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How to optimise the participation of Mau Forest's stakeholders in the struggle against forest degradation?

Tome 1: Understanding the uses, forest practices and perceptions of the Mau Forest stakeholders, Kenya



by **Anaïs Oddi**, September 2007

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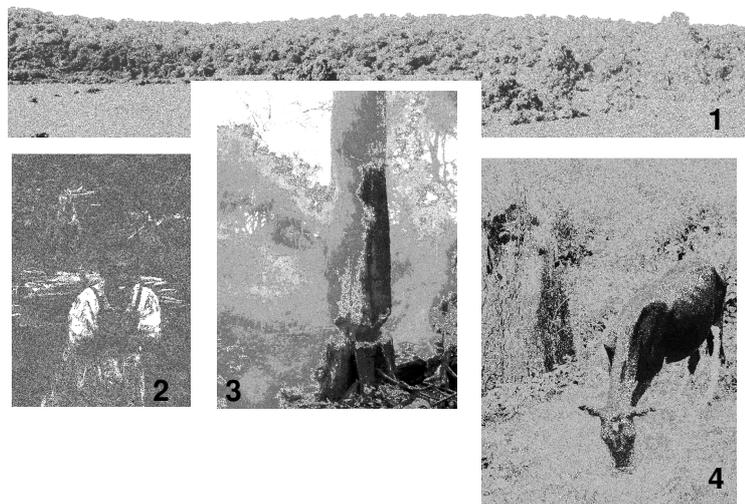
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*“If trees could scream, would we be so cavalier about cutting them down?
We might, if they screamed all the time, for no good reason.”*

(Handey, 1992)



1. View on Chepsir Tea Zone
2. Children fetching firewood, Nyakinyua
3. Cutting a tree for charcoal production, Bonde
4. Cow grazing in the Mau forest, Bonde

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Abstract

In Kenya as in many developing countries, some communities are living near the forest and depend on it. In the Mau Forest (Kenya), forest degradation is more common than forest improvement. The illegal exploitation of wood; as well excessive and destructive, is threatening the balance of the natural resource. As a result of that, forest cover has been deeply depleted in many parts of Mau forest. The objective of this study is to contribute to the success of the Forest Restoration in Eastern Africa, Indian Ocean Islands and Madagascar (Foreaim) project which will propose solutions to improve the state of forest resources.

In the context of the new Forest Act 2005 in Kenya, communities can be involved in the management of the forest. To restore the forest it is important to empower them, but before empowering communities, it is necessary to understand how they use the forest and what the causes of the forest degradation are. In this research, uses, forest practices and perceptions of forest communities are identified in order to understand their influence on the forest resources. Three villages with a different socio-economic context were studied: Nyakinyua, Bonde and Chepsir Tea Zone. Inventories of the forest adjacent to these three villages were carried out in order to link the identified uses and practices of the forest with its state.

The local population harvests trees for domestic uses but also as an income source. The main destructive activities are charcoal burning, farming and grazing in the forest. The communities' perception of the forest varies according to the environment and the forest uses. In Nyakinyua the forest state is alarming because it is intensively used. Beyond being degraded, some parts of the forest are deforested. In Bonde, the resource is relatively abundant but the uses are intensive. In Chepsir, the villagers depend less on the forest for their livelihoods and the forest is well conserved.

To restore the forest two main strategies are proposed: the *non residential cultivation* and *on-farm forestry*.

Key-words: Forest degradation – Perception – Practices – Forest Community – Rehabilitation – Joint forest management – Mau Forest (Kenya)

Résumé

Au Kenya comme dans beaucoup d'autres pays en voie de développement, des communautés vivent aux abords de la forêt et en dépendent. Dans la forêt de Mau (Kenya) la dégradation forestière est plus commune que l'amélioration de son couvert. L'illégal exploitation de bois, aussi bien destructive qu'intensive, menace l'équilibre de la ressource naturelle. En conséquence, dans de nombreuses zones de la forêt de Mau, le couvert forestier a fortement été réduit. L'objectif de la présente étude est de contribuer au succès du projet Foreaim (Forest restoration Eastern Africa, Indian Ocean Islands and Madagascar) qui proposera des solutions pour améliorer l'état de la ressource forestière.

Dans la nouvelle loi forestière de 2005, les communautés peuvent être impliquées dans la gestion de la forêt. Pour restaurer la forêt, il est important de donner du pouvoir aux communautés dans les décisions concernant la gestion de la forêt. Cependant avant d'entamer ces processus participatifs, il est nécessaire de comprendre quels sont les pratiques et usages forestiers de ces communautés et quels sont les facteurs responsables de la dégradation forestière.

Dans cette recherche, les usages, pratiques et représentations sociales des communautés forestières seront abordés afin de connaître leurs influences sur la forêt. Trois villages avec un contexte socio-économique différent ont été étudiés : Nyakinyua, Bonde et Chepsir Tea Zone. Des inventaires forestiers ont été menés afin d'établir un lien entre usage/pratique et état de la forêt.

La population locale collecte du bois pour répondre à des besoins domestiques mais également à des fins économiques, comme source de revenu. Les pratiques les plus destructives sont celles de la fabrication de charbon de bois, du pâturage et de l'agriculture dans la forêt. La représentation sociale de la forêt et de sa dégradation varie en fonction de l'environnement et des pratiques qui y sont mises en œuvre. A Nyakinyua l'état de la forêt est alarmant du fait d'un usage intensif de la ressource. Au-delà de la dégradation, la forêt est sujette à la déforestation. A Bonde, même si la ressource est utilisée de façon intensive, la forêt demeure pour le moment conservée. Enfin dans le village de Chepsir, la population dépend moins de la forêt pour vivre. Le peuplement forestier y est de bonne qualité.

Pour réhabiliter la forêt, deux stratégies sont proposées l'agriculture non permanente et le développement des arbres hors forêt.

Mots clés : Dégradation forestière – Représentation sociale Pratiques – Communauté forestière – Réhabilitation – Gestion participative – Forêt de Mau (Kenya)

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Acronyms

BA: Basal area

CFA: Community Forest Association

CIRAD: Centre de Coopération Internationale en Recherche Agronomique pour le Développement

COFEGFA: Community Food and Environment Groups Forest Association

ENGREF: Ecole Nationale du Génie Rural des Eaux et des Forêts

FOMAWA: Friend's of Mau Watershed

GPS: Global Positioning System

IIED: International Institute for Environment

IUCN: International Union for Conservation of Nature and natural resources

KEFRI: Kenya Forestry Research Institute

KFS: Kenya Forest Service

KFWG: Kenya Forest Working Group

KIFCON: Kenya Indigenous Forest Conservation Project

KWS Kenya Wildlife Service

MACOFA: Mau Community Forest Association

NGO: Non Governmental Organisation

NTZDC: Nyayo Tea Zones Development Corporation

PCA: Principal Component Analysis

RV: Relative density

UNCED: United Nations Conference on Environment and Development

UNESCO: United Nations Educational, Scientific and Cultural Organization

VRP: Variable Radius Plot

WCED: World Commission on Environment and Development

WP: Work-Package

WRI: World Resources Institute

WWF: World Wide Fund for Nature

Introduction

Global attention to environmental problems caused by increasing human disturbance gained momentum in the late 1960s and 1970. In the late 1980s it became evident that human impacts in various parts of the world had global implications (Schreckenberg & al., 1990). At the same time has come wider recognition of the urgency of satisfying basic needs, and of the pervasiveness of global economic inter-relationships (WCED, 1987). Basic needs and economic demands result in the development of use of natural resources to supply societies with necessary food, fibre and energy (Schreckenberg & al., 1990). However, extensive harvesting of the goods produced by the functioning ecosystem leads to disturbance and alteration of ecosystem processes. Forest is now recognized for the fundamental environmental services that it widely assumes. Hence, forest degradation is one of the most frequent subjects in the international debate on environment. Despite the efforts from Non Governmental Organisations (NGO), international institutions and governments, forest degradation is ongoing. One key question in this context is how to develop strategies to struggle against forest degradation. This kind of question can only be solved if many parameters – ecological, biological, sociological, political etc... – are taken into account. The Forest Restoration in Eastern Africa, Indian Ocean Islands and Madagascar (Foreaim) project was founded in order to bring solutions for this problem. It tries to develop strategies to limit forest degradation and to improve restoration attempts in these countries.

Kenya is considered to be a rich country in terms of biologic diversity. However, this country has over time lost some of its large biodiversity and resources mainly due to population increase, habitat destruction, desertification, over exploitation of species and conversion of land into agriculture and settlement (Republic of Kenya, 2002). Nowadays many Kenyan ecosystems have been highly reduced and disturbed by anthropic activities. It was recently estimated that closed canopy forests cover only 1.7% of Kenya's land area (Akotsi & al., 2006). Nevertheless the forest still provides crucial services to the people, the nation, and the environment. The Mau Complex is the largest remaining closed canopy forest block in Eastern Africa (Akotsi & Gachanja, 2004). This forest represents a valuable natural resource endowment for Kenya (Mwanduka, 2007). It is considered as one of Kenya's five "water towers". In addition, this forest contributes directly and indirectly to the livelihoods of many local communities. However, Mau Forest is being destroyed at an alarming rate (Akotsi & al., 2006) and therefore the Complex is highly concerned by degradation.

The member institutions of the Foreaim project decided to study this forest complex and especially the Western Mau Forest. The present study was carried out in three villages of the Western Mau Forest. Uses, forest practices and perceptions of the stakeholders are identified in this research. It aims to understand what the causes of the forest degradation are, how the different stakeholders use the forest, how they modify the resources and finally, to propose restoration strategies according to the local context.

After a presentation of the context, the problem statement will be developed. The methods put in place will be presented. The study about the perceptions, uses and practices of the different stakeholders will be detailed and a forest state of the art will be presented. Finally, before discussing and concluding the study, restoration strategies will be proposed taking the obtained results into account.

1 Environmental changes

1.1 *Restore the usefulness of ecosystems*

Humans may influence the disturbance regime in any particular ecosystem, where ecosystem disturbance is defined “as an event or series of events that results in altering the relationships of organisms (including man) and their habitats from their natural state, both spatially and temporally” (Wali, 1990). This may be done by affecting some of the naturally occurring disturbances or by introducing entirely new types of disturbances not experienced before by the species that make up a particular community (e.g. new kinds of grazing animals). More generally, problem emphasis shifted from small-scale phenomena with fast response to large-scale (regional to global) phenomena, with slow global changes in the biosphere producing discontinuous, unexpected changes at local levels (Schreckenberg & al., 1990).

The rationale for undertaking research on degraded ecosystems transcends such usual reasons as “they have been poorly studied”, or “they constitute a large area”. Rather, the urgency for studying these systems is that they may hold an important key for a long-term solution to human-environment problems in many parts of the world, some of which are effectively running out of land. If people could manage damaged ecosystems and even restore to productive use those that are highly degraded, then it may be possible to reduce the senseless expansion and movement of populations into “pristine” areas of high ecological value which are often marginal sites in terms of human carrying capacity (Schreckenberg & al., 1990).

1.2 *The case of Kenya*

1.2.1 **A fast growing population depends on the environment**

Population in Kenya was estimated at 30.4 million in 2001 and is increasing at 2.4% per annum up from an estimated 26.5 million in 1997 when it was growing at 3.4%. It is projected to increase to 35 millions by the year 2008 (Republic of Kenya, 2002).

Over the years a large number of the citizens of Kenya have been **squatters**¹. Post independent government have had to re-resettle them, in most cases in forested or woodland areas (Kigenyi & al., 2002). In the same time, agriculture became more and more important in the national economic growth and development (Republic of Kenya, 2002). Therefore increased socio-economic activities such as agriculture have compounded environmental problems, such as deforestation, depletion of land resources, “harmful” land use practices, pollution, catchments degradation and poor conservation of fauna and flora (Republic of Kenya, 2002).

Local communities, particularly in the rural areas depend on forests for provision of wood, fuel wood and non-wood products for their livelihoods. Forest contributes about 95% of the rural domestic energy (Republic of Kenya, 2002).

1.2.2 Management issues: From environmental ignorance to a new forest act

Environmental and natural resource degradation constitute a major challenge in Kenya's development progress (Republic of Kenya, 2002). Until the 1990's, economic development was largely viewed as separate from environmental conservation and preservation. This view largely contributed to the unsustainable development patterns through accelerated deforestation, desertification, degradation of soils, and depletion of wildlife resources. Therefore, Kenya is currently faced with the sustainable development challenge of ensuring that environmental considerations are integrated in all major national and sectoral policies, plans and decision-making processes (Republic of Kenya, 2002). In 1994, Kenya's government put in place the National Environment Action Plan (NEAP) and enacted an Environment Management and Co-ordination Act in 1999. These two strategies theoretically provide a basis for translating the Global Programme of Action on Environment and Development as articulated at 1992 United Nations Conference on Environment and Development (UNCED) and the resultant Global Environmental Charter under "Agenda 21".

Forest land is by Kenyan law a designated and legally **gazetted**² forest estate governed by the provisions of the Forest Act. All other land comes under the regulations and usages of either customary law (e.g. communally owned forests), or private tenure regimes (e.g. privately owned forests) (Legilisho-Kiyiapi, 2002). The Forest Act is the supreme law of the land governing the use of forests in Kenya. In Kenya, the limited area of gazetted forest land was estimated to be 1.7% of the total land area (Akotsi & al., 2006). Indeed, forest cover has been reduced due to excisions by government, which often do not follow legal processes, for development, settlements or for land speculation by well placed individuals (Kigenyi & al., 2002). For example, about 2,440 km², equivalent to 30% of Mau Forest, were degazetted in the 1990s for agriculture and settlements, while in other areas forests have been degazetted for industrial developments (Kigenyi & al., 2002). Moreover, large areas of the remaining natural forests have been over-exploited and degraded through selective cutting (Kefri, 2000). Out of the remaining area of closed-canopy forests estimated at 1 million hectares about 240,000 hectares will be lost in the next twenty five years (Kefri, 2000).

In 1986, in order to provide buffer zones between settlements and government forest, tea projects (commonly called 'tea zones') were established in some areas. The aim was to protect indigenous forests threatened by human encroachment and over exploitation and thereby contributing towards global environmental and biodiversity conservation. In addition, the project offered employment opportunities to many Kenyans, thus contributing significantly to the development of infrastructure and economic well-being in these areas. Nyayo Tea Zones Development Corporation (NTZDC) is a state corporation established to manage the government's tea projects around the forest zones. The Nyayo Tea Zones were established in gazetted forest reserves. Out of 6,000 ha of forested areas that were cleared for the tea zones, an estimated 4,000 ha are currently under tea (Matiru, 1999). Areas that were cleared in Nyayo Tea Zones but found to be unsuitable for tea cultivation were put under fuelwood plantations, especially *Eucalyptus saligna* and *Eucalyptus grandis* were planted. These plantations are maintained by local communities through a non-residential cultivation system whereby young trees are intercropped with vegetables and other food crops (Matiru, 1999).

Since 2005 the Forest Act 2005 has been put in place to improve the management condition of the forest and to adapt it to the local context. With this forest act, communities can now be involved in the conservation, control, management and utilization of the forests (Republic of Kenya, 2005). The Act provides several possibilities for Kenyans in general and forest communities in particular to take part directly or indirectly in the implementation and monitoring of the Forest Act and the consequent management of their forests (Republic of Kenya, 2005). To participate in the forest management, they can organize them in Community Forest Association (CFA) (Appendix A). Sustainable development in the long term should improve the negative effects of over-use of the forest, of poverty, and provide basic needs. It is in this context that the Forest Restoration in East Africa, Indian Ocean Islands and Madagascar (Foreaim) project found all its meaning and was implemented in Kenya.

1.2.3 The Forest Restoration in Eastern Africa, Indian Ocean Islands and Madagascar (Foreaim) project

The Foreaim project or Bridging restoration and multi-functionality in degraded forest landscape of Eastern Africa Indian ocean islands was initiated between partners in the North and South to find ways of restoring the integrity of degraded forests in Kenya, Uganda and the Indian Ocean island of Madagascar. This project is funded by the European Union. The project has a duration from 2005 to 2009. The general objectives of the Foreaim project are:

- to advance scientific understanding of the restoration processes;
- to produce knowledge, practical tools, models and management guidelines for restoration implementation;
- and, with full involvement of all stakeholders, to synthesize information on economic, societal, policy and marketing issues to enhance employment opportunities and incomes, thus improving livelihoods for all sectors of the community (Bouvet, 2006).

The project is divided in seven work-packages (WP) with different tasks. This study was carried out within the first work-package, WP1. The aim of WP1 is to study agro-ecological knowledge, tree management practices and the economic dependency of local populations on forests and tree based systems in the context of degradation. The synthesis of this knowledge will provide the socio-economic background and conditions for implementation of the tested technologies outlined in the others work-packages and aid fine tuning of the final development of a typology for restoration and rehabilitation. In Kenya the project is concentrated on the Western Mau Forest. It is the Kenya Forestry Research Institute (Kefri) which is the local Kenyan institution involved in this project.

1.3 Mau Forest, a central space of life

The Mau Forest is the largest remaining near-continuous block of indigenous highland forest in East Africa (Mwanduka, 2007). This forest contributes directly and indirectly to the livelihoods of many local communities (Mwanduka, 2007). Mau Forest provides sustenance to over 150.000 rural families that live in and within 2 kilometres of its boundary (Mwanduka, 2007). This region is highly populated and many people depend on forest resources to live (KIFCON, 1993).

It is also a reservoir of unique biological diversity (Njuguna & al., 2000). Mau Forest also supports one of the richest examples of East African montane avifauna. Forty-nine of Kenya's 67 Afrotropical Highland bird species including eight regionally threatened species are known to occur here. Five mammal species of international conservation concern live in the forest. These include two ungulates, the Bongo and Yellow-backed Duiker; two carnivores, the African Golden Cat and the Leopard and a sizeable population of African Elephant. Also found in the forest are the sparsely distributed Mountain Fruit Bat, the Giant Forest Hog, the Black-and-White Colobus Monkey, the Blue Monkey, the Red-tailed Monkey and the Potto (Mwanduka, 2007).

Western Mau Forest is one of the biggest blocks of Mau Complex (Langat & al., 2006) (Figure 1). This formation is at elevation of between 2000 to 2500m above sea level and lies at latitude 00° 13'29"S and longitude 035°34'07"E. Mean annual precipitation in this zone is around 2 000mm a year, more-or-less continuous around the year. The Western Mau is a gazetted forest for conservation and production forestry. The original gazetted area was 27,877 hectares but in 1995 it was estimated at 23000 hectares (Wass, 1995). About 50% is under plantation of Pines, Cypress and *Eucalyptus*. The Western Mau Forest Reserve is administered under the government land tenure represented by the Kenya Forest Service. In the Mau Forest, tea zones were created by a presidential decree in 1986 and provide an alternative income source through employment in the intensively managed Nyayo Tea Zone Corporation and fuelwood plantations.

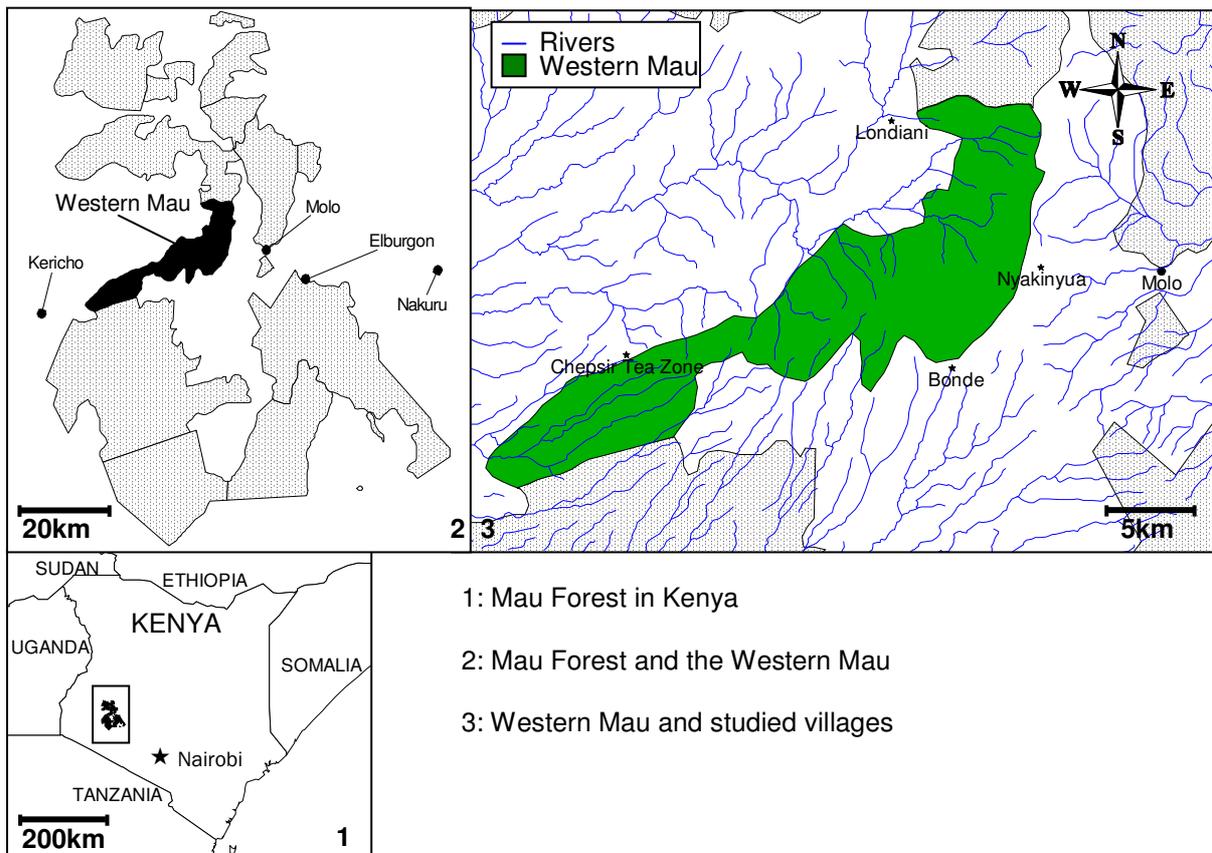


Figure 1: Localisation of the Western Mau forest, Kübler and Oddi 2007

The main stakeholders in link with the Western Mau Forest are the forest communities mainly composed of farmers, NGOs such as the Community Food and Environment Groups Forest Association (Cofegfa), Friend's of Mau Watershed (Fomawa), Mau Community Forest Association (Macofa) Community Forest Associations (CFAs) and also tea and wood factories (Timsales) (Langat & al., 2006).

2 Problem statement: Why and how to understand the perceptions, uses and practices of the forest communities?

2.1 Contextualisation and theoretic positioning

Mau Forest complex has been affected by clear-cuts which replaced its original status to plantations establishments, or through excisions for agricultural use and settlement (KFWG, 2001). It has been under constant pressure by adjacent communities and emigrants who have settled in these areas (KFWG, 2001).

The Forest Act 2005 foresees the involvement of the forest communities in the management. According to this act, "forest community" means a group of persons who have a traditional association with forest for purposes of livelihood, culture or religion or who are registered as an association or other organization implied in forest conservation. Precise guidelines and regulations concerning this involvement are being discussed by scientists, NGOs and decision-makers. However, there seems to be little consent about how the local forest communities can be best involved. According to Kruger (2003), it is necessary to understand the relationships between human communities and forests in order to understand how forest practices, uses and alternative forest management policies can affect different communities. This study examines these relationships. Possible ways to optimise the participation of Mau Forest's stakeholders in the struggle against forest degradation will be proposed and evaluated.

