evidenced by many stumps not very old and abandoned charcoal kilns). This further explained why frequency of some species such as *Juniperus procera* and *Bridelia mycrophylla* reduced by 2006 in Kedowa. This species are commonly used for poles and posts due to their high durability.

The graph of diameter distribution and percentage frequency assumes an inverse j- curve typical to a healthy natural forest only that there is a sudden fall of representations from saplings to the diameter class 10-19 in both the two visits but more profound in the second visit (*figure 7).* This is as a result of harvesting more trees in the last diameter class after the first visit. This opened up the canopy and lead to growth of pioneer species that were shade intolerant and thus more saplings in the second visit, few representations in the preceding two diameter classes were also as a result of destruction and falling of trees during felling of the bigger trees. This is further explained by the abundance and dominance of secondary succession species such as *Neoboutonia macrocalyx, Terbernamantana stapfiana* and *Vernonia auriculifera* which indicated constant disturbances from humans. These results are in line with the finding of GIS analysis which showed considerable drop in closed canopy forest, increased newly vegetated areas and settlements.

In contrast the local institutions in Ramogi forest though having derived over time through a process of cultural learning still have an open access coupled with low barriers specifically to sacred sites. Because of the nature of the process of crafting of this local institutions (culture and learning) there lacked elements to coordinate the compliance of resource users. This made it appear as a pro-poor resource and thus making it a means of survival and economic opportunity for the rural with limited options. The increased harvesting in the other parts of the forest as compared to the sacred sites points a clear picture of how rules regulating access and use of forest resources if not adequately enforced, the *de-facto* condition becomes one of open access rather than secure tenure, this marks a sudden change in tenure meaning a difference in policing and range of penalties for rule violation.

From the results of diameter distribution for the two visits in Ramogi, the first visit depict more or less inverse j curve normally associated by undisturbed natural forest, but the second visit there were more of saplings and less poles and withies in diameter class 19-20 and more of representatives of class 20-29 figure 8 an indicator that the forest was disturbed. This means at some level the demand of trees in the diameter class 10-19 increased and since they are used mostly for building many of them have been harvested by the youths for building of housing structures. This is further explained by the fact that local elders traditionally instituted rules and regulations to protect the groves from destructive use, depending so much on taboos and other social sanctions rather than active policing.

With dynamism in management, economy, development and society, the local communities are no longer as cohesive as they were before and thus no longer hold on traditional institutions. This has further increased disregard for the cultural values and believes by the youths and they confidently cut the trees for sale in the nearby market for fish smoking and building and construction industry. Contrary to this sacred, sites go always un-touched as they harbour the largest trees in the forest (*Melicia excelsa*) which are sacred and thus locals don't cut them in fear of punishment from the ancestors. It's worth noting that the demand of some species like *Rhus netalensis* is very high for locals believe when used in smoking fish it adds flavour making it a target for many and as a result it could not be found in some of the sample plots during the second visit. The fall in general frequency of trees during the second visit could be attributed to the increase in population and lack of employment forcing majority of the youths to get into the forest to get some income to fill in the gaps in times of income shortage from other standard sources and thus act as a safety net or insurance during unpredictable economic shocks.

Forest dynamics and livelihoods

Though they play a crucial role in the livelihoods of forest adjacent people the contribution of forests in their livelihoods and general economy has not well been documented. Cavendish (2000) makes a compelling case that forest income can play a crucial role in the livelihoods of rural households especially the poorest. For instance in Mau forest majority of the households (1-5 km from the forest) have 25-50% (table: 2) of their household income originating from forest activities. Take for example a moderate household consumes about 25 USD worth of fuel wood annually for domestic use. Apparently, this value seems so large to assign for a single specific product use , but one should not be surprised by this figure given that alternative sources of rural energy (mainly for cooking) in rural Kenya are nearly non-existent. If this value is projected for the entire 1300 households living between 1-5 kilometres from the forest it translates into a big value of the forest resource that is removed annually just for domestic use (excluding the value of fuel wood extracted for sale, posts and sawn timber).

The results of SANREM household study shows further that 9-12% of the average households income is derived from the forests. These results are in resonance with findings of a study by Otwoma and Odera (2008) who found out that the current extraction levels are higher than ever and past the mean annual increment. They further show that time taken to collect fuel-wood has increased meaning the condition of the forest has drastically deteriorated.

We argue that though forest degradation is driven by many other different players, sound institutions that will embrace the objectives and needs of forest adjacent communities can easily abate negative forest cover dynamics, this has been a little bit addressed by participatory forest management but still the formal institutions have a larger stake and that devolution has not fully been realized. There is need to think beyond bee keeping and grazing as a means of bringing forest adjacent communities on board as the trickle- down effect of the conversion of forest capital is non- existent. Other alternatives should be explored such as non-consumptive forest service's which can easily benefit the rural poor either directly or indirectly (internalized benefits). Indirectly through transfer of payment arrangements (compensation to local people for externalised benefits). Internalized benefits include; safeguarding healthy forest ecosystem for the purpose of protecting the quantity of local dwellers' water supplies. The direct benefits should be linked to poverty mitigation function of resource use e.g. carbon storage, hydrological protection biodiversity conservation and recreation role. The external forest environmental benefits are enjoyed by external users yet usually they have not paid for. Thus payment of environmental can become an important vehicle for livelihood improvement.