While carrying out this study, several research questions appeared and guided our work:

1. How is the concept of forest degradation defined in the sphere of "practical actions" and "official knowledge"?

In the definition used in this study, "official knowledge" sphere consists of researchers and experts from public institutions, research centres, universities, ministries, etc. working in the field of natural resources and environment. The produced knowledge depends on the –social, political, ecological etc. – context. The United Nations Conference on Environment and Development (UNCED) in 1992 symbolized the beginning of the debates of many actors claiming to have the capacity of expertise and research and the legitimacy to tell the "truth" on behalf of nature or to tell the "good" on behalf of society.

The "practical actions" sphere consists of those who make, the practitioners and especially the farmers because even if they do not take part in purely conceptual activities, they are source of information and knowledge. Thereby, farmers do not only decide whether to adopt or not innovations proposed by technicians, but

they also adapt and transform them (Darré, 1999). They have a certain way of thinking which can be qualified as both practical and technical (Darré, 1999).

2. How do the Mau Forest's stakeholders use the forest and with which practices?
3. What are the different dynamics and pressure on the forest resources and what are their impacts?
4. How is the forest and its degradation perceived by the local communities and how are these perceptions linked with the uses and practices?
5. How do they see the future of their forest?
6. In what extent could and would they participate in the restoration of the forest?

These questions led to following theoretical model (Figure 2).

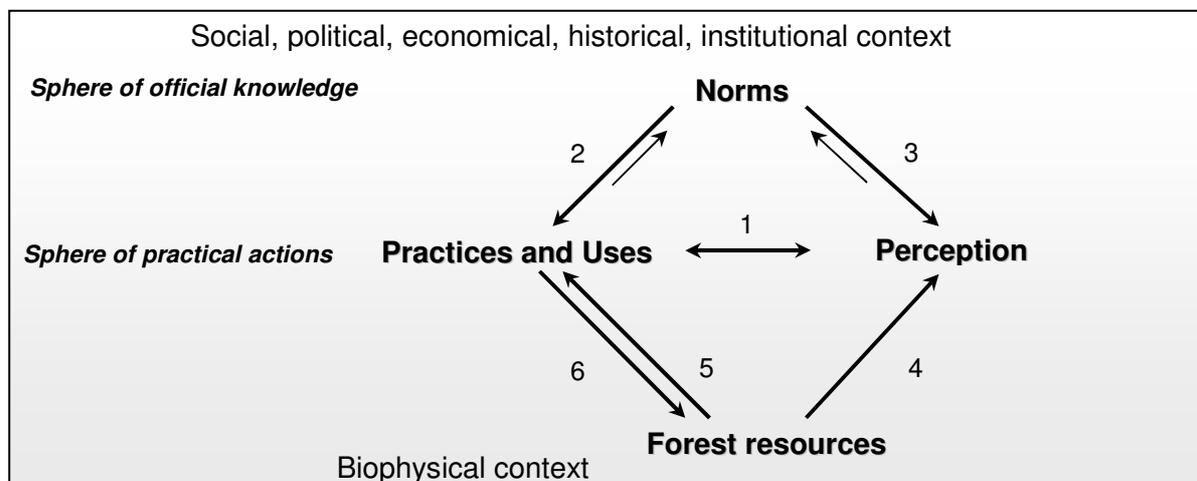


Figure 2: Theoretical model based from Figuié (2001)

This model determines that:

- A reciprocal relation exists between practices/uses and perception. Consequently, this relation is not a subordinational one (Arrow 1);
- The knowledge produced by researchers and experts is imposed as norms to the farmers (Arrows 2 and 3). However, knowledge produced by the practical action sphere seldom enters in the sphere of "official knowledge". This gap is not linked to the value of the knowledge itself but rather to the different social status of those who produce it;
- The couple practices/perception emerges from social structures which are expressed by the power of imposition of norms (Arrows 2 and 3) but also from the relation which links material reality and actors of techniques (arrows 4 and 5);
- In the technical sphere, norms can be adopted under two patterns: in the practices and uses (material adoption, arrow 2), and in the perceptions (adoption of ideas, arrow 3);
- These practices and uses have an impact on the resources (arrow 6);

- The relative importance of the different arrows is linked to the economical, political, institutional, social and biophysical context.

The purpose of this survey is to collect information regarding the uses, practices and representation of the Western Mau's stakeholders in the context of forest degradation and restoration. This study informs about the narrow link existing between communities and forest.

The main advantage speaking for the study of practices is that being observable elements, they allow understanding the mechanisms of a system (exploitation system or resource use system) (adapted from (Milleville, 1987). Practices are defined as the concrete way of doing something (Teissier, 1979). The concept of practices assumes that the technical fact can not be dissociated from the actor himself and the context, and that a given practice results from the choice of an actor which depends on a context and particular objective. The notion of practice is different from the one of technique. Practises are linked to the actions whereas techniques are linked to the knowledge. However, the two notions are deeply related because practices result from the application of techniques and the techniques constitute concepts elaborated from practical cases (Landais & Deffontaines, 1988). Thus, because practices are linked with actions, they are also related with uses. Indeed the uses are defined as the act of using, the application or employment of something for a purpose (Houghton Mifflin Company, 2000). Hence, a product from the forest harvested by a villager corresponds to a particular use and the way it is harvested to particular practices.

The concept of "social representation" or "perception" refers to all the social experience encoded in memory. It consists of knowledge shared by members of a community about a given subject (Castel & al., 2002). Several social representations exist between the different actors of a community. The social representation is an organisational mental construct which constitutes what is "visible" and may be responded to. It relates appearances and reality and even defines reality itself. The "social representation" consists of both abstract concepts and concrete images, both of which are organised around a "figurative nucleus", which is "a complex of images" that visibly reproduce a complex of ideas' (Moscovici, 1984). The central idea of social exchange theory is that the exchange of social and material resources is a fundamental form of human interaction (Ingoldsby & Smith, 1995).

Because it seems that in English literature "perception" is more often used than "social representation", this term will be used in the report. Perceptions of rural farmers with regard to land, and particularly to forests may differ among farmers according to their socioeconomic and demographic situations (Dolisca & al., 2006, Portes, 1971) and to their own history. Thus, perceptions towards forests are a combination of characteristics of individual farmers, as well as subjective evaluations of groups, that are functions of organizational characteristics (Dolisca & al., 2006). Understanding rural farmers' perceptions about the environment may provide a framework for forest conservation, management and future efforts in forest education because the actors' perceptions guide in the way to define and construe the forest according to their relations with it.

2.2 Forest degradation or deforestation

In this report the terms forest, forest degradation and deforestation are based on the definition of FAO (2001). The forest corresponds to a land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds *in situ*. It does not include land that is predominantly under agricultural or urban land use (FAO, 2001).

Deforestation corresponds to the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10% threshold (FAO, 2001). Deforestation implies the long-term or permanent loss of forest cover and implies transformation into another land use. Such a loss can only be caused and maintained by a continued human-induced or natural perturbation. Deforestation includes areas of forest converted to agriculture, pasture, water reservoirs and urban areas (FAO, 2001).

Forest degradation is a process leading to a “temporary or permanent deterioration in the density or structure of vegetation cover or its species composition” (Grainger A, 1993). It is a change in forest attributes that leads to a lower productive capacity. It is caused by an increase in disturbances. The time-scale of processes is in the order of a few years to a few decades (Lambin, 1999). For the FAO the forest degradation is defined as changes within the forest which negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services (FAO, 2001).

The factors of forest degradation or deforestation are either direct – in the case of deforestation in developing tropical countries, for instance the replacement of a forest area by a field of coffee trees is due to cash cropping which is the direct and visible factor – or indirect, as for example the opening of a road (public or for forest logging) in a forest zone, which, in addition to being a direct factor of relatively small significance (eliminating a strip of forest along the road) attracts farmers in search of land who will clear the forest for cultivation. With regard to the area cleared by these farmers, there is a direct factor (farming) as well as an indirect one (the colonization or forest logging programme)(Lanly, 2003).

2.3 Awareness and the restoration time: definitions and terminology

Restoration is one of several terms, along with rehabilitation, redevelopment and replacement that are used to refer to actions taken to ameliorate degraded land in one way or another (Figure 3). Their use in this sense has only become common in the last decades and as with many existing terms used within a new context, different authors apply them to express a variety of ideas. In this report we used the definitions proposed by the Man and Biosphere programme of Unesco (Schreckenber & al., 1990).

“Rehabilitation” will be used as the generic term to describe a management strategy designed to arrest the degradation of landscape and to make them more useful. The need for rehabilitation becomes evident when “bads” within the system outweigh the “goods” (Dyer & Ishwaran, 1990). The idea comparing ‘goods’ and “bads” is shorthand for making qualitative determinations about what is desirable or undesirable in a landscape — they

may be abstract and differ widely depending on the goals and objectives set for a given area. Restoration and redevelopment are regarded as tactics of rehabilitation efforts.

“Restoration” is defined as a tactic employed to return degraded land to its original condition (Dyer & Ishwaran, 1990). It does not emphasise resource utility but aims to reinstate entire communities of organisms closely modelled on those occurring naturally. In practice, restoration projects often have to settle for an approximation rather than a duplication of the original conditions (WRI-IIED, 1988). There are two approaches to restoration:

- Active restoration aims at an accurate re-creation of site conditions existing prior to the disturbance activity involving a consideration of all environmental components whether valued or not;
- Passive restoration abandons disturbed areas in conditions designed to be habitable to organisms that were originally present or others that approximate the original habitants, and creates opportunities for natural regeneration (Brinck & al., 1988).

“Redevelopment” is a tactic employed to repair degraded land to a more useful condition where the collective ‘goods’ exceed the “bads” (Dyer & Ishwaran, 1990). Redevelopment is clearly utilitarian. It aims to optimize the usable biomass of a site without being constrained by the need to attempt to recreate the original ecosystem (Schreckenbergr & al., 1990). According to Baskerville (1988), the development of resource often leads to the degradation that then requires a redevelopment. Replacement in the sense of creating an ecosystem different to the original is therefore included in the definition of redevelopment. There is a need to clearly define the objectives for any redevelopment scheme and these must be planned taking into account scientific requirements as well as the social conditions that lead to the degradation in the first place. Thus the role of changes in perceptions, needs, technologies, public opinion and political will in shaping development options and possibilities is important to take in consideration (Figure 2).

Exploitive development can adversely affect ecosystem characteristics in such a way that amenities and services obtained from the ecosystem prior to development may no longer be available. The first management option in rehabilitating such a degraded or derelict ecosystem is to do nothing, in which case it may restore slowly by natural processes. The second rehabilitation strategy is to redevelop the system to arrive at an altered state in which management “goods” exceed “bads” (Figure 3).

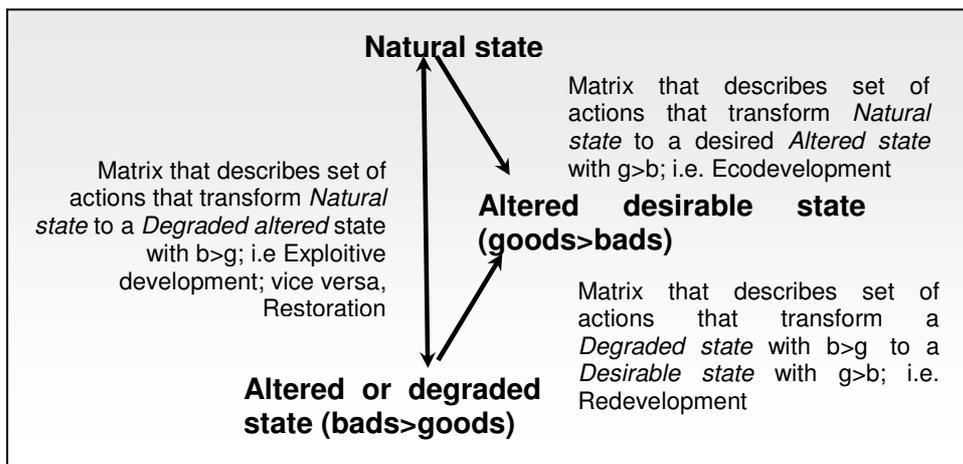


Figure 3: Rehabilitation ways and transformation in the environment

2.4 Research hypothesis and specific objectives

The research hypotheses which conduct this study are:

- **Hypothesis 1:** Because of intensive and destructive practices in some parts of Mau Forest, its future is sometimes compromised;
- **Hypothesis 2:** The responsibility of smallholders in the forest depletion is undeniable but others factors have to be taken into consideration in this process of degradation.

In order to verify these hypotheses, the following objectives were set:

- **Objective 1:** To characterize the determining local and regional factors of forest degradation and organise them hierarchically;
- **Objective 2:** To determine the uses and practices of the forest communities' members;
- **Objective 3:** To identify the perception of the Mau Forest's stakeholders (ecological, economical, social, and interests) about the Mau Forest and its future in the context of its degradation and restoration;
 - Sub-objective: To identify stakeholders' perception of the state of the forest according to the level of degradation;
- **Objective 4:** To propose a first restoration strategy based on obtained results and on the local context (to be more developed in following project periods).

3 Study methods

3.1 Working scale

According to Jouve (1992), the same area can be exploited in different ways. Thus, at the regional scale, strategies and main axes of project intervention have to be linked to the physical and human characteristics of the area and the way it is exploited (Jouve, 1992).

To study practices and uses at the regional scale, the agrarian system concept is well adapted. It is defined as "a way of exploitation of the environment which is historically constructed in a sustainable way, and also a powerful production system adapted to the bioclimatic conditions of a given space and responding to social conditions and needs of the moment" (Mazoyer, 1985). The landscape reading gives information about the morphology of the agrarian system. It is important to define a territorial and human unit linked to the working scale. In many African countries, the village scale is used to characterise the practices. According to Jouve (1984), "village" represents a specific organisation level of the environment which is expressed by the structure of the agricultural space. Hence, it represents the most relevant territorial unit to analyse the regional functioning of ways of exploitation and agricultural value enhancing. This entity possesses its own identity and its own coherence (Jouve, 1992).

To identify the interactions between the stakeholders of the Western Mau Forest and the natural resources at the local scale (inside the village), the household scale was chosen.

3.2 Selection of the villages

In order to select the villages, social and economic practices have to be known (Bedu & al., 1987). However, detailed information about census data and poverty indices on the village scale and a recent map were not available. Only data on the sub-location level which includes several villages was available. Data about the state of the forest surrounding the villages were neither existent.

We decided to select the study villages according to the following variables: state of the forest bordering the visited villages –*via* a rapid visual assessment–, approximate number of households according to key informants (as elders or teachers), availability of off-farm income sources, ethnic composition, and the distance to the principal markets. After having visited and compared several villages in the Western Mau, three villages were selected: Nyakinyua, Bonde and Chepsir Tea Zone.

Figure 1 shows the localisation of the three villages in the Western Mau Forest Information about these villages is summed-up in Table 1.

Table 1: Characteristics of the studied villages

Criteria	Nyakinyua	Bonde	Chepsir Tea Zone
Global state of the forest	Natural forest very degraded, no plantations	Natural forest medium state, plantations	Natural forest in good state, plantations
Number of households	700	200	59
Main activity	Farming (Food crops, mainly maize and potatoes)	Farming (Food crops, mainly maize and potatoes)	Farming (Food crops, mainly maize and potatoes), working in tea factory
Availability of off-farm income sources	Few	Few	Yes: Tea zone (Factory)
Average land size (ha)	0,4	1,6	2,8
Distance to the principal market (km)	3	7	2
Ethnic composition	Mainly Kikuyu, in few numbers Kisii, Luhya, Luo, Turkana, Kalenjin	Kalenjin (60%), Kikuyu (40%), but also Kisii in few numbers	Kalenjin (mainly Kipsiguis)

Further information is given in Appendix B and C about the history and the two main tribes present in the Western Mau Forest.

3.3 Used tools

3.3.1 Bibliographic research and exploitation of existing data

To study the history of the region and the knowledge produced about the forest degradation and restoration, we carried out a bibliographic research during all the study. The objective was to identify the issues at stake, the dynamics on the resource, and the behaviour of the stakeholders.

After having made a request, we obtained available GIS data about administrative boundaries and roads in Kenya from the Africover programme of the FAO (www.africover.org).

3.3.2 Interviews

Interviews combined with observations were the main tools to study the practices and uses of the stakeholders and their perceptions of the degradation and restoration of the forest. We divided the work in two stages: the first one, the study of the “official knowledge” sphere, allowed understanding the regional scale, and the second one, the study of the “practical action” sphere, understanding the farmers at a local scale. A typology based on the households trying to simplify the heterogeneity of the farmers through the identification of groups (types) presenting similar characteristics in relation to one or more selected factors was one of the expected product of this work. Depending on their categories, each type of household has unique characteristics, a unique choice of production and socio-economic activities, and subsequently of management and forest use options. Typologies provide classifications that guide investigating and theorizing (Sturtevant, 2003). They are useful to elaborate different strategies for the forest restoration according to the different households’ uses and practices of each type.

3.3.2.1 Study of the “official knowledge” sphere

Based on the regional scale, the aim was primarily to understand the relation between the social environment and the forest resources, as well as the different functions attributed to these resources during history. We studied the different diagnostics of resource uses and practices produced by the researchers of the Kenya Forestry Research Institute (Kefri), governmental institutions, and different experts from NGOs. We were also interested in the socio-economical, agronomical, ecological, political and cultural data about the Mau Forest, the methods to characterise it and their results.

Five open interviews were made with researchers from the Kefri and three with responsables of local NGOs (Community Food and Environment Groups Forest Association (Cofegfa), Friend’s of Mau Watershed (Fomawa), Mau Community Forest Association (Macofa). The subjects of the semi-structured interviews included the evaluation of the forest situation by the interviewed persons, the causes of its degradation according to them (if they thought that the forest was degraded), the threats, the indicators of this degradation and possible solutions to improve the situation.

Four open interviews were carried out with the Kenya Forest Service (KFS) (two foresters, one district forest officer and one forest guard) and one with a guard of the Kenya Wildlife Service (KWS). The main subjects of the interviews were their evaluation of the situation, the causes of degradation (if they considered that it existed), their criteria of judgement, the impact of different human activities on forest, the cause of the differences between the recommendation of the government and the practices of the communities and how the information come in the local communities (Appendix D).

3.3.2.2 Study of the “practical action” sphere

Local context and the different farmers’ practices were the focus point and the village scale was used. We studied the practical actions and the impact of the actual policy on forest degradation. Consequently we tried to analyse the dynamic of the degradation and the actual role the forest plays for the communities. We studied the practices of the farmers: How do they use the forest? To what extent do they use forest products? How often? For domestic uses or sale? We wanted to analyse if a divergence exists between governmental directives and effective practices. Finally, we concentrated on the stakeholders’ social perception of the forest degradation and its restoration. This part of the study was based on the stakeholders “justification” and on the analysis of their speech (how do they say it?).

The work was divided in two stages. We began to collect qualitative data using semi-structured interviews and open-discussions. The principle we used was to leave the investigated person the opportunity to express his/her point of view by answering open questions (Dockes & Kling-Eveillard, 2006). Thereby we admitted the existence of a relation between the degree of freedom left to the investigated person and the depth of information he/she could supply. After 20 open interviews were carried out in each village, we reached the saturation of information for our study.

In the villages, the interviews were conducted in the native local languages to diminish the interpretation biases. Two main languages are used in the study villages: Kikuyu and Kalenjin. Consequently we worked with two translators. Others languages are spoken in theses villages such as Luhya, Luo, Turkana and Kisii. In such cases, the interviews were conducted in Kiswahili. We trained the translators on the semi-structured interviewing techniques. We worked about the meaning of the words and their importance for our study. Indeed, not only the “global contents of information” interested us but all the words used to describe an object or a particular situation. We wanted to focus the study on what the interviewed persons said and how it was said.

A questionnaire was pre-tested with seven farmers in Nyakinyua and four in other villages of the Western Mau. Situated cognition theory considers that perceptions are context-dependent (Gigerenzer & Todd, 1999). Thus, we tried to place the interviewees in a context that made sense for the topic of perception that is examined. In our methodology, (1) interviews should be done in the field, at a location relevant to the interviewee’s actions, and (2) the interviewer’s first question should be related to the interviewee’s main actions at this location (Becu & al., 2005). We often provoked informal follow-up discussions and made use of our observations to assure the validity of our findings. Finally, we developed with the translators a note-taking technique to ensure a minimum loss of information during the process. We adopted the recording method of Becu & al. (2005). During the open

interviews we made a rapid-note taking, just at the end of the interviews, we completed the missing parts of the notes, in the following hours after the interview we carried out a chronological rereading of notes to complete missing parts and, as far as we could recall, rewriting the conversation in the way that the interviewee expressed it. Two survey guidelines were used: one for farmers and one for elders and chief (Appendix D). With the information gathered in the qualitative survey we constructed a first typology of the farm households.

In the second stage, a short questionnaire was produced using closed questions based on the first typology (Appendix E). In this questionnaire, key parameters which distinguish the differences between the identified types were used. It allowed obtaining a big number of relevant information about farm households in a short time. It was tested with five farmers and some questions were then clarified. The households were selected using spatial randomization. Working on all the streets of the village, every n-household was selected (n depends of the number of households in the villages). This method permitted to have a sample of the household according to their distance from the forest. Between June and August 2007, 232 households were interviewed: 100 in Nyakinyua, 73 in Bonde, and 59 in Chepsir Tea Zone. This gained data allowed to (i) validate the typology or not and (ii) to classify the farm households in the study villages into different types. A principal component analysis (PCA) followed by a cluster analysis (k-means) *via* the software *SPSS 13.0* was carried out to treat the data (explanation in Appendix F).

3.3.2.3 Overview of the social perception study

This part of the study was carried out *via* the 20 first interviews with open questions. We tried to approach the stakeholders' perceptions through an analysis of their speech within three classical dimensions described in the areas of psychology and social marketing (Lendrevie & al., 1989), which are attitudes, behaviours and knowledge.

First, attitudes, means the socially acquired capacities. They refer to precise objects (occupation, working practices, forest status, trees on farm, situation of farmers in the society). They are expressed in terms of opinions, states of mind, etc. Secondly, behaviours are such as described by the farmers: ways of acting and practices. Finally, knowledge corresponds to the scientific, technical or empirical information which can be used by the actors to understand a phenomenon. For instance, the knowledge can concern particular species of the forest, specific uses of trees or ecological functions of forests. It is important to underline that the aim was not to judge the level of knowledge of the interviewees. As it was argued by Figuié (2001), the study of knowledge could generate biases because the interviewee might answer what he thinks the interviewer expects from him.

Therefore, as in Bourdieu (1993) the objectives were to have a discussion about the stakeholders' practices and how they justify them in their own point of view. As our interest was in collecting the interviewee's perception of the forest degradation and restoration, topics were introduced through questions such as "can you tell me something about the forest?" and "how does this arise?" when talking about an environmental state, through questions such as "why is this so?" and "what is happening here/there?" when talking about environmental dynamics, and through questions such as "what do you do about X and why?" when talking about an action. Prompting questions were then used within each topic,

either to invite the interviewee to develop his argument or to talk about a predefined subtopic.

Then, during the transcription work we built an analysis grid (Appendix G) of the collected speeches which shows the classification systems (how is the level of forest degradation classified?) and the opposite classes (what are the elements associated with a “good” or a “bad” forest?). According to Darré (1985), we collected for every qualitative interview the words or groups of words linked to the forest and its degradation (pivot-word).

3.3.2.4 Sum-up of interviews’ objectives

Table 2 sums-up the interviews’ objectives and their carried out number in the villages.

Table 2: Interviews and associated objectives

First stage	20 interviews in each village → Open questions	- Qualitative information - Study of social representation - Elaboration of a typology
Second stage	232 short interviews → Closed questions - 100 in Nyakinyua, - 73 in Bonde, - 59 in Chepsir Tea zone	- Validation of the typology - Socio-economic information

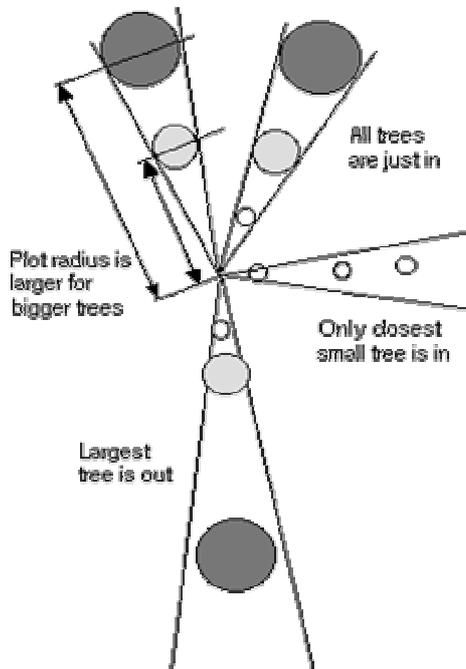
3.3.3 Forest inventory

Forest inventories were carried out in the forest surrounding the studied village. To organize the inventories, pre-inventories were accomplished.

The objective of the inventories was to characterize the state of the forest and its degradation. Because data concerning the state, the structure and the floristic composition on the stand level did not exist for this part of the Western Mau Forest, a data base was created. With it, a comparison between the present and future forest state might be possible. We combined two methods which allow a rapid fieldwork process: Bitterlich method and N-tree distance sampling. These methods might not have the best precision compared to other existing methods, but these two methods are nevertheless well suited for our study. They are very efficient because they reveal the searched information (characterisation of the forest state) in a short time.

3.3.3.1 Bitterlich method, Variable-radius plot (VRP)

The Bitterlich method (Bitterlich, 1948) is also called angle count sampling, variable-radius plot (VRP) method and plotless timber cruising.



With regard to the accuracy and speed of obtaining field data at the same level of sampling intensity, the angle-count method outweighs the rectangular and circular plots (Bay, 1960).

This method allows estimating the basal area of a stand (Appendix H). It combines average diameter and number of trees per hectare. An angle gauge is used to estimate the density of basal area in the forest (Figure 4). The surveyor simply counts those trees whose breast height diameter appears larger than the critical angle projected by the gauge (Scott & Gove, 2002). Trees that are narrower than the angle are not counted. Through geometric arguments, it can be shown that each such tree represents a constant amount of basal area per unit land area.

Figure 4: Variable radius plots (LeBlanc, 2000)

3.3.3.2 N-tree distance sampling

This method was used to identify the tree density in the stands, the distribution of the trees by diameter class and the floristic composition of the stands.

N-tree distance sampling is based on selection of the N-trees closest to a sample point located in the forest population of interest. Plot size is circular based on a radius to the centre of the most distant of the N-trees closest to the point, so that all N-trees are in the plot (Figure 5).

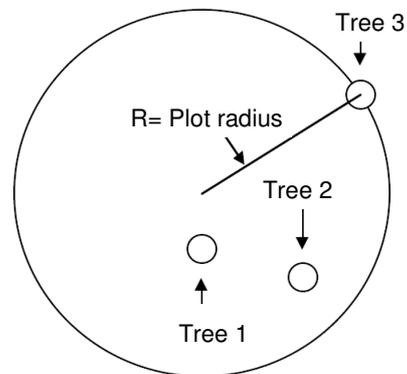


Figure 5: Plot for N-tree distance sampling with n = 3 (LeBlanc, 2000)

Consequently, the N-trees species, diameter class and the distance from the sampling point to the centre of the most distant of the N-trees were measured. Three diameter classes were established: a, b and c corresponding respectively to diameters between 10 and 30cm, 30 and 50cm and diameters larger than 50cm.

This method is time-competitive compared to other statistical methods (Kleinn & Vilcko, 2006, Lessard & al., 1994, Lynch & Rusydi, 1999, Trifkovic & Yamamoto, 2005). N-Tree distance sampling was compared to fixed-radius plots and horizontal point sampling by Lessard et al. (1994) in several forest types; their results suggested N-tree distance sampling might be cost-effective for rapid inventories. Fixed-radius plot sampling and N-tree distance sampling produce comparable results, but the N-Tree method uses an estimator with a slight theoretical bias (Paulo & al., 2005).

The aim of this study is not to obtain a high statistical precision, but to estimate the state of the forest degradation. Consequently, even if this method might not present the best accuracy, it is efficient in the estimation and characterisation of forest degradation.

Because the forest was dense or bushy in some places, it was estimated more judicious to employ this method rather than the Bitterlich method to determine the density, structure of the stand (distribution by diameter class) and floristic composition. As the N-trees are located near the surveyor and hence concentrated on a small area, it is faster to take measurements such as tree species and diameter class. Compared to the fixed radius plot method, the N-tree method has the advantage that it gives information about remaining trees in degraded or deforested area, because it is not limited to a restricted area (for example a circle with a radius of 10 meters).

The floristic composition was determined *via* the relative rensity (RV). This value corresponds to the importance of a species according to the total number of individuals in a sampling area (Appendix H) (Latreille & al., 2003).

3.3.3.3 Organisation of the measurements

Forest degradation usually occurs slowly through land cover modifications (not conversions). Open forest degradation may affect, and therefore be indicated by the phenology of the vegetation cover (Lambin, 1999). Consequently, additional parameters were used. The cover of the canopy, shrubby stratum and herbaceous stratum in percentage were evaluated at every sampling point. At each point the level of regeneration was also measured. For this, the number of seedlings (or approximation, if many seedlings) was counted in an area of 1m². Thus, the measurements at each sampling point were carried out by the combination of the Bitterlich and N-tree distance methods and particular parameters were in addition noticed. Sampling points were located with the help of a GPS Garmin 12.

Table 3 sums up the measured parameters.

Table 3: Measured parameters for each sampling point

Measurements in each sampling point	
Bitterlich Method	- Number of trees larger than the angle gauge to estimate the basal area
N-tree Method	- Distance of N-tree from sampling point - Identification of tree species with the assistance of local people - Tree diameter <i>via</i> three classes: a ,b, c
Additional measurements	- Cover of the canopy - Cover of the shrubby stratum - Cover of the herbaceous stratum - Regeneration

In the deforested area (canopy cover less than 10% spanning over at least 0.5ha), each point was measured at an interval of 200m. In the other parts of the forest each point each point was taken at a distance of 150m.

In addition, during the transect walks observations concerning the vegetation pattern (changes in the canopy cover or in the floristic composition) were noted and located *via* a GPS.

The number of sampling points was estimated after having carried out pre-inventories. The methods used during the pre-inventories were the same than the ones used during the inventories (*cf.* Table 3). The sampling plots were located in the forest adjacent to the villages. With the obtained results the number of required plots was calculated using the coefficient of variation to obtain results with a maximal error of 20% for a confidence level of 95% (Appendix H).

3.3.4 Cartography to illustrate

Maps are an appropriate way to illustrate information about the territory. It is also a very visible way to share the incentives of the decision process concerning land-uses (d'-Aquino & al., 2002). The study site and the inventories results are presented in a map built with the software MapInfo Professional 8.5. We used for this GIS layers (roads, forest ranges) based on data from the IUCN downloadable on the homepage of ILRI (<http://www.ilri.org/gis/>). The rivers and localisation of the city were digitised from a regional map of 1979. In the sum-up map (Figure 26), interpolation was performed using the Inverse Distance Weighted (IDW) method, with a decay function to the power of 2, a measurement radius of 4 km and a cell size of 0.03 km.

4 A forest shaped by communities and communities shaped by the forest

4.1 Agrarian system in the villages

The sublocation is the smallest administrative scale in Kenya. One sublocation is composed of several villages. Two specific authorities have responsibilities in the villages; elders who are involved in peace creation and resolution of conflicts and chief who represents the administrative authority. These authorities coexist but do not seem to interfere a lot.

Concerning the land tenure, in the region, farmers can either be freehold or leasehold tenants of land after registration and issue of title deeds. Freehold is the greatest interest in land a person can have and gives the holder absolute ownership of the land. Leasehold is an interest in land for a definite term of years and may be granted by a freeholder. Conflicts between the different tribes can exist in the region. Kenyan history knew many ethnic conflicts and some marks of these confrontations are still present. Pressures on land due to overpopulation in regions like Kenya's Central and Rift Valley provinces have been one of the causes of internal struggle. Land problems have fermented greed and jealousy in the minds and the hearts of people, and the recent ethnic clashes in Kenya have been attributed to lack of land (Forest Action Network, 2000).

Farmers live with their family and together they form a household. The household unit is defined by a nuclear family (and attached people) its lands and goods. The household is composed of parents and children, and possibly by grandparents or grandsons. The family members work and consume within the household. Generally, the household owns a main house and sometimes smaller ones on the same land for adult children. In their house they have a kitchen where the family members can eat collectively. On their land they produce crops. Thus, household is the unit of accommodation, consumption and production (see tome 2 of this study by Kübler (2007)).

The main activity in the three villages is farming. The cultural system is mainly based on the culture of maize and potatoes, but also on other food crops such as cabbages, carrots, beans, peas and onions. Maize is the basic staple food of the Kenyan diet, consumed mainly in form of “Ugali³”. Maize and potatoes are produced for self-consumption and if the production is superior to the household’s consumption, the excess is sold. Thus, it can become an important cash crop if the cultivated surface is relatively big. Usually, the households do not buy supplementary basic staple food. Food crops such as onions, carrots, and beans are mainly produced for sale. In the three villages, arboriculture is not common. In addition, tea in Chepsir and pyrethrum (*Chrysanthemum pyrethrum*) in Bonde and Nyakinyua are produced by some farmers exclusively for sale.

These productions constitute an important income source for these villagers. They allow them to buy basic goods (sugar, salt, clothes, oil, pens...) and to pay the occasional fees (school, transport, medicine...etc.).

Livestock keeping is very common in the Western Mau. Milk is very appreciated by the people of this region and consumed by some farmers up to three times a day. One farmer in Chepsir said: “*I do not drink a lot of water but I drink milk instead!*”. The production is as much for self-consumption as for sale, if the number of cows allows it. Meat of cows, goats and sheep is predominantly intended for sale in bigger cities such as Molo. A small part of the production is nevertheless consumed in the villages. Small livestock such as poultry is also often kept and reared by the households.

Animal traction is rarely used in the Western Mau. Most of the fieldwork is done manually by the members of the households and sometimes in big farms with the assistance of casual labour.

A few people in the three villages possess a small business like a shop. In Chepsir, the second economic activity after small-scale agriculture is related to tea production. In Bonde and Nyakinyua, this kind of economic opportunities are rare. In these two villages, young people are more often concerned by the lack of jobs and the search for income sources. Some of them move from the village to the city in order to find a job. Farmer’s work force is numerous in the region, but the offer is usually bigger than the demand.

In the region, infrastructures like roads, telecommunication and electricity are deficient. Production activities are thus disturbed and limited during some parts of the year (bad road conditions during the rainy season). In the three villages, electricity is restricted to villagers who possess a generator. In Bonde and Nyakinyua water piping systems do not exist. In Chepsir Tea Zone, the villagers formed an association and constructed a piping system in

order to bring water from the sources in the forest to the households. In the three villages, the collective infrastructures are often restricted to a primary school and churches. Usually, the children whose parents can afford to pay the school fees for the high level of education (secondary school, high school or university) have to leave the village to study.

It is in this local context that the illegal extraction of forest products takes place in some part of Western Mau.

In addition to the difficult socio-economical context, the history of the region has often been problematic because the relations between the diverse tribes were sometimes ambiguous and compromised. Even if the situation between the different ethnic groups is nowadays better than during the land clashes (1992), some bitterness remains still between the different clans. An extract of the Kenyan history of the Rift Valley including the different tribes living in the region of the Mau Forest is given in Appendix B. Table 4 shows the history of the three villages and the meaning of their name.

Table 4: History of the villages and meaning of their name

Criteria	Nyakinyua	Bonde	Chepsir Tea Zone
History (detail of the Kenyan history in Appendix B)	Before 1963: Big farm of a British colonist (1600 Ha). After independence (1963) a group of old ladies bought the land. The name became Nyakinyua. Around 1970: Many people arrived mainly from Central Province and Rift Valley to do farming	Before 1963: Big farm of a British colonist 1963-1978: Squatters 1978: Purchase of the land by a community from Muranga district, squatters were still there 1997: Division of the land and purchase by new arrivals	Before 1968: Big farm of a British colonist, Brookborn 1968: Arrival of the first settlers 1972 – 1975: Forest exploitation by a big company from Elburgon 1986: Installation of Tea zone, plantation of cypress
Meaning of the village name	Old Mature Ladies	Valley	To cross something

4.2 The forest and its degradation: perception

4.2.1 A double vision of the forest degradation in the “official knowledge” sphere

In the perception of the “official knowledge” sphere, forest plays a very important role for many people. The environmental services of the forest such as the regulation of water catchments, soil erosion control, nutrients recycling, carbon sequestration etc. are widely acknowledged by this sphere.

Both scientists and NGOs agreed that Mau Forest is highly affected by human activities. According to them, it has been extremely degraded and its cover has been deeply decreased in the last 10 years. The forest is especially disturbed in the zones adjacent to

the villages where the population pressure highly affects the amount and the quality of the resource. The combination of population growth, high poverty levels, no job alternatives and a certain “laxity” of the government lead to environmental destruction. Illegal logging for charcoal burning, the harvest of construction materials, poles and fences, and collecting firewood constitute the major sources of forest degradation. Grazing is also estimated to be a main degradation cause, because it disturbs the regeneration of the forest and therefore endangers its future.

On the other hand, according to the foresters, only 10% of the natural forest in Mau is seriously degraded. In their perception, grazing is not common in the indigenous forest because of the closed vegetation where animal can not pass. For the KFS one of the most important problems is the lack of funds in the service: *“There are not enough vehicles, not enough guns, not enough guards to control all the forests”*. Nowadays, one guard has about 1000ha under his responsibility.

For this sphere of “official knowledge”, the promotion of on-farm forestry and the implementation of the new Forest Act 2005 including the involvement of the communities in forest management represents a solution to protect this environment against degradation. A scientist from the Kefri reported *“for the moment, the forest is a government’s propriety. Thus, communities have no interest to manage it in a sustainable way. However, with the new policy it becomes their propriety and they will be able to find a reason to take care of it”*.

Nevertheless, as underlined by the Cofegfa and the KFS, *“to change attitudes takes a long time”*. Hence, to imagine that this new law alone will change the situation and farmer’s attitudes seems utopian, especially if the general lack of communication, information and education about the forest is taken into account.

4.2.2 Forest: a vast reservoir of goods in the “practical sphere”

4.2.2.1 Different images linked to the forest

These results are based on the qualitative interviews. The forest images of the villagers were classified into four categories: economical, useful for domestic use, ecological and political. A mix between these aspects was possible. The words were ordered by lexical groups (Table 5). It was important not to separate a used word from its context of quotation. For example, the classification of *“water”* was dependant of the quoted context. When water was mentioned as a source of rain, it was ordered as *“ecological”*. When it was mentioned as drinking water, it was ordered as *“useful”*.

Table 5: Vocabulary used by interviewees grouped in lexical group

Lexical Group	Economical	Useful for domestic	Ecological	Political
Vocabulary	Money, Revenue, Charcoal (as a source of revenue), Employment...	Firewood, Water (to drink), Charcoal, Honey, Construction Material, Medicine, Grazing, Hunting, Farming...	Rain, Water Catchment, Wild Animals, Good Air, Climate...	Corruption

The forest is perceived by the villagers as a vast reservoir of all kinds of vital products and services. However, the perception varies in the three villages (Figure 6). In Nyakinyua, the perception of the forest is the most “economical” of the 3 villages. Thus, a farmer confided: *“The only source of income in the village is the nearby forest, there are no other alternatives”*. Most people associate the forest with a fuel and energy resource and consequently sometimes with the revenue which can be generated by these products. *“The forest permits us to make charcoal and to have revenues”*. Charcoal, quoted by 15 persons out of 20, and firewood were very often mentioned and seem to occupy a main place in their perception. The useful aspect is also important in this village, *“forest gives us firewood and a lot of products such as honey, medicine and construction material”*. According to the villagers, the forest is also a suitable place to carry out activities such as farming and grazing.

The fifth of the 20 interviewees perceive the forest with its destruction and its *“very bad state”*. *“The forest is not as before, there are fewer trees now”*. The ecological aspect of the forest seems to occupy a minor place in the villagers’ perception. Only 4 persons out of 20 quoted this image. In Nyakinyua, the perception of the forest is the least “ecologic” of the three villages.

In Bonde, the economic aspect of the forest is also important. However, people described it more often as useful. *“Forest helps people to live and almost every household uses charcoal”*. For the villagers, the forest is also a source of fuel in form of firewood and charcoal. Charcoal was mentioned by 17 interviews out of 20. This product occupies a high place in the forest perception of this village. Moreover, forest is a place to collect products such as poles and fences and to undertake activities like grazing. The ecological role of the forest is more important than in Nyakinyua, but less than in Chepsir. One farmer associated the forest directly with a political problem. Hence, for him *“the corruption is very important in this forest and if nobody takes care of the forest, it will be out!”* Like in Nyakinyua, some farmers (3 out of 20) perceive the forest in the context of destruction.

Through their speeches, the villagers of Nyakinyua and Bonde appeared very dependent on the forest resource.

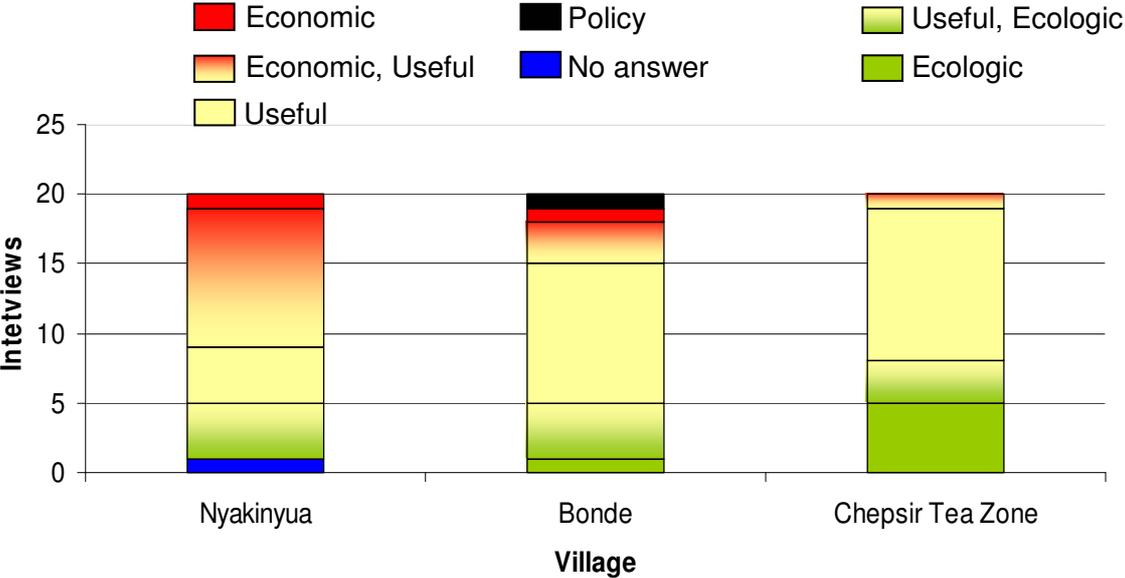


Figure 6: Farmers’ perceptions of the forest (according to our perception)

Finally, in Chepsir the economical perception of the forest is on a low-level. People do not depend on the forest as much as in the two other villages. Charcoal was mentioned by four farmers, but only to explain one of the reasons why the forest was in a bad state in other villages. The forest perception of the villagers is more ecologic and useful. Thus, the forest is associated as a useful fuel source, but only through firewood. The activities linked to the forest, especially hunting, occupy an important place in Chepsir. The ecological perception of the forest is the most important of the three villages. For many farmers, *“Forest is a place with many trees and animals, it is also a source of water catchment. We get honey, firewood and medicine from it”*. An important point is the perception of the destruction, which appeared several times (in eight interviews out of 20). Nevertheless, contrary to the destruction described by the people from Nyakinyua and Bonde, which was in relation with the forest degradation, in Chepsir, the destruction was linked to the "good state" of the forest. Indeed, many farmers related the forest with wild animals such as elephants. According to the farmers *“wild animals come, destroy our maize and once, they even killed one person.”* This image of fear and destruction caused by wild animal was a prevailing feeling for the people from Chepsir.

In Nyakinyua and Bonde the definition of a good forest is slightly more productive than in Chepsir. Thus, a good forest has been defined as *“a dense forest with very tall trees, with many trees and different species”* but also as *“a forest where people can get every product they want.”* In Chepsir, an older lady defined a good forest as *“a forest that has been taken care of, one where trees haven't been cut, where wild animals don't have to come out of the forest.”* She also added that *“every forest is good as long as people can use it”*. The difference between the villages is bigger in the perception of a bad forest. In Bonde and Nyakinyua people described it often simply as *“a forest without trees, which has been destroyed by human activities”*. Contrarily, in Chepsir several farmers reported that *“a bad forest does not exist because all the forests are good”*. People in Chepsir are not used to perceive a degraded forest, because the forest adjacent to this village is in a “good” state. Consequently, it is difficult for these farmers to imagine a “bad” forest. On the contrary, in Bonde and Nyakinyua people are confronted with a degraded forest everyday. Hence, it is easy for them to describe what they see in some parts of the forest.

Finally, the notion of illegality and respect for the law is very different between the villages. In Nyakinyua and Bonde *“almost all households in the community produce charcoal”*, even if this activity is theoretically forbidden by law. Apparently, people do not abide by the law in these two villages. In Chepsir, on the other hand, charcoal making is forbidden in practice, because people abide by the rules. Law and authority seem to influence the way to act. A farmer expressed: *“If you want to go inside the forest to harvest wood, you need a permit; if you don't have it, it is illegal and if a guard catches you, he arrests you”*. Moreover, one farmer reported that *“if somebody destroys the forest, people report it to the forest guards.”* The farmers of Chepsir consider illegal activities in the forest as negative. In the two other villages, according to some farmers *“the guards just arrest people and later release them after some arrangements”*. In Nyakinyua, one farmer even told us that *“the promoters of the illegal activities are the forest guards themselves”*. The illegal activities in the forest appear to be almost-normal in the village life and everybody can do them.