Limitations to the study

Several factors, however, limited this study. One of the major problems was the limited availability of cloud-free images. As a result, the presence of clouds in some of the images used resulted in gaps in the forest change analysis. More satellite images acquired during the wet season would have been useful in teasing out phenological differences and thus assist in separating some of the forest cover classes accurately. Lack of ancillary data sets, such as aerial photographs also affected the study negatively. Further, lack of ancillary data made it impossible to use more sophisticated forest cover change mapping techniques such as Classification and Regression Trees (CART), which could potentially have improved the accuracy of the forest cover maps, in addition to mapping finer forest cover classes. More importantly also, this study would have benefited from more field data. Thecurrent study is based on limited field data due to financial constrains. Finally I would like to acknowledge the uncertainties that are associated with any satellite image mapping as a result of the methodology used. For example, the Ramogi images did not have enough ground control points during processing this limited the use of overlay of the images for change detection analysis. And as aresult each image was classified differently and the resulting histograms used to caulcate areas from the three images and total changes in forest clas cover computed mathematicaly.

Conclusion

The increased trend of degradation of the forest shows the effects of a weakening local institution in management of Ramogi forest. The negative forest cover changes witnessed in Mau forest Kedowa block provides strong evidence of how flawed institutions and livelihood pressure can strain an important natural resource. From the study it's evident that the area under close canopy forest in Kedowa forest has reduced with especially in the last phase of the study, the area under newly vegetated or secondary re-growth has also increased further due to opening up of the forest by the locals whose population has increased drastically with limited survival options. Information of extraction levels further reveal that more of forest products are being out for sale by the locals as a means to livelihood. This is supported by a vibrant charcoal and fuel wood market within the vicinity of the forest.

This study has provided important baseline information that can be easily updated using intense location-in-depth studies based on primary data. This will greatly help refine the understanding of the relationship between forest dynamism, livelihoods, and institutions especially in the wake of institutional dynamism and help in formulating better forest policies for management in Kenya

Recommendations

From the results of this study two recommendations can be made. Firstly future research should seek to use multi-seasonal and finer spatial and spectral resolution satellite data. These data would be useful in mapping forest cover classes more accurately. Further, the data would facilitate the separation of some of the most difficult to separate classes like newly vegetated areas from shrubs. Secondly there is need also to focus more on the utilization of satellite remote sensing in monitoring forests in Kenya. This would update existing maps and provide a more accurate and efficient method to detect changes.

Bibliography

Bagine, R. K. N. 1998. Biodiversity in Got Ramogi hill, Kenya and its evolutionary significance. African journal of Ecology 36: 251-263.

Biosafety News. 2004. The vanishing forests of Kenya. Picasso Productions, issue No.49, Nairobi, Kenya.

Cavendish. I. 2000.Emperical regularities in the poverty environment relationship of rural households: Evidence from Zimbabwe. World development 28(11)

Davies. S. 1997. Livelihood adaptation; Paper for workshop making, livelihoods work-women and children in: Rajasthan, mimeo, Brighton IDS, 5-6 June University of Sussex.

Ellis F. 2001: Rural livelihoods and diversity in developing countries. Oxford University press New York.

Fairbairn. And Needle. C. 1995. The forest transition in Italy working paper No.2 department of Geography, University of Aberdeen.

Gunderson LH and Holling CS (eds.) (2002). *Patchy: Understandingtransformations in human and natural systems*. Island press WashingtonD.C USA.

Kamugisha. J.R., Ogutu Z.A. and Stahl M. 1997:Parks and people-conservation and livelihoods at the cross-roads' Paper presented to the East African Symposium on common property management, Uganda International Conference Centre. 26th-28th March 1996

Kloosterb. D. 2000. Common forestry and tree theft in Mexico. Resistance or complexity in conservation? Development and change31:281-306.

Kumar M (2004). Digital Image processing. In: MVK Sivakumar, Roy PS,Hansen K, and Saha SK (eds.) *Satellite remote sensing and GISapplication in agricultural meteorology.* Proceedings of the trainingworkshop 7-11 July 2003, pp81-102 Dehra Dun, India.

Mother. A. J. Fairbairn. J. 2000. From the fields to reforestation: The forest in transition in Switzerland, Environment and History 6 (200) (4), pp.399-421.

Ongugo, P. and Njuguna J. 2004. Effects of decentralization policies on forest management: experience from seven forests of Kenya. Paper presented to the10th Biennial Conference of the International Association for the study of the common Property (IASCP), 9th to 13th August 2004, Oaxaca, Mexico.

Otuoma. J.and Odera .J. 2008. Reconciling conservation and livelihood needs in Got Ramogi forest. Paper presented to the 4th Biennial Conference of Kenya Forestry Research Institute (KEFRI), 6th-9th October 2008, Nairobi Kenya

Scott. J. C. 1998. Seeing like a state: How certain schemes to improve the human condition have failed-New haven, Conn: Yale University press.

Tou.J.T. and Gonzalez.R.C.(1974). *Pattern recognition principles*. ReadingMassachusetts Addison- Wesley publishing Company

Wass P (ed.) (1995). *Kenya's indigenous forests: status management and conservation*. IUCN (Forest Conservation Programme) Gland andCambridge