4.2.2.2 Awake villagers about the state of their forest

Villagers evaluated the present state of the forest and compared it with the past one (Figure 7). In Chepsir, according to the 59 villagers which were interviewed with closed questionnaires, the state of the forest near their village is nowadays mainly better (for 48%) or identical (for 36%) than the state of the forest used to be (10 years ago or less if new resident). Only 10 farmers (17%) described the state of the forest as worse than before and nobody perceived the forest as degraded. For them, the state of the forest is medium, good or even very good (respectively 41%, 21% and 21% of the interviewees). One of the quoted reasons for this positive estimation was the fact that *“community and the forest department take care of the forest together, we [they] collaborate”*. For the future people predicted that the state of the forest will be even better *“because now, we [they] have some associations which manage the forest and plant trees”*.

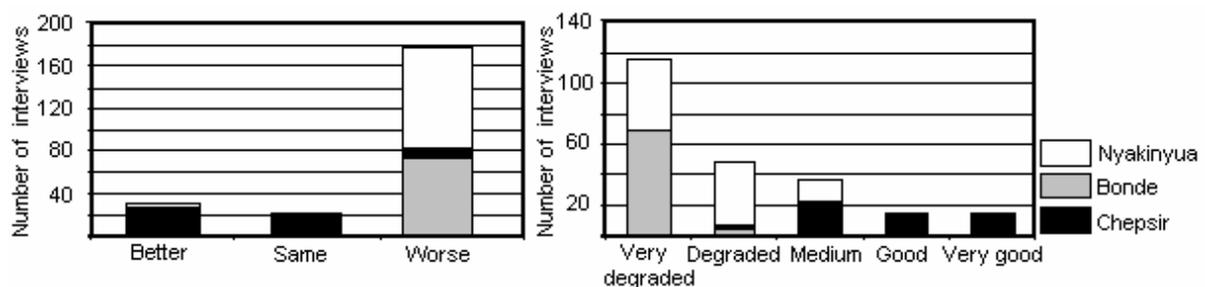


Figure 7: Perceptions of the villagers about the state of the forest

Except for four villagers out of 100 interviewees in Nyakinyua who considered that the forest was better than before, 96% in Nyakinyua and 100% (73 interviews) in Bonde described the state of the forest as worse than in the past. In these two villages, the forest was perceived as very degraded (95% in Bonde, 46% in Nyakinyua), degraded (5% in Bonde, 41% in Nyakinyua) or medium (13% in Nyakinyua).

According to the people from Bonde and Nyakinyua, the source of forest degradation is varied. For them, the main source of degradation was the government. Three governmental problems were underlined:

- lack of interest: *“The government is not much concerned about the maintenance of the forest, it has failed in his responsibility”*;
- corruption inside the forest department: *“The forest guards come here to harass us and to take money from us when they find us inside the forest.” “They neglected their duty and they do not protect the forest”*;
- lack of employment in the region: *“We do not destroy the forest because we want to, but because we have no alternative. If we had jobs, we wouldn’t destroy it.”*

For some farmers, mainly old ones, communities and especially “the youth” were responsible of the degradation: *“The youth do not have any jobs and they go into the forest to earn money”*. Others thought that the government and communities were guilty. Finally, in Bonde outsiders from the village were also mentioned as a source of degradation: *“The people from Molo come here, they cut the timber, they split it, and they carry the timber away.”*

Concerning the management of the forest, in Nyakinyua and Bonde, most of interviewed people expressed a discontentment and underlined a failure of the government management (mainly caused by corruption). On the contrary, in Chepsir people seem to be satisfied by the public forest management and even proud of the cooperation between the government and the villagers. Farmers perception of a given forest management regimes is likely to be influenced by an array of factors that are related to their socio-economic characteristics, interactions with forest management and such like factors.

4.2.2.3 Lucidity about the disturbing activities

According to the 232 interviewed persons, the most disturbing activities for the forest are cutting trees and charcoal burning (respectively 41.2% and 40.7% of all quoted activities) (Figure 8). By cutting trees people described illegal cutting to make fences, posts and construction material. For charcoal burning, trees are cut, too, but people mentioned this activity separately. These two activities could hence be grouped together. Moreover, charcoal burning was quoted by a majority of 71.2% of the interviewees as the worst threat for the forest.

According to the villagers, grazing and farming in the forest also threaten it (respectively 6.8% and 6.3% of the quotations). The majority of the people who quoted grazing as a threat come from Bonde, the majority who quoted farming come from Nyakinyua. However, while for the NGOs and the researchers grazing in the forest is often perceived as the main threat for the forest, the farmers only mentioned it twice as the first cause of degradation. Firewood harvesting and non timber forest products (such as honey, ropes and herbs) were slightly pointed out (respectively 3.2% and 1.7% of the quotations). Finally, once children were mentioned by an old lady as a disturbance to the forest.

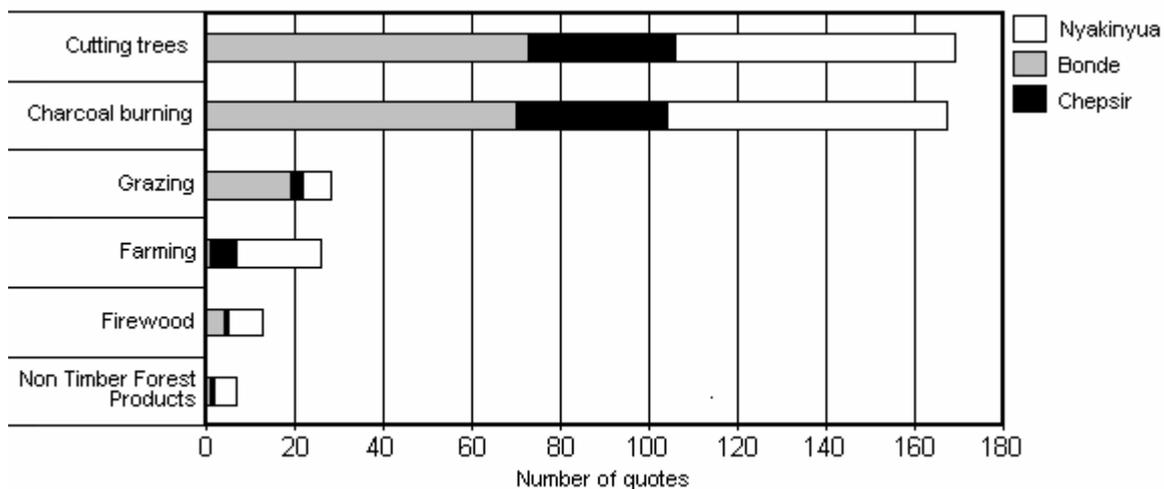


Figure 8: Perceptions of the villagers about the disturbing activities

4.3 Uses and practices in the forest, a reflection of the forest perception?

The different forest uses and the intensity of these uses influence the pressure on the resource. Local populations harvest trees for domestic use and for cash income. Firewood,

charcoal, construction material and poles are the most extensively used forest products by the villagers which depend on the forest. Other forest products are herbs for medicinal uses, honey, bush meat, water and thatching grass. These products are also used very frequently, but they do not seriously threaten the forest - at least not in the immediate future.

4.3.1 Fetching firewood

Collecting firewood is a very important forest use for the people of the three villages. Almost every family collects firewood because the villagers mainly use wood for cooking. Alternative energy sources such as gas, electricity or small kerosene burners require a cash investment in appliances and utensils which is often not affordable by the villagers (Mutimba & Barasa, 2005). The collected firewood is mainly for domestic consumption. The average consumption of one household slightly varies between Bonde (7.9 headloads of 15kg per week) and Chepsir (6.6 headloads of 15Kg per week). In Nyakinyua, the average amount of wood consumed by one household was with 4.3 headloads per week the least important of the villages. Possibly, the degraded state of the adjacent forest and consequently the long walk (around 2 hours) to search firewood result in a lower consumption rate. This consumption is however difficult to evaluate accurately. It depends on the needs of the family, on the size of the household and can vary weekly. Finally, some people sell the collected firewood (mainly to old persons, shops or in the near city) to earn some revenues.

Firewood is collected usually by women during the day. They transport it on their back, on their head or with donkeys. Children are also implicated in the collection of firewood (Figure 9). They usually collect it on Saturdays, Sundays or during school holidays.



During the main holidays in July and August, many children collect firewood intensively in order to make a stock for their family. In theory, a permit from the Kenya Forest Service is necessary to collect firewood. It costs about 45Ksh (about 0.45€) a month and gives the right to collect one headload (about 15Kg) of firewood per day per person. In Chepsir, almost everybody buys this licence, but in Nyakinyua and Bonde many households do not possess it and nevertheless, collect firewood illegally.

Figure 9: Children fetching firewood, Nyakinyua

Villagers use mainly *Olea europaea* ssp. *africana*, *Olea capensis*, *Teclea nobilis* and in a few amount *Juniperus procera*, *Prunus africana*, *Dombeya torrida*, *Vangueria* sp., *Albizia gummifera* and *Croton macrostachyus* for firewood. In Chepsir and Bonde, due to the plantations near the village, people also use *Cupressus lusitanica*, *Eucalyptus* sp. and *Pinus patula*.

Fetching firewood is not a threat for the sustainability of the forest if this activity is carried out according to the law (only dead wood might be harvested). However, if living wood is collected, trees are destructed and the collection of firewood can endanger the resource.

4.3.2 Charcoal burning

Charcoal took a very important place in the forest perception of the villagers in Nyakinyua and Bonde and was almost inexistent in the one of Chepsir (*cf.* 4.2.2). This difference in the perceptions can be explained by the following results.

There is a gap between Nyakinyua and Bonde on the one hand where charcoal is produced and sold, and Chepsir on the other hand, where this use does not exist. This study shows that a different socio-economic context can explain this variation. In Nyakinyua, 84 out of 100 interviewed households (84%) and in Bonde 36 out of 73 interviewed households (49%) produce sometimes charcoal.

The commercialisation of charcoal is an important source of revenues for some villagers. In Nyakinyua and in Bonde, respectively 59.5% and 41.6% of the households which produce charcoal sell it. In the villages, one bag is sold for approximately 250KSh (about 2.5€) in Nyakinyua and 150Ksh (about 1.5€) in Bonde. For some farmers, charcoal burning represents therefore an important economic activity.

Table 6 shows the average weekly production in the two villages of those who produce charcoal and the average weekly amount of commercialisation of those who sell. Much variation exists within the produced and commercialized quantities.

Table 6: Amount of charcoal production and commercialisation

Unit: Bag of 35kg	Weekly charcoal production of producers				Weekly charcoal commercialization of sellers			
	Mean	Standard deviation	Max	Min	Mean	Standard deviation	Max	Min
Nyakinyua	1.7	3.4	24	0.13	2.6	4.7	23	0.3
Bonde	1.9	1.9	10	0.5	2.8	2.4	10	1.0

According to the producers, more charcoal is made during the dry season because the paths into the forest are more accessible during this time of the year. In addition, Mbugua (2000) reported that charcoal production for cash income becomes more important during the dry season and extended drought, when other types of activities fail to produce sufficient household income.

Charcoal burning in the forest is against the law. During the interviews and questionnaires, people often seemed afraid of having to face eventual judgements regarding this illegal and destructive practice. Hence, they might have deliberately underestimated or concealed the quantity of charcoal they produce. It is therefore very possible that the above results undervalue the real production and commercialisation of charcoal. However, the results give information about the general trends of charcoal production.

Whatever, charcoal production represents an important income generating activity and is done by most households on a small-scale basis (Mbugua, 2000).



Charcoal is produced mostly by men during the day and sometimes also during the night (Figure 10). Sometimes people get together in organized groups and produce charcoal on a substantially larger scale (Mbugua, 2000). Axes and pangas (machetes) are used to cut the trees. Most of the charcoal makers are rather young (15 to 40 years old) because this activity is exhaustive and requires a good physical condition: long walk to the forest (1-2 hours), ability to cut and transport trees. Children are also involved in the production and transport of charcoal.

Figure 10: Young man cutting tree for charcoal production, Bonde

Like firewood, children usually produce or collect it on Saturdays, Sundays or during school holidays. The charcoal burners mainly target indigenous tree species. The species used are principally the same as for firewood: *Olea europaea ssp.africana*, *Olea capensis*, *Teclea nobilis* and in few amounts *Celtis africana*, *Acacia sp.* and *Dombeya torrida*. According to the local people, “these woods burn well”.



The charcoal is produced with an earth-mount-technology (Figure 11), like the one originally used in Europe during the Middle Ages (Girard, 2002). The burning process takes an average of six days. Wood is put in dug-out earth pits, lit and covered with earth. The combustion of one part of the wood produces enough heat to carbonize the remainder (Stassen, 2002). Alternatively, heaps of wood are covered with earth and sod and lit through openings in the earth cover (earth kilns).

Figure 11: Earth kilns for charcoal production, Nyakinyua

Those openings can be judiciously opened and closed and new ones can be made to control the introduction of air. This technique produces very low yields (inconsistent quality because it is difficult to maintain uniform carbonization) and environmental pollution from the release of tars and poisonous gases (Girard, 2002). According to Girard (2002), to create one kg of charcoal using this method eight to twelve kg of wood are needed. Consequently, the efficiency ratio of this technique is only around 8% to 12.5%.

Once the burning process is finished, the charcoal is usually transported from the forest to the village by donkeys, yet sometimes by the farmers themselves. From the villages to the market place, the charcoal is usually carried by bicycles. According to people this kind of transport attracts less attention from the local authorities and the running costs are not high.

4.3.3 Harvest of construction materials, fences and poles

Despite the exploitation ban of timber from indigenous forests, the local people obtain construction materials both from the natural and planted forests (Mwanduka, 2007). Trees are mainly used for fencing and farm construction. The tree commonly used in Bonde and Nyakinyua to make poles is the East African cedar, *Juniperus procera*. Because of its durability and hardness this is the favourite species of consumers for this use. The producers have various criteria to select a tree to cut:

- The good quality of the tree is very important: “*Twisted trees are hard to work with and don’t give good quality planks.*” Moreover, “*trees which are too small are not used because they do not give a lot of planks*”;
- It must be possible to fell the tree without difficulties (influence of slope, no other blocking trees around);
- The donkeys should have access to the site;
- It should be easy to escape from the site in case of guard controls.

The harvest frequency depends of people’s needs and could not be exactly quantified. However, according to the people and our observations this destructive activity is important in the forest of Nyakinyua.



Like charcoal, construction material is collected mostly by men during the day and also during the night (Figure 12). Most of the producers are rather young (15 to 40 years old) because the harvesting requires a good physical condition. Poles are transported using donkeys. The products are sold in the nearby city or in the village.

Figure 12: Man transporting East African cedar planks (*Juniperus procera*), Nyakinyua

Three exotic species are used to a lesser extent in Nyakinyua and Bonde: *Cupressus lusitanica*, *Pinus patula* and *Eucalyptus* sp. Among these species, people seem to prefer cypress for construction material (producers quotes it 25 against 14 for pine and 13 for *eucalyptus*). These woods come mostly from the public forest (poaching or cutting of branches) or very rarely from farm. In Chepsir, people use almost exclusively exotic species, mainly cypress. It comes often from governmental plantations (harvest of branches) or from farms. In few quantities *Acacia* sp., and *Podocarpus falcatus* are also used. Furthermore, bamboos are used as fences and construction material in Bonde.

4.3.4 Forest grazing



Livestock keeping is one of the major economic activities of forest adjacent population of Mau Complex (Langat & al., 2005). According to the regulation, a permit has to be delivered by the Kenya Forest Service to graze in the forest. It costs 20KSh per animal per month. Many persons do not get this license, especially in Nyakinyua and Bonde. Hence, it was difficult to evaluate the actual number of animals grazing inside the forest from the office records on grazing permits of the foresters.

Figure 13: Cows grazing in the forest, Bonde

Moreover, the office records are more likely to reflect the level of monitoring by forest guards than the actual pressure by cattle grazing. Hence, local people were more able to evaluate themselves how important the forest is in their grazing habits.

Grazing in general is most important in Bonde (Figure13) and the number of animals is the highest in this village, followed by Chepsir and Nyakinyua (Table 7). In Bonde, the majority of households keep livestock (89%) and almost everybody agreed that forest is very important to their graze habits (83.5% of interviewees and 88% of the farmers with livestock). Indeed, 86% of them graze their animals in the forest, both in the natural and plantation forest. These results are accentuated by those of the researchers from the Kefri who found out that the local population depends substantially on forest for animal grazing and that domestic animals graze in the forest for about nine months in a year (Langat & al., 2006).

In Nyakinyua and Chepsir respectively 70% and 78% of the interviewees keep livestock. Opinions about the importance of the forest are divided. In Chepsir 49% of the interviewees and 63% of the farmers who have livestock think that forest is important for grazing. In this village people often have bigger land sizes than in the other two villages and they can graze their animals there. In Nyakinyua for 59% of the interviewees and 67% of those who have animals, consider the forest important for grazing.

Grazing without permit in the forest is illegal, but nevertheless many farmers in Nyakinyua do not have a license. As for charcoal, these results can give a trend but they probably undervalue the real situation because people might underestimate deliberately the number of animals grazing in the forest. However, even if in Nyakinyua farmers have fewer animals than in the two others villages, 95.8% of those who graze their animals in the forest depend on it (75% in Chepsir and 84.7% in Bonde).

In Chepsir animals graze mostly in the plantations of cypress near the village, in Bonde both in natural and plantation forest and in Nyakinyua only in natural forest. Goats are

theoretically not allowed to graze in the natural forest, but in practice this regulation is often not respected by farmers.

Table 7 sums up the results and shows the repartition of animals.

Table 7: Livestock keeping in the three villages and importance of the forest to graze

Village Nb interviews		Nyakinyua 100		Bonde 73		Chepsir 58	
% of farmers with livestock		70		89		78	
Average of animals of these farmers and coefficient of variation	Cattle	1.7	88.4%	7.5	144.0%	4.2	102.3%
	Goats	0.3	391.3%	1.5	584.7%	1.5	198.1%
	Sheep	2.5	91.8%	7.7	185.8%	2.1	154.3%
% of farmers with livestock who graze their animals in the forest		41		86		46	
% of animals of these farmers which graze in the forest		95.8		84.7		75.8	

4.3.5 Farming in the forest

Only Nyakinyua is concerned by illegal farming inside the public forest. Due to population growth and demographic shifts, the periphery of the adjacent forest is being encroached. Involved farmers clear the forest by cutting trees and sometimes using fire and then they plant crops such as potatoes, onions or cabbages. Generally, these farmers own less than 0.4 hectares of land, many of them own no land at all. The farming in the forest is done for subsistence or for commercial use. Apparently, the authorities are aware of these actions, but they do not hinder people to get access because some “*domestic arrangements*” between farmers and authorities exist.

Encroachment in Nyakinyua is high and active. Like charcoal burning and harvest of poles, it disturbs forest dynamic.

In the Nyayo Tea Zone of Chepsir, the “non resident shamba system” is practiced. “Shamba” means “field” in Kiswahili and under the “shamba system”, comparable to the “taungya system”, farmers are temporarily allotted government lands where young tree seedlings have been planted. While the trees are young, the farmers are allowed to plant food crops and to take at the same time care of the trees (Gathaara, 1999). Forest plantations can so be established by cheap or totally free labour and at the same time, employment among the rural population and national food production is increased (Gathaara, 1999). After three years of cultivation the trees start to shade the agricultural crops. The farmers then have to move out of the allocated plot. This system is highly approved by farmers and seems to work very well in this village.

4.3.6 Honey and bush meat

Honey is appreciated by the villagers for its nutrition and taste. It also constitutes for some farmers an additional income source. Even if honey collecting is theoretically sometimes prohibited in the natural forest, the villagers harvest it. The harvesting is reserved to men. In Nyakinyua 8% of the 100 interviewed households harvest honey. Of the three villages, the honey production of those who produce is the lowest with an average of 0.6kg a year. According to an aged farmer “before there was a lot of honey but now the production has decreased”. In Bonde, the number of producers is the highest with 48% of the 73 interviewed households. The average production of these farmers is around 1kg a year. In Chepsir, the households who produce honey produce the biggest quantity of the three villages. Out of the 59 interviewed households, 23% produce honey, with an average of 3.5kg a year. The domestic use of the producers is with around 0.5kg a year approximately, the same in the three villages. Consequently, in Chepsir around 3kg of the annual honey production is sold and represent an income source. The producers collect honey usually from natural hives in the forest, but they also use artificial ones occasionally. Often, fire is used to extract the honey from the natural hives.

Hunting is theoretically prohibited in the forest by the law but practised, exclusively by men. Only few people hunt in Nyakinyua. In Chepsir and Bonde however, it is a widespread activity. Bush meat can be accounted for both in economic and cultural terms. According to the people, the commercial use of the hunted species (mainly ungulates such as antelopes, gazelles, bush-bucks, and rarely buffalos) is not very high. Traditionally, Kalenjin are a forest tribe whereas Kikuyus are a tribe of farmers (*cf.* Appendix C). In addition to the economical value, harvesting of honey and hunting are also a cultural heritage. This observation might explain the higher level of these activities in Chepsir and Bonde, where a lot of Kalenjin live. In addition, the state of the forest influences the occurrence of wild animals. In a degraded forest like the one of Nyakinyua, wild animals are present in fewer numbers than in the two other forests. Consequently, hunting in Nyakinyua is more difficult; this fact might also explain the low level of hunting in this village.

4.3.7 Medicinal plants

Vegetal medicinal substances (roots, leaves, barks) from the forest are used for ailments illness and deficiencies. Their uses are a time-tested approach to care, cure and prevent which Western science (especially in the pharmaceutical field) has gradually come to recognise. Due to the high costs of imported pharmaceuticals (which are often sold under bad storage conditions or after dates for recommended use have expired), these plants are viable alternatives. However, the prescription of these plants requires the traditional knowledge on how to use them (Trefon, 1994).

Many plants are used in traditional medicine by the villagers. For instance *Olea europaea* (used mainly for malaria, fever, dental hygiene), *Prunus africana* (for chest pain, malaria, fever), *Warburgia ugandensis* and *Rhus* sp. (for chest problems, pneumonia), *Trema orientalis* (for coughs, sore throat, asthma, bronchitis, yellow fever, toothache, also vermifuge and anti-plasmodium), *Ficus thonningii* (for muscular disease), *Ekebergia capensis* (for herpes, malaria) and *Teclea nobilis* (malaria and fever) are the most known quoted species to this use. In the three villages medicinal herbs are used. In Bonde 71% of

the 73 interviewed households, in Chepsir 81% out of the 59 interviewed households and in Nyakinyua 16% out of the 100 interviewed households consumed medicinal plants. Because of the small amount which is harvested, this use does not represent a destructive and disturbing activity for the forest.

4.3.8 Water

In the three villages the daily water consumption of the people is mainly collected inside the forest. Some villagers also have a well on their land. In Chepsir, a pipe system has been put in place to bring water from the forest to the village.

4.3.9 Uses in small quantities

To build traditional houses some plants are used to establish the roof. Thatching grass is one of the products collected from the forest in small quantities. Records from forest offices indicate that the level of collection has gone down in recent years most probably due to substitution with other products such as corrugated iron sheets (Langat & al., 2006). This was confirmed by the farmers who substitute this traditional material by modern ones because of their durability and toughness. Fibres for ropes and other uses which need cordage are also a product from the forest.

Some eatable fruits such as passion fruits are consumed by villagers and sometimes sold on nearby markets. Some spicy herbs and mushrooms are also used for cooking. Highly seasonal, mushrooms are appreciated by villagers for their mineral and protein content, as well as for their taste. Mushrooms are not abundantly sold due to their short life span.

Finally, during the forest inventory in Nyakinyua, an area with some *Cannabis sativa* was found on an ancient charcoal burning spot. This plant is used to smoke and is considered as a drug. This use of the forest seems to be neither frequent nor to feed an important commercial market, but to be intended mainly for the local use.

4.3.10 A link between practices and perception

The perception of the forest and its degradation presented some differences between the three villages. Nyakinyua and Bonde, the two villages with a pronounced “economical” perception of the forest, are also the villages which use the forest mostly as an income source through charcoal burning and harvesting of poles. In addition, in these two villages, where the practices of illegal logging are common, problems of discontentment towards the forest management were reported (problems of corruption for example). The people of Chepsir Tea Zone, the most “ecological” of the three villages, do not practice these destructive activities. A link between these uses/practices and perceptions seems to appear.

4.4 Which actors for which uses and practices? Typology of the farmers and link with the forest uses and practices

Different uses and practices of the forest were characterised between the villages. However, in the three villages, different types of actors exist and can use the forest in

different ways. Farmers and households can be classified into different types according to their own eco-politico-sociological context. Four main types of farmers were identified.

4.4.1 Availability of the PCA and explicative variables

In order to characterize the different farm households, the data treatment of the PCA was oriented according to three themes: the farm land and the orientation of the production, the livestock, and the off-farm income. We call these variables the “intern factors of the household”, because they constitute the “nucleus” of the characteristics of a household.

Table 8 presents the different variables used for the three themes.

Table 8: Themes and variables studied in the PCA

Theme	Variable
Farm land and orientation of the production	Land size of farm
	Size of rented size
	Percentage of sold production (independent value)
Livestock	Number of cattle
	Number of sheep and goats
	Number of donkeys
Off-farm income	Number and type of casual labour
	Number and type of regular labour

For the reasons underlined above (*cf.* 4.3.2), the forest uses were not included into the PCA. Because of the illegal nature of some of the forest uses and practices, farmers could have voluntarily underestimated or even omitted information.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.68. Normally, a PCA is adequate for values superior to 0.5 (Appendix F). The PCA extracted three factors with eigenvalues of more than 1. These factors explained 62.5% of the total variance. Figure 14 and Figure 15 respectively show the projection of the three PCA components on the 1-2 and 1-3 factorial plane.

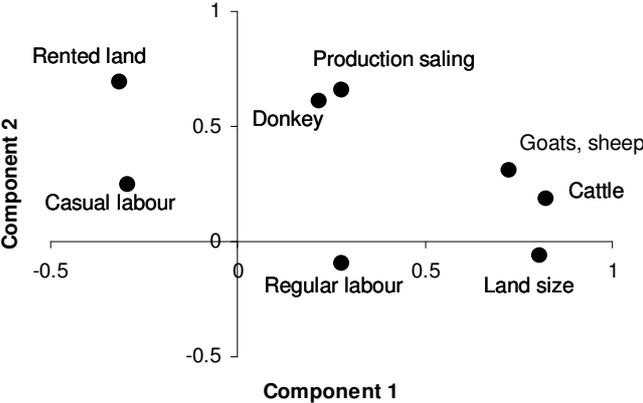


Figure 14: Graphical representation of the variables in the factorial plane 1-2 of the ACP

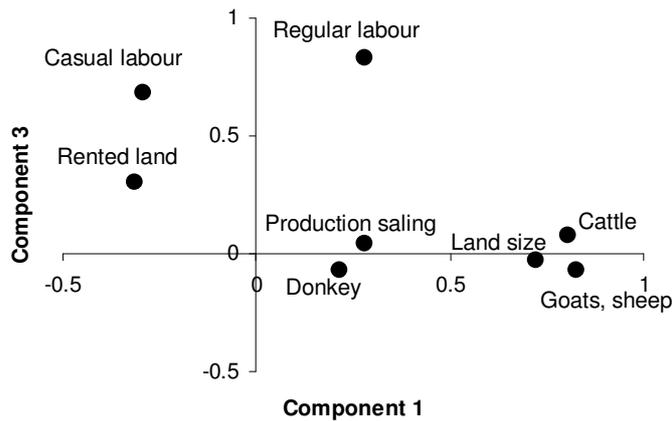


Figure 15: Graphical representation of the variables in the factorial plane 1-3 of the ACP

The first axe of the ACP is represented in the factorial plane 1-2 (Figure 14 and 15). It explains 29.5% of the total variance. This component is characterised by the variables “land size of farm”, “number of cattle” and “number of sheep and goats”. It corresponds to the basic resources of the household.

The second axe explains 19.9% of the total variance (Figure 15). It is mainly compiled by “size of rented land”, “percentage of sold production” and “number of donkeys”. This axe was interpreted as the effort of economical valorisation of the familial work force.

Finally, the third axe explains 13.1% of the total variance (Figure 15). This axe is characterized by “importance of regular labour” and “importance of casual labour”. It determinates the off-farm income of a household.

The overall of the interviewed farmers (232 households) are represented according to the three axes previously defined (Figure 16). K-means clustering based on these results permitted to obtain groups. Classifications between three to seven groups were carried out. We retained four classes because the most relevant and balanced results were obtained with this number of groups.

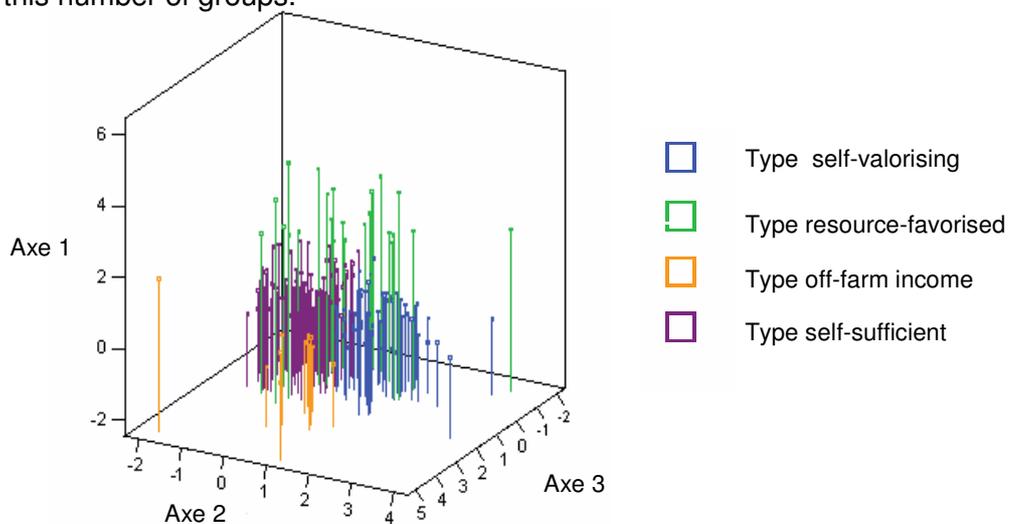


Figure 16: Graphical representation of the PCA

Table 9 indicates the average value of each variable of each type. These results are discussed in 4.4.2.

Table 9: Mean values of the variables for each type

Type	Farm land size (ha)	Sold Production (%)	Rented land size (ha)	Production of Charcoal (kg)	Commercialised charcoal (Kg)	Regular labour	Casual labour	Number in HH	Number of children	Cattle	Goats	Sheep	Donkeys
1	0,5	55	0,6	59,0	44,7	0,3	2,3	6,4	3,1	2,0	0,3	2,5	1,0
2	0,8	22	0,1	19,1	10,5	1,2	1,5	5,9	3,5	1,5	0,2	1,1	0,2
3	0,9	45	0,6	42,9	15,1	9,1	5,9	8,8	4,0	1,8	0,3	2,4	1,2
4	4,8	51	0,3	19,2	8,3	2,2	1,2	7,3	4,7	11,4	3,3	10,8	1,1

4.4.2 Description of the four types of farmers

4.4.2.1 Type *self-valorising* (1)

The type *self-valorising* combines households of farmers who own an average surface of 0.5ha. They often have a small herd of cattle and sheep which rarely exceeds 10 animals. Often, the production of maize and potatoes (principal staple foods) on their own field is not sufficient for their subsistence needs.

The work force of the households of this category comes mainly from the family itself. As incomes are generally insufficient for the livelihood needs of the household, the strategy chosen by farmers of this type is to valorise economically the work force of the family by renting additional land. On these rented lands, food crops for commercialization or cash crops such as pyrethrum (*Chrysanthemum pyrethrum*) are often produced. On average, the surface of rented land is 0.6ha and 55% of the agricultural production is commercialized.

The farmers of this type also sell their work force as casual workers. In 86% of the households of type *self-valorising*, at least one member carries out casual work on a weekly basis and in 70% of the households, at least two members carry out casual work. The households whose members carry out a regular work are with 12% of the cases the exception in type *self-valorising*.

As the profits from the rented land are low and the sale of work force is not always possible, the families of this type are forced to constantly seek other income sources.

4.4.2.2 Type *self-sufficient* (2)

Households of this type are characterized by a very small effort to valorise economically the work force of family members. The average land size of type *self-sufficient* is 0.8ha and thus higher than that of type *self-valorising*. The agricultural production is mostly meant for subsistence farming and seems to meet the needs of the household. On average, only 22% of the agricultural production is sold.

Like the households of type *self-valorising*, those of type *self-sufficient* often have a small herd which rarely exceeds 10 animals.

Only few people of the households of this category carry out a casual work. This is due to the self-sufficiency in basic stable foods and to the small employment market in the area. Members of the families of type *self-sufficient* have more often regular work than those of type *self-valorising* (on average 3 times more often). However, regular work remains rare in this type (71% of the households do not have any family member who carries out a regular economic activity).

4.4.2.3 Type *off-farm income* (3)

The households of type *off-farm income* form a minority in our study. They are characterized by an importance of regular and casual work carried out by the family members. At least one member of these households carries out a regular work and at least three members carry out casual work.

The average land size is with 0.9ha bigger than those of type *self-valorising* and *self-sufficient*. The herd of this type is normally smaller than 10 animals.

In addition to their own land, the families of type *off-farm income* rent 0.6ha on average. They sell 45% their agricultural production. This type, which includes only eleven families, does not encounter any problems in achieving the first objective of self-sufficiency. It is thus characterized by a second objective, which is profit making (accumulation of incomes).

4.4.2.4 Type *resource-favorised* (4)

The households of the type *resource-favorised* have an average land size of 4.8ha. These farmers often use paid labour force. Their production of maize normally meets the needs of the household. Few households of this type rent land and if they do, the surface is usually small.

Many households of this type have a herd of cattle, sheep or goats which can count 100 heads and more. These animals are either taken care of by paid workers or by the members of the family itself. The surplus of production (especially potato and maize) is sold on the markets. An average 51% of the agricultural production of this type is sold. The work force of the families of this type is less used than that of the other three types. This observation can be associated with the fact that type *resource-favorised* has the means of supporting the school fees for their children. Hence, the children are often sent to school and work rarely in the fields.

4.4.3 Distribution of the types by villages

The repartition of the different types of households by village is presented in the Figure 17.

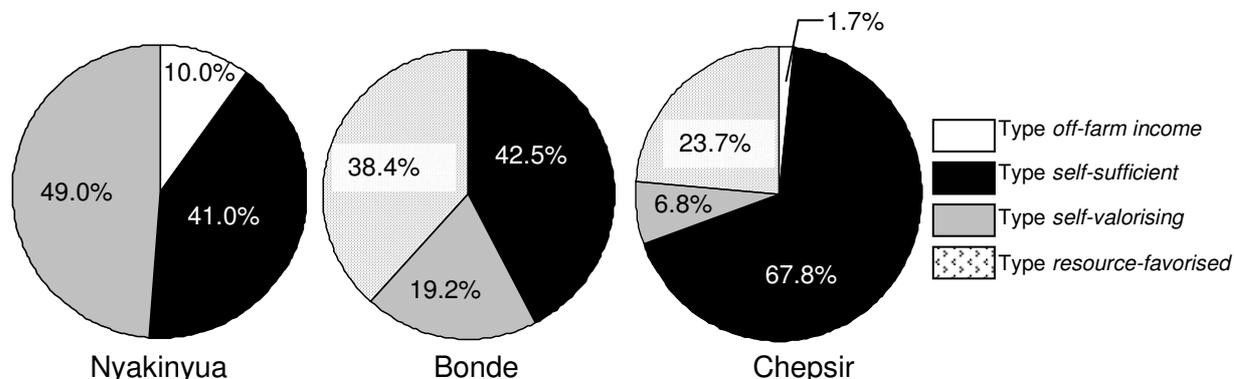


Figure 17: Distribution of each type by village

Type *self-sufficient* is composed of 48.3% of the interviewed families and it is the most predominant type in the three villages. Respectively 41.0%, 42.5% and 67.8% of the households of Nyakinyua, Bonde and Chepsir form this type.

Type *self-valorising* represents 28.9% of the interviewed households. It is dominant in Nyakinyua, where 49.0% of the 100 interviewed households belong to this type. In Bonde and Chepsir, respectively 19.2% and 6.8% of the households are part of this type.

Type *resource-favorised* represents 18.1% of the overall of households. In Bonde, 38.4% of the 73 interviewed households and in Chepsir 23.7% of the 59 interviewed households belong to this type. Not one of the interviewed households of Nyakinyua belong to this type.

Only 4.7% of the 232 interviewed farmers belong to the type *off-farm income*. In Nyakinyua, 10.0% of the interviewed households belong to this type and in Chepsir 1.7%. This type is absent in Bonde.

4.4.4 Link with the forest use

No strong links or relations are apparent between the types and the collection of firewood. It seems that this use of the forest is common to all the types and that most of the households depend directly on the forest as an energy source. Project KIFCON has suggested that 100% of the farmers living adjacent to the Mau Forest use it as a source of firewood (KIFCON, 1993).

Charcoal making has been identified as the main destructive use (Langat & al., 2006). In order to establish a potential link between the typology and the illegal forest uses, an indicative factor was created. This factor permits to determine who is implicated in illegal trade of charcoal (production or transport) (Table 10). As mentioned above (*cf.* 4.3.2 or 4.4.1) some persons probably voluntarily omitted their charcoal production. However, the implication in the transport of charcoal seemed to be easier to admit.

Factor Illegal Use of the Forest (FIUF) = Charcoal production (bag/week) + Transport of illegal forest products (number of persons/week)

Table 10: Value of the Illegal Use of the Forest Factor (FIUF) by villages and by types

FIUF Mean	Type self-valorising	Type self-sufficient	Type off-farm income	Type resource-favorised	Total
Nyakinyua	1,9	0,7	0,9	0	1,3
Bonde	1,2	0,6	0	0,39	0,6
Chepsir	0	0	0	0	0
Total	1,6	0,4	0,8	0,3	/

The households of type *self-valorising*, which have only small land sizes, are those which are the most involved in the charcoal trade. On the contrary, type *resource-favorised*, with the biggest land sizes, is only slightly implicated in these processes. Although type *off-farm income* has regular and casual labour and an average land size which is bigger than that of type *self-sufficient*, this type is twice as much engaged in the charcoal trade than the type *self-sufficient*.

As the table shows, no household produces or transports charcoal in Chepsir, independent of the type. On the other hand, all the three types which can be found in Nyakinyua are involved in the charcoal trade. This demonstrates the prevailing role of this village in this activity. Bonde has an intermediate row in this classification. Consequently, other ‘exterior’ socio-eco-political factors might explain the difference between the villages in terms of forest use.

4.4.5 Influence of extern factors to explain differences?

Four types of households were determined in the study villages according to their “intern factor”. This typology provides classifications that guide investigating and theorizing and might be useful to elaborate different strategies for the forest restoration. Depending on their categories, each type of farms has a unique choice of production and economic activities, and subsequently of management options. The environment in which they function is, to a large extent, similar. In this way, differences in terms of forest uses and practices were identified between the “very poor” and the “richer” farmers. However, inside the different types, some differences in terms of forest uses and practices appeared according to the village: Chepsir, without illegal use, Nyakinyua and Bonde with illegal use. Therefore, some other extern factors are responsible for this difference.

It is time to put in relation the perception of the villagers with these observations. The interviews conducted in Bonde and Nyakinyua revealed that corruption inside the institutions which govern the forest is widespread. This problem was already reported from other Kenyan forests (Okowa-Bennun & Mwangi, 1996). The foresters told us that the funds were too few to assure a good management and control of the forest in the areas where no forest guards live. A **group dynamic phenomena**⁴ and different levels of moral acceptance among the villagers might also constitute a factor in favour of these illegal forest practices.

Finally, it might also be possible that with their more “economical” and “productive” perception, the relations towards the forest were different among the villagers of Bonde and Nyakinyua on the one hand and Chepsir on the other hand.

As it is shown, the context in its global nature, with intern and extern factors, allows better understanding of the interactions between the population and the resource. Decision-making of the farmers, taking in consideration all these factors, will permit to understand more deeply these narrow interactions (*cf.* tome 2 of this study by Kübler (2007)).

4.5 State of the forests: Inventories result

The coefficient of variation of the basal area, which was calculated after the pre-inventories, informs about the theoretical number of sampling points required to obtain a maximal error of 20% for a confidence level of 95% (Table 11).

Table 11: Number of plots in the inventories, theoretical and practical

Village	Coefficient of Variation (CV) (%)	Theoretical number of plots	Number of plots in inventories
Nyakinyua	78.8	60	60
Bonde	86.0	71	72
Chepsir Tea zone	60.0	35	53

Consequently, we carried out 60 sampling points in Nyakinyua, 72 in Bonde and 53 in Chepsir Tea Zone. In Nyakinyua, we used N = 4 and in Bonde and Chepsir N = 6.

4.5.1 Nyakinyua and its threatened adjacent forest

The forest adjacent to Nyakinyua corresponds to a montane forest (altitude about 2700m). It is characterised by an irregular stand of *Juniperus procera*, the East African cedar. The diameters of these cedars are variable, but trees of more than 1.30m of diameter can still be found in few numbers. For the slow growing *J. procera* this indicates that some trees are at least 100 years old (KFS Forester, personal communication). *J. procera*, with a relative density of 31.5%, is the most frequent remaining species. The floristic composition associated with *J. procera* is composed of *Cussonia holstii*, *Cassipourea malosana* and *Ficus thonningii*, with a relative density superior to 10%. Species with a relative density between 1% and 10% are *Allophylus rubifolius*, *Podocarpus* sp., *Olea capensis*, *Dombeya torrida*, *Teclea nobilis*, *Pavetta gardeniifolia*, *Acacia* sp., *Olea europaea*, *Dispyros abyssinica*, *Polyscias* sp. and *Euclea divinorum*.

The forest was divided in 2 strata (Figure 25). Stratum 1 is adjacent to the village and has a vegetation cover inferior to 10%. The mean vegetation cover of the canopy of this stratum 1 is only 5.2% (+/- 2.3). According to the forest definition of the FAO 2001 (see 2.2), this area bigger than 0.5 ha, can be considered as deforested (Figure 18).



Figure 18: View on the adjacent forest of Nyakinyua

Stratum 2 might not be considered as deforested, but with a mean vegetation cover of the canopy of 18.5% (+/- 4.8) this area is seriously degraded. The state of the forest near Nyakinyua is alarming. In some parts, the gazetted forest looks more like grazing land than forest.

The area has been overexploited by the communities and parts of it are now used for grazing (mean grass cover of the soil in stratum 1: 33.8% (+/- 18.7)). Other parts of stratum1 are characterized by a very dense cover of shrubby vegetation (64.4% (+/- 14.4)). These parts are neither used for grazing nor for tree planting. In the degraded area (stratum 2) the tree density is 81.4 trees per ha (+/- 31.7). Inside this stratum the density can vary between 8.0 and 265.3 trees per ha. The basal area of this area is 6.71m²/ha (+/- 1.6). These values are very low and confirm the alarming situation.

The woody stand of the degraded area (stratum 2) is composed by 62% of trees with a diameter between 10 and 30cm (corresponding to 50.6 trees per ha). The class of large trees superior to 50cm of diameter represents 14% of the total individuals of Nyakinyua (corresponding to 11.5 trees per ha). The structure of the stand is shown in the figure 19.

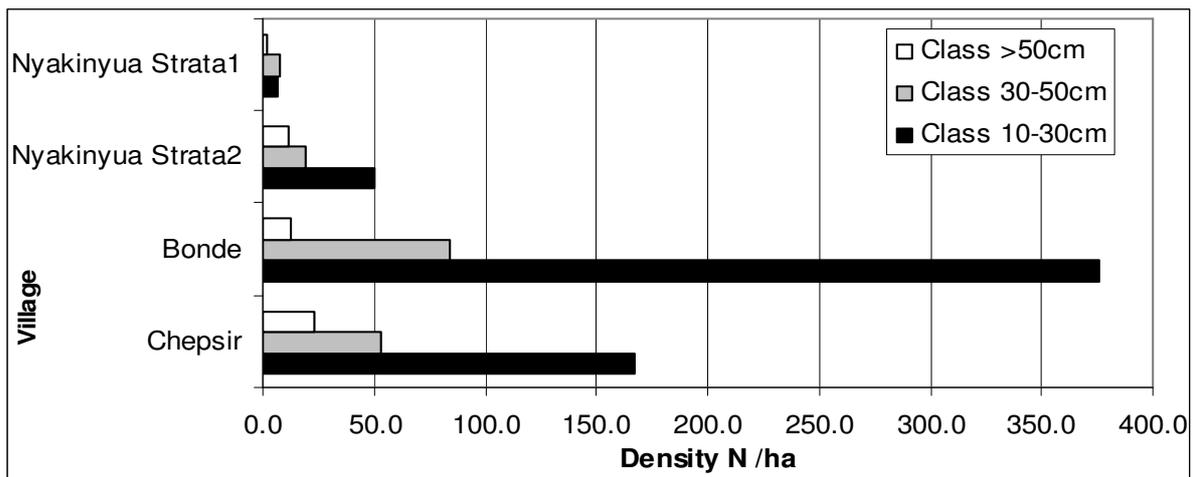


Figure 19: Distribution of the diameter classes in the adjacent forests of the three villages

The calculation of the relative density in the sampling area shows the distribution of the diameter classes of the main species (Figure 20). The class of large trees is mainly represented by *J. procera*. This species, together with *Cussonia holstii*, constitutes also an

important species in the class of small trees. *Ficus thonningii* is the second species present in the class of large trees.

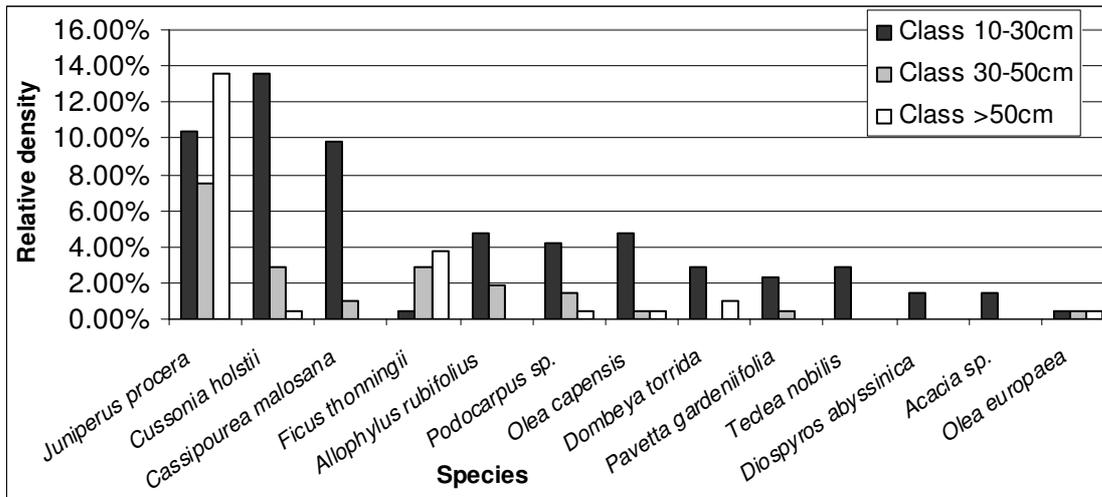


Figure 20: Relative density of the main species, Nyakinyua

In the forest adjacent to Nyakinyua, the regeneration is extremely low. Many seedlings are eaten or destroyed by domestic animals such as cattle, donkeys, sheep and goats. In addition, some seedlings are harvested by farmers. Thus, less than 2 seedlings per m² were found in the degraded part of the forest (stratum 2).

The dynamic of the degradation is continuing and the pressure on the forest is very high due to an extensive use by the local community. The future of this forest is deeply compromised. The stock of mature trees has been strongly decreased and the regeneration is almost inexistent. Maps of the inventoried forests sum-up the results (Figure 25).

4.5.2 Bonde and its generous forest

Like in Nyakinyua, the forest in Bonde corresponds to a montane forest (about 2700m of altitude). Two vegetation types are identified: bamboo formations (*Arundinaria alpina*) and a formation of *Podocarpus* sp. mixed with irregular stands of *J. procera*. A transition area of *Podocarpus* sp. and *J. procera* stands mixed with bamboos can also be found.

The formation of bamboos is located on the western part of the inventoried forest. The Bamboo cover is very dense and reaches a height of 15 to 20m. In the forest of *Podocarpus* sp. mixed with *J. procera*, cedars of more than 1.5m of diameter are still present. More very large trees with a diameter bigger than 1m can be found in Bonde than in Nyakinyua. The floristic composition associated with this type of vegetation is composed mainly of *Podocarpus* sp., *Olea capensis*, *Teclea nobilis* and *Olea europaea* (relative density superior to 10%). Species with a relative density between 1.5% and 10% are *Prunus africana*, *Croton macrostachyus*, *Dombeya torrida*, *J. procera*, *Ficus thonningii*, *Bersama abyssinica*, *Polyscias* sp., *Cussonia holstii*, *Pavetta gardeniifolia*, *Rhus natalensis* and *Diospyros abyssinica*. The diversity of trees appeared to be bigger than in Nyakinyua (Figure 21).



Figure 21: Relative density of the main species, Bonde

The mean tree density in this forest is 472.3 trees per ha (+/- 96.1). The woody stand is composed mainly by trees of a diameter between 10 and 30cm (79.6% of the individuals of Bonde, corresponding to 375.9 trees per ha). The class of large trees represents 2.6% of the totality of individuals (corresponding to 12.4 trees per ha) (Figure 19).

Results based on the relative density show that *J. procera*, *Ficus thonningii*, *Polyscias* sp. and *Dombeya torrida* are the most important species in the class of large trees. The distribution of the diameter class of the main species is presented in figure 22.

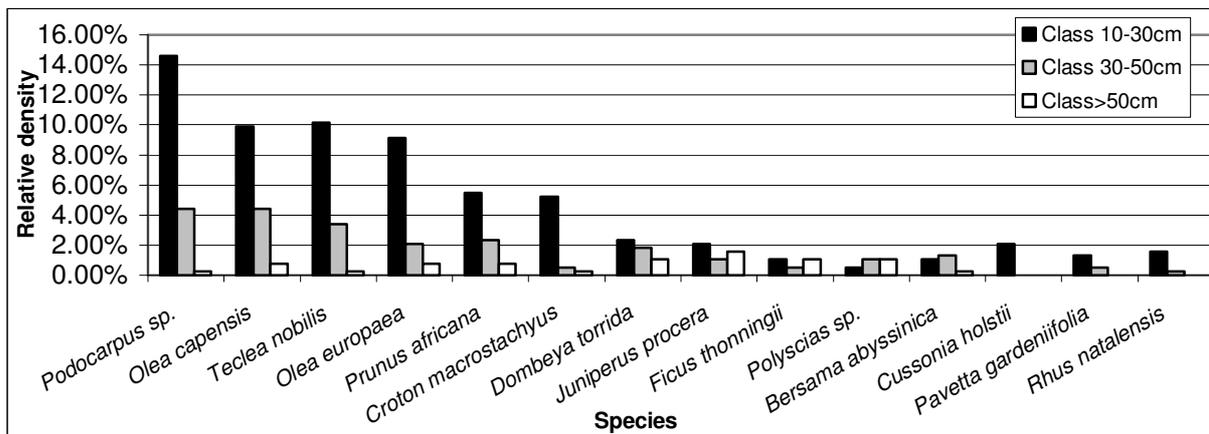


Figure 22: Relative density of the main species, Bonde

The mean basal area of the area is 18.55m²/ha (+/- 2.0). These results indicate that the basal area of this forest is rather high compared to Nyakinyua. However, 67% of the 73 interviewed villagers arrived in this village around 1998 or later. Consequently, destructive activities, such as burning charcoal or harvesting of poles, have been going on for only 10 years or less on a relatively large scale. Observations made during the fieldwork hint that the dynamic of the degradation and the pressure on the forest is very high. During the inventory, many charcoal burners and earth kilns were encountered in the forest. The illegal activities occur in patches. Thus, degraded and destroyed areas are scattered in a mosaic pattern over the inventoried zone. Consequently, impacts of intensive uses of the forest are not yet clearly visible *via* the inventories. Finally, even if tracks showed the presence of domestic animals in the forest, the forest regeneration appears abundant and many seedlings can still be found (around 6,6 seedlings/m² (+/- 1.0)).

The forest of Bonde does not seem to be much degraded. Nevertheless, the resource is not limitless and if the uses continue the same way as today, it is possible that in 10 or 15 years the state of the forest will be like the one of Nyakinyua. Maps of the inventoried zones sum-up the results (Figure 25).

4.5.3 Chepsir Tea Zone and its well-conserved adjacent forest

In Chepsir Tea Zone the forest corresponds to a montane forest (about 2400m of altitude) of *Podocarpus* sp. mixed with *Prunus africana*. *P. africana* is characteristic of the afro-montane ombrophyl forest (White, 1983). This species is dominant with a relative density of 35.2%. During the seventies (1972 and 1975) the forest was exploited by a timber company called Raiply and *P. africana* was the most harvested species. This species was traded on the international market for the manufacture of products used in medicine (WWF, 2006). The forest of Chepsir Tea Zone has been surrounded by the Nyayo Tea Zones and plantations of the government since 1986 (Figure 23).



Figure 23: View on the tea zone and adjacent forest of Chepsir Tea zone

In this forest, the floristic composition associated with *Podocarpus* sp. is mainly represented by *Cassipourea malosana*, *Syzygium cordatum*, *Croton macrostachyus* (relative density superior to 10%). Species with a relative density between 1.5% and 10% are *Prunus africana*, *Olea europaea*, *Dombeya torrida*, *Diospyros abyssinica*, *Teclea nobilis*, *Polyscias* sp., *Cussonia holstii* and *Ficus thonningii*. *Juniperus procera* is absent in this forest.

The mean tree density is 243.9 trees per ha (+/- 43.1). This value is inferior to the stand of Bonde. The mean basal area for this area is 18.67m²/ha (+/- 1.69), which is slightly superior to the one of Bonde. It is the highest one of the tree villages.

The woody stand is composed mainly of trees with a diameter between 10cm and 30cm (68.5% of the individuals of Chepsir, corresponding to 167 trees per ha). The distribution of large trees is the most important in this forest compared to the forests adjacent to the other two villages. The class of large trees represents 9.6% of the totality of individuals (corresponding to 23.4 trees per ha). This explains why the basal area in Bonde and Chepsir is quite similar but the density is superior in Bonde. The structure of the stand is presented in figure 19.

Results based on the relative density show that *Prunus africana*, *Polyscias* sp. and *Dombeya torrida* are the most important species in the class of large trees. *Podocarpus* sp. is mainly present in the small diameter class between 10cm and 30cm. The distribution of the diameter class of the main species is presented in Figure 24.

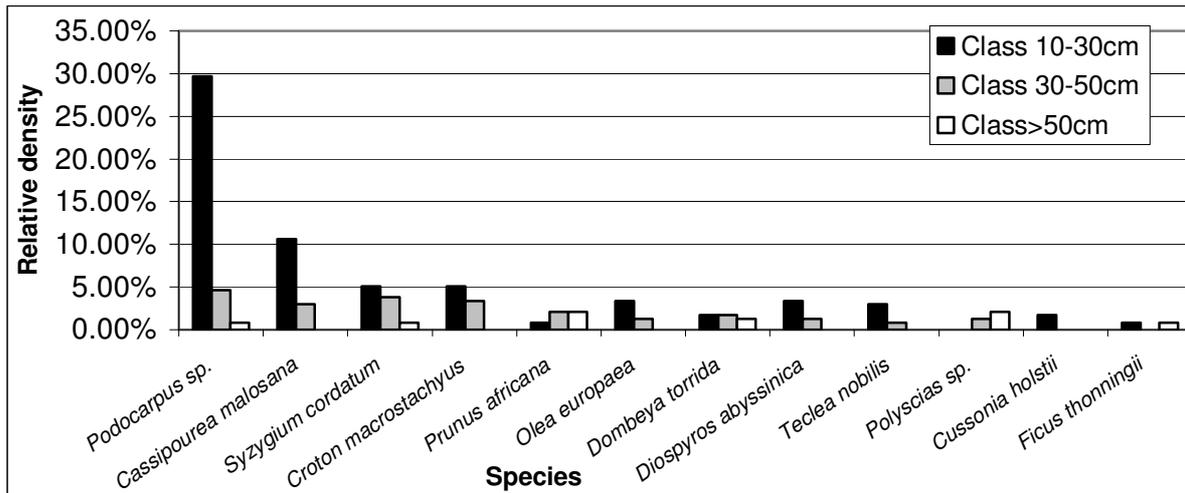


Figure 24: Relative density of the main species, Chepsir Tea Zone

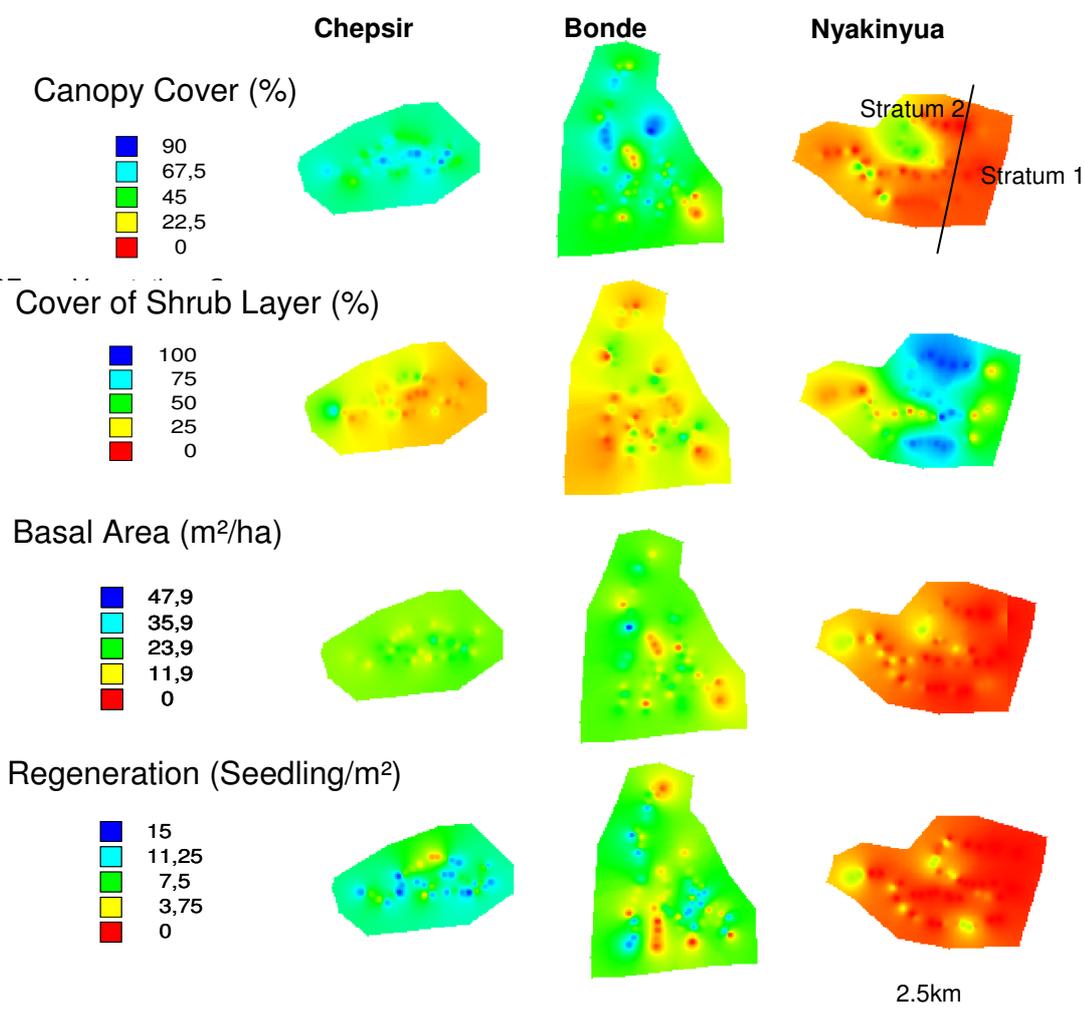
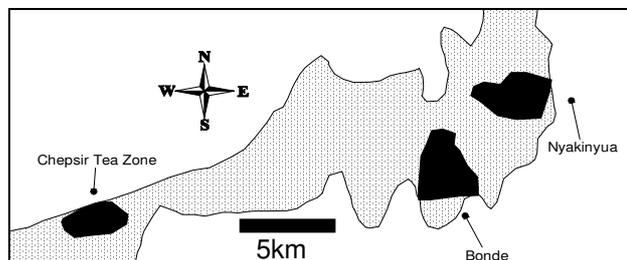
Because of wood exploitations between 1972 and 1975, most of the large trees have been harvested. Consequently, the quantity of trees with a large diameter like the basal area is not very high. The regeneration is relatively abundant (around 9.3 seedlings/m² (+/-1.23)) and there are very few traces of grazing in this natural forest. The pressure exerted by the community is almost insignificant and the sustainability of the resource is not threatened by the villagers. The inventory reveals a well conserved forest. Maps of the inventoried forests sum-up these results (Figure 25).

4.5.4 Environment, practices and perceptions: the link

The human impact on the forest varies in the 3 villages. In Chepsir, the state of the forest appears to be very well conserved with abundant regeneration, an important canopy cover and the highest basal area of the three villages. This is related to the absence of destructive practices in this forest. Moreover, this “healthy” environment and the sustainable forest use reflect the “ecological” forest perception of the villagers in Chepsir.

In Bonde, the forest does not seem to be much degraded. However, the repartition in a mosaic of degraded areas indicates that some places are affected by the destroying activities. Sometimes people seemed to consider that the resource will always be there, even with intensive and destructive practices. The resource is not limitless and if the uses continue in the same way as today, it is possible that in 10 or 15 years the state of the forest will be like the one of Nyakinyua.

In Nyakinyua, with a low basal area, regeneration and canopy cover, the state of the forest is alarming and its future is very threatened. The high extraction of product exceeds the thresholds of sustainable utilization. The heavy dependence of forest resources for livelihoods and the “critical” state of the forest can be linked. Participatory mapping realised with villagers of Nyakinyua (Kübler, 2007) and their forest state perceptions (cf. 4.2.2.2) confirmed that they are aware of the very degraded state of the forest.



Kübler and Oddi, 2007

Figure 25: Maps of the inventory zones with the main characteristics of the forests

5 Strategies for the rehabilitation of Mau Forest

In this part, the expressions rehabilitation, redevelopment and restoration are in reference with the previous definitions (cf. 2.3). To determine the strategies which could be adopted for the rehabilitation of Mau Forest, the factors of degradation are identified. Two main strategies are proposed: the non residential cultivation and on-farm forestry. Propositions for the rehabilitation and an “objectives-tree” finalise these results.

5.1 Degradation factors

The degradation factors are defined according to Lanly (2003) (cf. 2.3). The principal direct factors of the degradation of Mau Forest are the activities exerted by the local communities. Illegal cutting of trees, grazing in the natural forest and encroachment by farming are the main disturbances. Because of the lack of mature trees and regeneration in some parts, for example in Nyakinyua, the future of the forest is extremely threatened.

However, some indirect factors such as the poverty level, population density and governmental management failures influence the state of the forest, too. An overall of political, social and economical interactions influence how the villagers manage and use their forest (Figure 26). The resource availability can also have an impact on the local practices.

In Chepsir, the revenues per household often exceed those in Nyakinyua and Bonde. Some people work in the tea company and others own relatively big lands (average of 2.8 ha). In addition, the tea zone constitutes a physical barrier against illegal extraction of wood. Furthermore, the Kenya Forest Service is present in this village, applies its authority and informs people about the management of the forest (Forest Act 2005). Finally, the population density is the lowest of the three villages. As a result, people do not use the forest as intensively as in the two others villages and are conscious about the importance of its ecological services (for instance availability of drinking water). They have formed a Community Forest Association (CFA) and have created tree nurseries. In Chepsir, 75% out the 53 interviewees are aware about the existence of CFAs. They are ready to be involved in the forest management.

In Nyakinyua and Bonde, the population density is higher than in Chepsir. Most of the villagers make their living only with farming and few of them have regular jobs. The average land size per household is around 0.4ha in Nyakinyua and 1.6ha in Bonde and some people own no land at all. Moreover, apparently corruption is a widespread phenomenon in these forests, which is aggravated by the lack of forest guards. As a result, the perceptions and uses of the forest differ from those in Chepsir. Thus, for some people of Nyakinyua “*this forest has no future*”, for others in Bonde “*this forest is big, when the nearest forest will be harvested, we [the villagers] will go farther*”. The history of the region and of the villages also explains parts of the forest degradation. In Nyakinyua the villagers have constantly arrived since 1963, whereas in Bonde most of the farmers came in the end of the nineties. Consequently, in Nyakinyua the forest is intensively exploited, highly degraded and deforested in some parts. With the help of the farmers we tried to evaluate the dynamic of

the degradation. In Nyakyniua, the villagers estimated that they have advanced 1400m in the forest since 2000.

In Bonde, the forest is intensively used, but because of the recent arrival of most of the households and the lower population density, the consequences on the forest are not yet clearly visible. Finally, only 22% out of the 100 interviewees in Nyakinyua and 1% out of the 73 interviewees in Bonde were aware about the new forest policy and the community involvement in the forest management. No Community Forest Association (CFA) has been formed so far. The villagers have to be informed before they can be involved.

In the two villages, where the forest degradation is very high, people are not informed about the community involvement which is foreseen in the Forest Act 2005. There is clearly a lack of environmental awareness among the farmers in these two villages. Moreover, people seem to mistrust the governmental institution which manages the forest, the Kenya Forest Service.

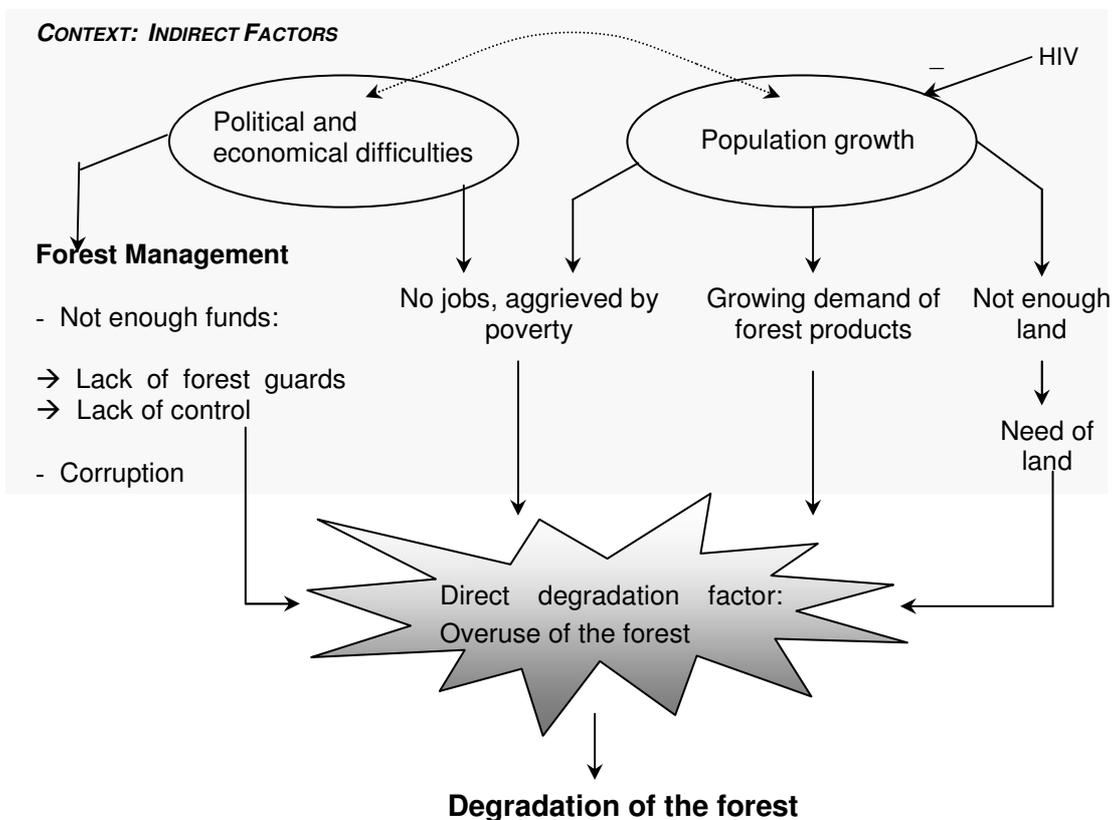


Figure 26: Model of interactions between the factors of degradation

5.2 Propositions to rehabilitate the forest

The way to rehabilitate Mau Forest will be envisaged through community involvement in the management of the forest as it is foreseen in the Forest Act 2005. Empowering communities to manage and regulate the use of a resource is an interesting way to reduce the environmental pressure. The resource is under the responsibility of a certain community and consequently, it will not be an open access-resource. A community which depends on a resource for their livelihood and which knows that it will have the right to use this resource for a long time is more likely to refrain from misusing it.

Two main strategies have been proposed by the farmers of the three study villages: the non-residential cultivation (also called NRC or the non-resident shamba system) and on-farm forestry.

5.2.1 Non-residential cultivation

In Nyakinyua, the forest is the most degraded of the three villages. Farmers are conscious of the critical state of “their” forest and have very often proposed one solution to rehabilitate it: the non-residential cultivation. They showed a big motivation and will of involvement to rehabilitate the forest using this strategy. With this approach, farmers who live nearby the forest are allowed to cultivate annual crops around planted tree seedlings. Digging the soil helps to mix forest topsoil and subsoil (Ng’weno, 2004). The farmers care both for the young trees and for their crops. After around three years, the young trees are strong enough to grow without care and the farmers leave this field. Rules and agreements have to be clearly established by the authorities and the farmers. Farmers sign an agreement and stick to certain terms and conditions. If farmers follow the rules, everyone benefits. The farmers raise crops for a few years, and later trees are harvested from the plantation. Finally, when a plantation of mature trees is harvested, tree seedlings have to be planted to replace it. The advantages of this method are shown in table 12.

Table 12: Advantages of the non resident shamba-system

Advantages of the non resident shamba-system	
Kenya Forest Service	Farmers
Low costs in plantation establishment	Food for the use of the household
High growth of tree seedlings	Financial return from crop growing
Protection of trees from animal damage	Contribute to household food security
Farmers assist in raising seedlings	Use of wood residuals when plantations are harvested
Farmers assist in fighting fires	

However, attention has to be paid with this method. Non-residential cultivation is an efficient method, but only if it is well managed. An important control and supervision from the authorities and/or NGOs have to accompany the farmers and is necessary for success. In addition, farmers could assist the government to establish forest plantations if they are organized under a Community Forest Association (CFA). These self-regulating associations could take action against those who eventually abuse the system.

The system was abused in many areas where it was used (Ng’weno, 2004) and thus stopped. Many problems caused by the shamba-system have been analysed in the past and are now known (Ng’weno, 2004):

- Inadequate involvement of farmers in plot allocation leading to corruption in allocation methods;
- Inadequate supervision (both at ground level and nationally), leading to farmers who did not plant tree seedlings or did not care for them and animals grazing in the new plantation and destroying the seedlings;
- Farmer continued to use a field in the forest to grow crops and became “squatters”;
- Opening of larger areas than those planned by the annual planting program leading to an extension of the field deeper and deeper into the forest;

- Use of equipments that was not compatible with tree establishment;
- Exclusively fast growing species such as Cypress, Pines and Eucalyptus were planted in the deforested area or very degraded forest. In the degraded zones near the forest, mixed systems with indigenous trees (such as *Juniperus procera*, *Prunus africana*) and exotic ones could instead be put in place.

This strategy was mainly proposed in Nyakinyua by the farmers of the type self-valorising with small land sizes and few income sources.

5.2.2 On-farm forestry or trees on farm

On-farm forestry or trees on farm refer to all land-use systems and practices in which woody perennials are deliberately left or grown on land also used for crops and pasture. Farmers can use farm forestry practices such as homestead tree planting, field tree planting and farm boundary planting (Teketay & Eshete, 2005). Farmers plant trees in pursuit of their livelihood goals of income generation, risk management, household food security and optimum use of available land, labour and capital. Many products, services and roles needed by people can be fulfilled by trees.

In Mau Forest, some people have trees on their farms. However, very few of them practice arboriculture. For instance, only 12 farmers out of 232 possess fruit trees. Most of the interviewees do not have more than twenty trees on their farms. The species which can be found are *Cupressus lusitanica*, *Pinus patula*, *Eucalyptus* sp., *Grevillea robusta*, but also indigenous species such as *Dombeya burgessiae*, *Acacia* sp., *Croton macrostachys* and in few quantities *Juniperus procera* and *Prunus africana*. These trees are mainly used for construction, timber, firewood and as a boundary marker.

In the three villages many farmers showed themselves motivated to plant trees on their farms. They expressed a great interest to plant exotic trees (cypress above all, then “blue gum” corresponding to *Eucalyptus* sp.). They explained that if they could plant trees, they would plant exotic species. Even if they prefer generally indigenous trees (for construction, charcoal burning or cultural values), the exotic ones grow much faster and “*the indigenous trees grow very slowly*”. Moreover, farmers underlined that they only have a limited choice of available species. Nevertheless, among the indigenous trees, they proposed *Olea europaea*, *Olea capensis*, *Vepris nobilis* and *Prunus africana*.

Preferences for tree species are largely determined by knowledge and speed of growth, this may lead to a bias for indigenous species. Therefore, species preference lists must be interpreted with great caution. These factors can cause short-term productivity and long-term stability losses in the diversity of ecosystems and hamper farmers from making decisions to optimise their livelihood goals. Farmers, extension workers and scientists active in tree domestication could focus on improving access to seedlings of a wider range of species. Research on this domain is actually done by the Foreaim project and Kefri and could improve the establishment of on-farm forestry. Addressing access to seedlings and knowledge simultaneously will allow farmers to diversify their plantation.

However some factors like the lack of land to plant trees present a limit on on-farm forestry. Indeed, most of the farmers have small land sizes and consequently the loss of available land for annual crops were often quoted to explain the reasons why they did not plant trees. The availability of money to buy seedlings was also a problem.

As underlined by Shrestha (2003) trees on farm present positive factors like the reduction in temperature of air and soil, efficient utilization of solar radiation, suppression of weed growth, conservation of moisture, maintenance or increase of organic matter, protection of soil from erosion, nitrogen fixation, and reduction in wind speed to the crop. But as told by farmers, there are some negative effects: the competition for light, moisture and nutrients between tree and agriculture crops may be considered negative factors (Basavaraju & Gururaja Rao, 2000).

Consequently, this strategy to improve the stock of wood is mainly available for the farmers who possess enough land to plant trees on their farm or for farmers with small land but with others income sources. It is extremely dependant on farmer's decision-making (see Kübler 2007).

5.3 Propositions for the Mau Forest rehabilitation

According to the local context, the observations made during the field work, the results of the inventories and interviews and what people suggested, first propositions for the management of Mau Forest can be established. This guideline is divided in three parts and based on a work of the World Bank (World Bank, 1996):

I. Creation of CFAs in the communities

- Information, education and communication about the forest and the Forest Act 2005 (by the Kenya Forest Service, NGOs...);
- Organisation of the forest communities in CFAs.

II. Interface between Kenya Forest Service and CFAs

- Demonstration of the capacity of communities in forest protection and management;
- Communities gain further managerial and technical forestry skills aiming at self-management.
- Creation of **forest management plans**:

Objectives:

- Consideration of local needs: mainly fuelwood, grazing, farming;
- Zonation and mapping of the forest (degraded and conserved area) (to avoid additional opening-up of sensitive forest areas);
- Raising fodder plots in the forest adjacent to the villages;
- In the deforested and highly degraded areas: tree plantations with rapid growing species such as cypress, pine or eucalyptus;
- Determination of areas without grazing (area with new seedlings, in the natural forest);
- Determination of areas for grazing (deforested area without replacement, then in the future plantation of more than 3 years old);
- Organisation of cycle management by specific area;
- Ensure that no illegal destructive activities are carried out in the forest: system of control inside the community, more forest guards, institutional support;
- Create a community forest management agreement.

III. Involvement of Local Population in Forest Protection and Management

- Rehabilitation of farmers involved in illegal logging (for instance charcoal burners) into plantation activities (non resident Shamba system);
- Reforestation of encroached areas by actively involving the encroachers themselves (non resident Shamba-system);
- Participatory management by the villagers;
- Training of villagers and farmers in the development of protected forests;
- Establishment of tree nurseries;
- Development of on-farm forest;
- (To form a cooperative to market the trees and get fair prices, influence of the market).

5.4 An “Objectives-tree” for the following stage of the Foreaim project

Having identified the factors of degradation and the potential strategies to rehabilitate the Mau Forest, the next step is to create an “objectives-tree”. This is done by converting the degradation factors to positive conditions in the objectives tree, with the criterion that an objective must be both desirable and attainable. Figure 27 is the resulting objectives-tree for forest rehabilitation.

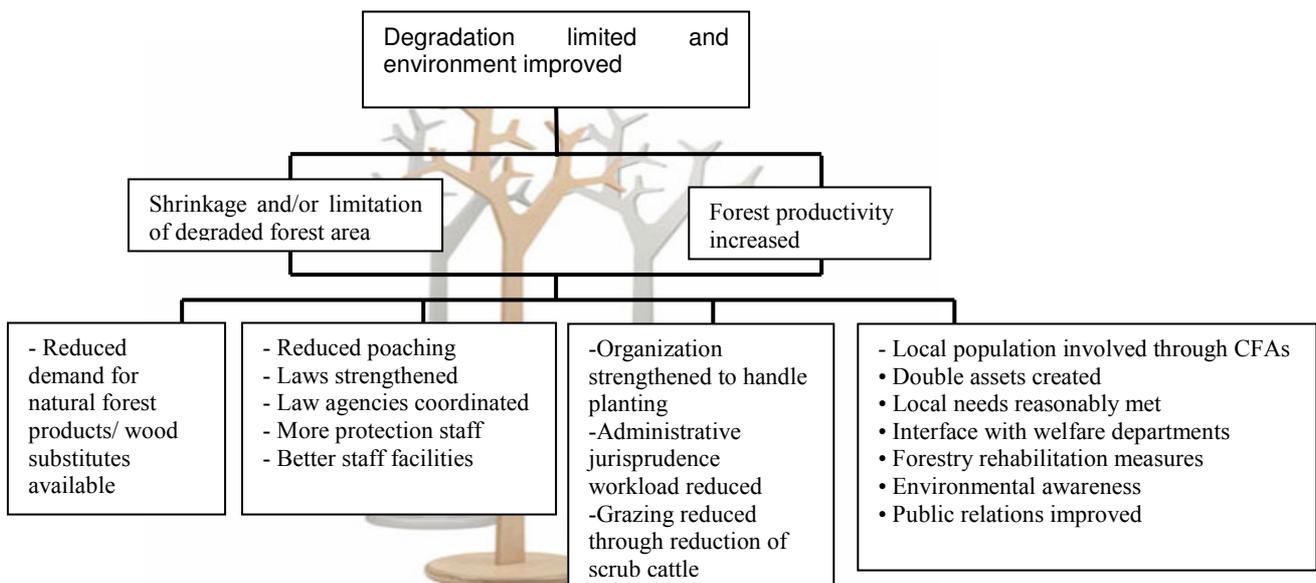


Figure 27: Objectives-tree, adapted from the World Bank 1996

The “objectives-tree” indicates what the future will look like by solving each problem. This tree is done by converting the degradation factors to positive conditions in the objectives tree, with the criterion that an objective must be both desirable and attainable.

6 Discussion

6.1 *Limits of the study*

The variety of languages spoken by the many tribes living in Western Mau was sometimes a limiting difficulty. During the interviews, according to the answered question and their formulation, the responses can be biased and the type of knowledge extracted can be different (La France, 1987). Therefore, the work with the translators about the meaning of the used words was very important to limit errors during the translation. However a loss of information was possible during the interviews. In addition, many activities in the forest are illegal. Because of the direct implication of people in these activities, the establishment of communication was sometimes difficult with them. Sometimes they mistrusted us, which could have biased some results.

The precision of the inventories is not optimal, but it is sufficient for this study. Indeed, these inventories constitute the first data base in the studied areas about the forest adjacent of the three villages. The results permit to characterize the present state of the forests. They could be used in the future to compare the forest state in terms of structure and floristic composition of the stand. One objective of the Foreaim project is to evaluate the state of the forest. The proposed method could be used in order to characterize the degradation in the other parts of Mau Forest. For the moment, some plots have been put in place in the forest for the monitoring of regeneration or growth rate of some species, but specific inventories of the forest were not yet carried out.

Finally, the last limit was the weather condition between June and August. It was very rainy and muddy and because of the bad state of the roads, the fieldwork was sometimes immobilised and slowed down for several days. For the next fieldwork in the forest or in the villages, which necessitate many moves, it is maybe easier during other months of the year.

6.2 *Degradation factors: a controversial subject*

In the Mau Forest, forest degradation is directly attributable to humans clearing land for agriculture or pasture, logging, and extracting forest products. Illegal logging is a pervasive problem, causing enormous damage to forests and to local communities (Ozinga, 2004). These direct causes of deforestation are themselves symptoms of underlying demographic, social, and economic interactions. While patterns of forest degradation vary, its three main essential causes can be summarized in one sentence; “people, poverty and policy.” The relationships and interactions among these forces are often very complex, challenging the ability to understand this phenomenon.

Concern with population pressures is ubiquitous in literature on deforestation, forest degradation, loss of biodiversity and underdevelopment. Many scholars focus on overpopulation when they analyse resource use (Meffe & al., 1993) ; (Wilson, 1992). According to Wilson, “the raging monster upon the land is population growth. In its presence, sustainability is but a fragile theoretical construct”. A policy document from the World Bank affirms that “the causes of environmental degradation are as varied as its manifestations. But at the heart of the problem is the rapid rate of population growth in many developing countries” (Banuri & Marglin, 1993). However, two themes in the literature about overpopulation merit a critical focus: the concern with population growth in the developing world and concern with the activities of the numerous small producers who use

land (Agrawal, 1995). Wilson (1988) asserts, “exploding human populations are degrading the environment at an accelerating rate, especially in tropical countries”. (Li, 1991) claims that “the most important thing the Chinese government can do to break the vicious circle of overpopulation and deforestation is to promote the practice of family planning and to strictly control population growth”. Nevertheless as underlined by Agrawal, Li reveals also that China’s forested land area changed from 8% in 1949 to 12% in 1984 to 8.4% in 1988. In this condition if forest area increased and decreased while population went up each year, clearly there are other factors that are much more significant in explaining deforestation or forest degradation.

In Mau Forest demography alone does not conduct to environmental dynamic; nevertheless it is an accelerating factor of the forest degradation. Two main problems confront the conservation and management of natural forest in Kenya. These are competition for land and the increased pressure on the remaining land resource (Ongugo & Mwangi, 2000).

The responsibility of numerous small producers and users in environmental degradation is evident among writers such as Wilson (1992). Poverty and a general lack of access to capital, resources, and technology contribute to the forest degradation in two ways. First, poor communities often fail to provide adequate forest resource management, leading to general environmental degradation (Nash, 2001). In Mau Forest, poor rural families are more likely to support themselves with the use of forest products such as fuel, fodder, and building materials. Second, in poor rural communities, the continuing need for family labour supports high fertility and rapid population growth, which some analysts believe places additional strain on forests (Nash, 2001).

However, micro-level research shows that people and the environment are not necessarily antagonistic and it provides a different perspective on the population environment relationship. Smallholders, even under significant market and population pressures, can demonstrate the capacity to conserve forest resources (Agrawal, 1995).

6.3 New technologies to diminish the pressure at the level source

There is also a need to address the problem of inefficient charcoal production technologies. The traditional charcoal kilns have an efficiency of about 15% (Mbugua, 2000). By introducing modern kilns, less resource in wood could be used for the same production of charcoal. A judicious utilization and processing of resources could reduce the demand in wood. With clear regulations and controls some modern kilns could be established in some villages to produce legally charcoal (with plantation wood). In the same way, in Kenya and in Mau Forest, many households use a metal charcoal stove for cooking which is called a jiko stove. Researchers at Kenya Energy and Environment Organizations (Karekezi & al., 1989) developed a new ceramic model of the jiko stove that uses less fuel and therefore helps to reduce the degradation of the forest (Appendix I). But the new generation of jikos is little known and used by the households in Mau Forest. Its utilisation could also reduce the amount of firewood. But because the new stove costs slightly more than the old ones, there is a need to educate people about the savings in fuel costs (International Development Research Centre (IDRC), 1996).

6.4 Participation of forest communities under conditions

The destruction of natural forests for timber, cropland, fuelwood and pasture has a negative impact on many poor rural families who are dependent on forest resources. Moreover the

deterioration of forests has accelerated soil erosion, sedimentation of rivers, increased flooding, and overtaxed the land's capacity to regenerate and sustain.

Recent years have seen a number of changes in the management of forests. There is a major shift towards a more decentralized and people oriented forestry. Responding to scarcities, in some countries, villagers have started organizing themselves to reverse degradation and rehabilitate productivity. The result has been a renewal of degraded ecosystems. It is now being recognised that local communities need to be involved in establishing sustainable forest management systems (Saigal, 2001). Many examples of community forest management have shown that when people are involved in the management of their forest they can do it in a sustainable way. Joint Forest Management in the forest of Arabari Range in the state of West Bengal (1971) is only one of numerous examples of success (Joshi, 1998).

The Kenyan government opened opportunities for the forest communities in the Forest Act 2005 by decentralizing authority and responsibility for resource management. The Kenya Forest Service and the forest communities (*via* CFA) have to enter into an agreement to jointly protect and manage forest land adjacent to villages and to share responsibilities and benefits. Substantial areas of degraded forests should be rehabilitated.

However, in the Forest Act 2005, the concept of forest communities remains blurred. For instance, there is little clarification about the persons and groups which form a community. The Act refers to "resident in the same area" but it does not clarify from how many kilometres from the forest a community can be considered as a forest community. In the same way there is no appropriate mechanism or procedure to define use-right boundaries between different Community Forest Associations. Currently, in many parts of Mau forest, there are no mechanisms for permitting participation of communities in forest management. Even if this new Forest Act 2005 has been implemented, its application on the field level remains hindered because the communities lack relevant information about it.

Local people support forest protection only if they are able to have financial returns from benefit-sharing schemes. Consequently, the various initiatives should lead to greater access and more benefits from forest resources for local people as a reward for increased responsibility for its protection from grazing, illicit harvesting or fire. In the Mau Forest some few villages, such as Chepsir, have already organised themselves in CFAs. However to ensure successful involvement of the forest communities in the Mau Forest management and its long term economic viability, ecological sustainability and social acceptability, conditions have to be respected. These conditions are:

- well defined user groups with transparent Memorandum of Understanding on the roles and responsibilities of the CFA and the Kenya Forest Service;
- a legal back up for the CFAs;
- appropriate institutional and financial mechanisms;
- appropriate silvicultural practices for the management of the forests;
- stakeholders need to have a voice in decision-making;
- assured security of tenure and access to benefits;
- creation of goods and services for local communities and overall socio-economic development;
- creation of employment and income sources;
- CFA to collaborate with industry or organisations for commercialisation of forest products;

- Finally, – very important, but difficult to carry out – provide an assistance to the farmers (Funds and dissemination of information by NGOs, governmental institutions).

However, in some parts of the world, joint forest management failed and led to conflicts. Even if sanctions can exist, some people (farmers or not) try “to get more than others”: some people are individualist (see tome 2 of the study (Kübler, 2007)). This kind of persons develops their own strategies and does not act as if everybody was jointed in one same objective. For these reasons, it is important that a strong framework with many conditions was respected and support the communities. Moreover, the decline in opportunities for labour services and the increasing number of surplus labourers increase problems of social security and ethnic conflicts. Tensions and conflicts can also be accentuated.

6.5 Alternatives: Redevelopment or/and Restoration

The current forestry situation in some part of Mau Forest indicates that the population's demand of forest products from natural forests can be supplied only at the cost of environmental degradation. Plantations of fast growing tree species should be established to meet the demand for timber and fuel for the growing economy and to reduce pressure on remaining natural forests. In this context, production of wood in private sectors *via* on-farm forestry is one of the alternatives which could supplement the demand of forest products from natural forests. One of the challenge confronting farm forestry are lack of appropriate incentives to support commercial production of wood and inadequate funding levels to support and initiate training of stakeholders and investment in efficient management land, resource assessment and pricing, utilization technologies and processing (KFS, 2006). Moreover, according to some farmers land sizes are too small to develop on-tree farming. Because of these factors, farmers often decide not to plant trees on their land. Another alternative is the non-residential cultivation which permits to develop plantations and in the same time to contribute to the food security of farmers.

However the question how to rehabilitate the Mau Forest remains. Redevelopment with plantations for mainly utilitarian aims or restoration with ecological objectives? The answer will depend of the objectives of the government and the communities. Development of plantations (including on-farm forestry) with indigenous trees is not to be neglected. The Mau Forest is a reservoir of unique biological diversity (Njuguna & al., 2000) and a large number of species are threatened by its degradation and human activities. For instance some species such as *Prunus africana* or *Juniperus procera* are included in the red list of the IUCN (IUCN, 2007) and thus are internationally recognized as threatened (classification in Appendix J). To maintain biodiversity in the natural forest and to diversify the plantations, the reintroduction of indigenous trees (in farms or plantations) has to be envisaged and developed. Research programmes of Kefri should deliver important information about potentialities to re-establish the two endangered species cited above and other indigenous trees.

6.6 Which benefices for struggling against the forest degradation?

Several villages in Mau Forest, such as Chepsir, are not concerned by the active degradation of the forest because their forest was well conserved through the time. In a “good” forest, wild animals are present in more important number than in a degraded one. In some villages, as Chepsir Tea Zone, elephants can consequently be attracted by maize fields, leave the forest and destroy the cultivations. If people observe and “suffer” of “negative effects” of the forest, it is legitimate for them to have questions about the benefices of conserving the natural resources. For these farmers, who asked sometimes “*what interests do we have to keep the forest in a good state?*”, some values of the forest have to be reminded.

Mau Forests, like the other forests in Kenya and all over the world, offers a big number of environmental services. It regulates water flow, soil erosion, nutrients recycling, carbon sequestration and the climate and, is shelter for many species. Hence, the benefits to convert the forest to other uses would not adequately compensate the for loss of access to these valuable life-supporting resources nor would these gains be sustainable in the long term (Mwanduka, 2007).

Forest, if it is managed in a sustainable way, can also regularly offer many useful products such as medicinal herbs, fuelwood or timber and generate revenues for communities. Finally, a “good” forest with its animals and its rich vegetation could even be interesting for the development of eco-tourism, and so some parts of Mau Forest could be protected more efficiently.

Conclusion

The continued destruction of the Mau Forest threatens the livelihood of many people. Not only the forests are at stake, but also the welfare of communities and the prevention of environmental threats. Forest rehabilitation has become necessary for many parts of Mau Forest, particularly where local communities are dependant on the forest resources. There is an urgent need for a rapid development of environmentally and economically viable practices in the region of Mau Forest.

In some parts of Mau Forest, its future is extremely compromised by a highly active degradation. Some communities living near the adjacent Western Mau Forest use the forest extensively for subsistence purposes. Encroachments by farming and intensive grazing in the forest degrade the ecosystem and threaten the balance of the resource. In addition to subsistence use, there are illegal practices for commercial extraction of forest products such as charcoal burning, which are a relevant factor in the forest depletion. The extraction rates exceed the thresholds of sustainable utilization leading to irreversible damage and destruction of the forest. If present rates of disturbance and deforestation are not checked and brought to a limit, it is conceivable that entire Mau Forest and the invaluable services it performs will be lost within the next twenty years (Mwanduka, 2007).

The responsibility of smallholders as farmers in the forest depletion is undeniable. The main factors of degradation are the impact of human activities in the adjacent village to the forest, but problems of corruption or lack of funds within the governmental institution indirectly participate in the forest degradation. Thus, other factors have to be taken into consideration in this process of degradation as poverty, political problems and high demography.

For the sphere of “official knowledge” strategies to rehabilitate the forest rest often on community participation in the forest management. Thus, forest rehabilitation is not only a technical issue but also one of community involvement. However at this time, many villages in Mau forest are neither aware of the Forest Act 2005 nor about the implementation of communities *via* CFA in the forest management. It seems to have a gap between the expectations of the “official knowledge” sphere and the actual actions carried out in the sphere of practical action. Moreover, some ambiguities concerning the concept of “forest community” can generate other difficulties in the implementation of the Forest Act 2005.

It is sure that the success of this rehabilitation depends on the involvement of the communities, based on their own will and knowledge regarding resource use and its conservation. However, co-operation between all stakeholders and the will to achieve common goals are also essential to accomplish rehabilitation programs in Mau Forest and Kenya. This may only be possible with a strong institutional framework of the Kenyan government and international organizations along with research and development, economic and marketing studies, education and training, information and technological development, and above all, active participation of rural people.

While forests will continue to be lost for decades to come, it is very important that the struggle against forest degradation is done as rationally as possible. Only then the long-term benefits to humankind will be favourable and the costs for the environment minimal.

Lexique

¹: a **squatter** is a person who settles on land or occupies property without title, right, or payment of rent (Houghton Mifflin Company, 2000).

²: a **gazetted forest**, is one which has been surveyed, demarcated on the ground, and declared as a forest reserve. These forests are legally owned by the Government of Kenya, and are managed directly by the Kenya Forest Service on behalf of the state. Areas which may have to be excised from the forest reserve, for any reason, must be formally de-gazetted. Gazetted national parks and national reserves, managed by the Kenya Wildlife Services, also contain forests and other types of woody vegetation

³: **Ugali**, is a staple starch component of many African meals, especially in southern and East Africa. It is also sometimes called sima or posho. It is generally made from maize flour (or ground maize) and water, and varies in consistency from porridge to a dough-like substance.

⁴: **Group dynamic phenomena**, is a general term for group processes. In psychology and sociology, a group is two or more individuals who are connected to each other by social relationships. Because they interact and influence each other, groups develop a number of dynamic processes that separate them from a random collection of individuals. These processes include norms, roles, relations, development, need to belong, social influence, and effects on behaviour. The field of group dynamics is primarily concerned with small group behaviour (Forsyth, 2006).

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Appendix A: About the Kenyan Forest Act 2005

I. Generality

The Forests Act 2005 was enacted by Parliament of Kenya and also received Presidential Assent on 18th November 2005. The draft Forest Policy and the Forest law envisage a radical change in the way forests are managed. The Forest law has provisions that are aimed to enhancing the participation of private sector and communities in the management of state forests.

The Forest Department has identified the following as precondition for successful implementation of private sector and community participation in forest management:

1. Good and transparent information on forest valuation and inventory of growing stock.
2. Comprehensive forest law and policy accompanied by clear rules and regulations defining roles and obligation of stakeholders.
3. Cost effective forest valuation guidelines, which are replicable in wide areas.

Expected outputs:

- A well developed and clear rules and regulations that provide an effective and transparent framework facilitating the implementation of the provisions relating to participatory approaches proposed in the Forest Bill.
- Approaches to asset valuation in the case of plantations and other land that may be utilized by local communities and industries in the context of their involvement in forest management.
- Develop an effective concession management information system to ensure that concessions and other engagements are awarded in a transparent process.

Policy implications:

- After gazettelement of subsidiary legislation it is expected that the private sector and community participation in management of state forests will be streamlined.
- Putting in place mechanisms of forest valuation will assist in setting the royalties, fees and charges, which reflect the true value of forest resources. This may reduce inefficiency in processing the forest products since the licensee will have paid the full price of forest products.
- Involvement of communities in forest management is expected to reduce incidences of forest destruction since community will have incentives to protect the forest.
- Conservation of forest will contribute to environmental sustainability through ecosystem services such as flood control, soil stabilization. This is in accordance to millennium development goal number 7.

- After putting in place rules and regulations, institutional arrangements which include community forest associations, it is expected that exploitation of forest resources will contribute to reduction of poverty through employment creation.

Source: Kenya Forest Service, www.kfs.go.ke/html/fao%20fnpp.html

II. Extract of Forest Act 2005: community participation

PART IV – Community Participation

45 (1) A member of a forest community may, together with other members or persons resident in the same area, register a community forest association under the Societies Act.

(2) An association registered under subsection (1) may apply to the Director for Permission to participate in the conservation and management of a state forest or local authority forest in accordance with the provisions of this Act.

(3) The application referred to in subsection (2) shall be in the prescribed form and shall contain –

- a) a list of the members of the association and its address;
- b) the Constitution of the association;
- c) the association's financial regulations;
- d) the area of forest for which the association proposes to undertake conservation and management;
- e) the association's proposals concerning –
 - (i) use of forest resources;
 - (ii) methods of conservation of biodiversity;
 - (iii) methods of monitoring and protecting wildlife and plant populations and enforcing such protection; and
- f) such other information as the Director may require.

(4) Where there is no management plan in respect of the area, or where the association proposes that there be a new management plan, the application shall be accompanied by a draft management plan.

(5) The provisions of this act regarding management plans shall apply in respect of the draft management plan submitted under subsection (4).

(6) The Director shall cause to be kept an up to date record of all associations participating in the conservation or management of forests.

46 (1) An association approved by the Director under section 46 to participate in the management or conservation of a forest or part of a forest shall –

- a) protect, conserve and manage such forest or part thereof pursuant to an approved management agreement entered into under this Act and the provisions of the management plan for the forest;
- b) formulate and implement forest programmes consistent with the traditional forest user rights of the community concerned in accordance with sustainable use criteria;
- c) protect sacred groves and protected trees;
- d) assist the Service in enforcing the provisions of this Act and any rules and regulations made pursuant thereto, in particular in relation to illegal harvesting of forest produce;
- e) with the approval of the Board enter into partnerships with other persons for the purposes of ensuring the efficient and sustainable conservation and management of forests;
- f) keep the Service informed of any developments, changes and occurrences within the forest which are critical for the conservation of biodiversity;
- g) help in fire fighting; and
- h) do any other that is necessary for the efficient conservation and management of the forest.

(2) The management agreement between the Director and the association may confer on the association all or any of the following forest user rights –

- (a) collection of medicinal herbs;
- (b) harvesting of honey;
- (c) harvesting of timber or fuel wood;
- (d) grass harvesting and grazing;
- (e) collection of forest produce for community based industries;
- (f) ecotourism and recreational activities;
- (g) scientific and education activities;
- (h) plantation establishment through non-resident cultivation;
- (i) contracts to assist in carrying out specified silvicultural operations;
- (j) development of community wood and non-wood forest based industries; and
- (k) other benefits which may from time to time be agreed upon between an association and the Service:

Provided that:

- (i) none of the activities specified in this subsection shall be carried out so as to conflict with the conservation of biodiversity; and
- (ii) the Director may, in consultation with the association, make rules regulating the performance thereof.

47 (1) An association may, with the approval of the Director, assign any or all its rights under a management agreement to a suitably qualified agent on mutually agreed terms.

(2) The Director shall not approve any assignment which would derogate from the main objectives and purposes set out in the management agreement.

(3) The management agreement shall be deemed to provide that an association shall be liable for all the activities, acts and omissions of the assignees of its rights under the agreement.

48 1) The Director may terminate a management agreement with an association or withdraw a particular user right where –

- a) an association grossly breaches the terms and conditions thereof;
- b) he considers such action as necessary for purposes of protecting and conserving biodiversity; or
- c) the association itself so requests.

(2) Where the Director intends to terminate a management agreement or withdraw a particular user right on either of the grounds stipulated in subsection (1) (a) or (b) of this section, he shall give the affected association thirty day's notice to show cause why the management agreement should not be so terminated or the user so withdrawn.

(3) Where a request for termination of a management agreement or the withdrawal of a user right has been made by an association, the Director shall make inquiries into the grounds for the request, and where he is satisfied that it is in the best interests of the association and of conservation to do so, may grant the request.

(4) Where an association is aggrieved by the decision of the Director under this section, it may, within thirty days after being notified of the decision, appeal to the Board against the decision.

(5) Nothing in this section shall be construed to limit the grounds on which, in accordance with the terms of a management agreement, the agreement or any user right may be terminated.

Source: Forest Act 2005, Republic of Kenya 2005

Appendix B: An extract of the Kenyan history: Ethnic conflict in the Rift-Valley Province (Oyugi, 2002)

There is evidence to suggest that where ethnic conflict has emerged in Africa, there has always been political machinations behind it (see e.g. various studies in Nnoli 1998). Politicization of ethnicity often takes place in a situation characterized by an inequitable structure of access.

The problem of ethnicity, having emerged during the colonial period, has been progressively accentuated since independence with the emergence of ethnicity as a factor in national politics. Ethnicity in Kenya became a national concern as early as during the colonial period but was accentuated in the post-independence period during the implementation of the policy of Africanization. Ethnic tensions developed especially around the structure of access to economic opportunities and redistribution of some of the land formerly owned by the white settlers.

Most of the land in question was in the **Rift Valley** province and was historically settled by the **Kalenjin** and the **Maasai**. The other area that was affected by colonial settlement was the Central province. But the crisis was aggravated during the mid-1950s when forced land consolidation took place during the emergency period, which benefited mainly the progovernment group that had not joined the *Mau Mau* revolt. And when the state of emergency was lifted at the end of the 1950s, most of the detainees returned home to find that they had lost their land to the loyalists. As some moved to the urban centres in search of wage and self employment, a large wave of this group moved to the Rift Valley in anticipation of what was expected to be land redistribution after independence. A number of them joined relatives and kinsmen who had moved to the Rift Valley many decades earlier and were staying in some of the settler owned land as squatters. Therefore, when the redistribution of some of the land formerly owned by the white settlers began, it is these squatters that became the instant beneficiaries of the allocations.

But the policy that gave rise to large scale land acquisition by "outsiders" in Rift Valley was the policy of 'willing buyer willing seller' that the government assumed for land

transfers after the initial political settlement on about one million acres.

Using the economic and political leverage available to them during the Kenyatta regime, the **Kikuyu**, **Meru** and **Embu** groups, but especially the **Kikuyu**, took advantage of the situation and formed many land-buying companies. These companies would, throughout the 1960s and 70s, facilitate the settlement of thousands of Kikuyu in the Rift Valley, especially in the districts with arable land – notably **Nakuru**, **Uasin Gishu**, **Nandi**, **Trans Nzoia** and **Narok**. The land in the said districts historically belonged to the **Kalenjin**, **Maasai** and kindred groups such as the **Samburu**. But the **Kikuyu**, **Embu** and **Meru** were not the only ones to acquire land in the Rift Valley after independence. The new entrants in the post independence period included the **Kisii**, **Luo** and **Luhya**, who moved into and bought land that bordered these districts.

This new settlement continued in spite of opposition by the indigenous ethnic groups of the Rift Valley. In fact the Nandi, in particular protested in a more dramatic manner when in 1969 at a meeting in Nandi Hills, what became known as the "Nandi Declaration" was made after a gathering of radical political leaders in Nandi met to protest what they regarded as an invasion of their ancestral land by outsiders. Aware of these protests even before the "Nandi Declaration" the Kenyatta regime relied on the senior **Kalenjin** in the government to neutralize the political opposition to the settlers. And none other than the then Vice-President (a **Kalenjin**) would play a leading role in this strategy. But as fate would have it, it was this same Vice-President, finding himself as the country's President, who would have to deal with the most exclusive ethnic conflict arising from a policy that he had personally contributed to implementing.

However, during the first decade of his rule, Moi by and large managed to contain the situation helped largely by the politico-administrative culture that had been fostered during the one party era. But he at the same

time put in place a mechanism that weakened the capacity of the **Kikuyu** to continue acquiring more land in the Rift Valley province. It is in the above context that the problem in Rift Valley province that is the subject of analysis here is to be seen.

The ethnic conflict in the Rift Valley took place against a background of an impending general election. This was to be the first time since independence when a truly multi-party election was to be held in post-independent Kenya. This is because this time round, the ruling party was seriously threatened with the probability of being removed from power by the combined political opposition, which had in the first place mobilized public opinion that ultimately forced the government to change the constitution to allow the operation of multipartyism. Playing a major role in the emergent opposition movement were the **Kikuyu** and the **Luo** communities.

It should be recalled that Moi had worked very closely with the **Kikuyu** people, both during the Kenyatta years and during the first few years of his presidency. However, he had slowly fallen out with them through his policy of rectifying the structure of access to benefit his **Kalenjin** community at the expense of the **Kikuyu** – the former in-group.

By the late 80s, therefore, the **Kikuyu** were a bitter group looking for any opportunity to regain the ground lost during the Moi era. The **Luo**, on the other hand had been the leading outsiders since the mid-60s when they fell out with the **Kikuyu**. Therefore in the run up to the multiparty elections, the two groups had formed an alliance of convenience and out of necessity to dislodge the Moi regime. Radicalized politicians from Gusii and Luhya later joined them.

By coincidence, all these communities had benefited from land settlement in and around Rift Valley and therefore became the target of "revenge" by the KAMATUSA coalition that control led political power at the time. Expecting at the time to be humiliated at the forthcoming elections, the KAMATUSA group in KADU got together and decided that those ethnic groups that were betraying them should be taught a lesson. The lesson in question involved their expulsion from especially the "**Kalenjin-Maasai** lands" in the Rift Valley. Such an expulsion would also rid the province of anti-KANU, anti-Moi voters; thereby denying the opposition critical votes needed to

attain the 25% requirement. The ethnic "ideology" was at once invoked and politicized in order to mobilize the KAMATUSA group throughout the Rift Valley to evict the "outsiders" from their ancestral land. The mobilization campaign was spearheaded by some very senior cabinet ministers who addressed rallies in major towns in the Rift Valley and exhorted their kinsmen to protect their "own" government.

Cases of ethnic clashes erupted towards the end of 1991 directed practically against all non-KAMATUSA Rift Valley inhabitants. Cases of people being killed here and there begun to appear frequently in the local press. But the most effective strategy employed was the destruction of homes and property of the victims in the hope that they would flee to their "ancestral lands". Those who sought refuge in mission centres became targets of ruthless attacks (to see more ICJ, 2000).

In some areas, whole communities were dislocated on flimsy grounds. A case in point is in Narok where the then Minister for Local Government declared a settlement scheme at Enosupukia trust land on the grounds that it was a catchment area. This was intended to weaken the voting power of outsiders in the area. The same was the case with the Luo in Kericho who were removed from an area they had settled for over sixty years. In the meantime, the non-KAMATUSA who had reached majority age were denied identity cards and thereby registration as voters in the hope that they would go back to their ancestral land. The Parliamentary Commission appointed to investigate these clashes established the magnitude and extent of the clashes and reported that by the time of compiling their report, a total of over 700 people had been killed. Many others had fled their homes while others had been forcefully evicted and dumped in areas claimed to be their places of origin. Another report by the US State Department put the toll as at December 1993 at 1000 dead and between 150.000–250.000 displaced. (Cited in Amisi, undated but written in the late 1990s). In the meantime efforts were being made on the ground to acquire the lands that had been abandoned out of fear of attacks.

Efforts to Resolve the Conflict

Ethnic clashes in the Rift Valley in the early 90s became a matter of concern at both the international and local level as humanitarian organizations began to look for ways and means of resolving the conflict. Some of the organizations that were principally involved include the Robert Kennedy Memorial Centre for Human Rights, the Commonwealth Observer Group, Human Rights Watch (Africa), the Kenya Human Rights Commission, the National Elections Monitoring Unit, etc. (see Amisi undated).

It should be recalled, in this connection, that aid conditionality had played a significant role in influencing the government's decision to legalize multipartyism in December 1991. Therefore Kenyans were always hoping that donor influence could be brought to bear on the government to end the ethnic violence and possibly facilitate the search for a lasting

solution to the problem. Notable pressure came from the USA, Germany and Denmark.

The problems (such as loss of property and forceful eviction of "outsiders" from their farms) which were supposed to be addressed soon after the elections remain unresolved in a majority of cases. And although many people have since gone back to their lands, there are still many families who are living in areas where they sought refuge. Efforts by UNDP beginning early 1994 to resettle the clash victims did not receive enthusiastic support from the government.

In summary, the land situation in Rift Valley province has remained as volatile as it has always been during the second half of the last century. It is some kind of "volcano" waiting to erupt.

Source quoted by the author:

- ICJ, International Commission of Jurists 2000 (Kenya Section) The Political Economy of Ethnic Clashes in Kenya (Nairobi: ICJ).

Acronym used:

- KADU: Kenya African Democratic Union (founded in 1960, to challenge the KANU. It aims was to defend the interests of the tribes so-called KAMATUSA
- KANU: Kenya African National Union
- KAMATUSA : KAlenjin, MAasai, TURkana and SAmburu

Appendix C: Few words about the history and characteristics of the two main tribes present in the study villages: The Kikuyu and the Kalenjin.

The kikuyu (otherwise spelled Gikuyu) (Hoppe, 2002)

Although uncertain, ethnologists believe the Kikuyu came to Kenya from West Africa (present day Cameroon) together with the other Bantu tribes. On reaching what is now Tanzania, they moved east past Mount Kilimanjaro and into Kenya, finally settling around Mount Kenya, while the rest of the group continued migrating to Southern Africa (to become present-day Zulus, Shonas, etc.) They were originally hunter-gatherers but unlike the Nilotic tribes who were pastoralists, they began farming the very fertile volcanic land around Mt. Kenya and the Aberdare Range. Having migrated to their current location about four centuries ago, the Kikuyu now make up Kenya's largest ethnic group. The Kikuyu people spread rapidly throughout the Central Province and Kenya (Lambert, 1956).

The Kikuyu rely heavily on agriculture. They grow many food crops depending of the region; bananas, sugarcane, arum lily, yams, beans, millet, maize, black beans and a variety of other vegetables. They also raise cattle, sheep, and goats. They use the hides from the cattle to make bedding, sandals, and carrying straps and they raise the goats and sheep to use for religious sacrifices and purification. In the Kikuyu culture boys and girls are raised very differently. The girls are raised to work in the farm and the boys usually work with the animals. The girls also have the responsibility of taking care of a baby brother or sister and also helping the mother out with household chores. Men are the head of the house.

Though they are traditionally agricultural people and have a reputation as hard-working people, a lot of them are now involved in business. The Kikuyu economy centre is mainly around agriculture, with little or no hunting or fishing (Lambert, 1956). Most of the Kikuyu still live on small family plots but many of them have also seen the opportunities in business and have moved to cities and different areas to work. They have a desire for knowledge and it is believed that all children should receive a full education. They have a "terrific reputation for money management" and it is common for them to have many enterprises at one time. The Kikuyu have also been active politically. The first president of Kenya, Jomo Kenyatta, was actually a Kikuyu.

The Kalenjin (Robert E. Daniels & al., 1987):

Kalenjin is an ethnic group of Nilotic origin living in the Great Rift Valley in western Kenya. One of their myths says they came originally from Misri, a name for Egypt (Sutton, 1978). In 1887, the Kalenjin represented about 12% of Kenya's population.

There are several smaller tribal groupings within the Kalenjin: Elgeyo, Keiyo, Kipsigis, Marakwet, Nandi, Pokot, Sabaot, Terik, and Tugen. They speak several languages that are not mutually intelligible but are linguistically closely related. Nandi and Kipsigis are the two major dialects of what is called the Kalenjin language (linguistic family of Kalenjin languages). This language also encompasses languages spoken in Tanzania (e.g. Akie) and Uganda (e.g. Kupsabiny).

They are pastoralists. Kalenjin "love" their cows and land. They grow millet, maize and now tea and sorghum. Traditionally Kalenjin built round homes of sticks and mud plaster, with pointed thatch roofs with a pole out the center (Sutton, 1978). Nowadays homes are commonly wood and stone with modern facilities, though traditional homes are still common also. They were used to live near the forest.

The children of Kalenjin were taught to respect elders. Even now respect is very important in the Kalenjin culture. Manners are important and men are the head of the house. The Kalenjin at one time pierced their ears, men and women alike, and then put sticks in them to stretch the lobes (Sutton, 1978). They did this so that they could wear beads in their ears. Many old Kalenjin can still be recognized by their stretched earlobes. They stopped doing this for hygiene reasons.

Until the early 1950s the Kenyan peoples now known as the Kalenjin did not have a common name; they were usually referred to as the 'Nandi-speaking tribes' by scholars and administration officials, a practice that did not immediately come to a halt after the adoption of the common name 'Kalenjin' (Evans-Pritchard, 1940). In the late 1940s and the early 1950s, several 'Nandi-speaking' peoples united to assume the common name 'Kalenjin', a Nandi expression meaning I say (to you). Due to this effort, the peoples were transformed into a major ethnic group in Kenya.

The Kalenjin have been called by some "the running tribe." Since the mid-1960s, Kenyan men have earned the largest share of major honors in international athletics at distances from 800 meters to the marathon; the vast majority of these Kenyan running stars have been Kalenjin

Kalenjin relate well to most tribes. However, there have been clashes between Kalenjin and the Luo and Kikuyu since even before independence. Kalenjin are active politically. They were active even before their son Moi was elected to the office of President. Kalenjin names are heard commonly in government and all areas of Kenyan life. The Kalenjin are very religious people

Quoted sources by author:

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Robert E. Daniels, Clark M. H. and McMillan T. J., 1987. A bibliography of the Kalenjin peoples of East Africa. University of Wisconsin. African Studies Program,.

Sutton J. E. G., C.E. Ehret J. E. G. S., W.R. Ochieng' a.o., 1978, p. 21-52 and groups T. A. K. K. h. e., 1978. The Kalenjin. In: B. A. Ogot (Ed.) Kenya before 1900. pp. 21-52.

Appendix D: Opened questionnaire used during the study

I. Questionnaire for “official knowledge” sphere: Guideline

1. Can you tell us something about the Mau Forest? about its state?
2. According to you, what are the causes of forest degradation?
3. What are the criteria to characterise a degraded forest?
4. What are the indicators of forest degradation?
5. What are the impacts of different human activities on forest?
6. Can you tell us something about the new Forest Act 2005?
7. Can you tell us something about the differences between the recommendation of the government and the practices of the communities?
8. What could you propose as solutions to improve the state of the forest?

II. Questionnaire for farmers: Guideline

a. Kalenjin ; b. Kiswahili

1. What are your general activities?
 - a. Ne boisiengung nebo Kila?
 - b. Una shughulika na nini kwa ujumla?
2. Can you tell me something about the (Mau) forest?
 - a. Imuchi imwawan ki agobo osnetab Mau?
 - b. Unaweza kunieleza chochote kuhusiana na misitu?
3. Since when do you live here?
 - a. Kiimenye yu kongeten au?
 - b. Umaishi hapa tangu lini?
4. What changes have you noticed since you live here?
 - a. Ne walet ne kiriger kongeten nimeny yu?
 - b. Ni mabdiliko gani umeshuhudia tangu uishi hapa?
5. What comes to your mind when you hear the word 'forest'? (images)
 - a. Ne nenyone kabwatutuguk nigao ngolyot osnet? (borosti)
 - b. Ni mawazo gani hukuja wakati una sikia neno misito?
6. How will the forest be in the time of your grandsons?
 - a. Tatun koune osnet en betusiek ab bomorisiekuk?
 - b. Ni shu hululisho gani ungetoa ili kuboresha hali ya misitu?
7. Which solutions could you propose to improve the state of the forest?
 - a. Ne netos imwa anan ortinwek chekimuchi kewalen kit neu osnet inguni?
 - b. Msitu mzuri ukoje? Msitu ulio haribiwa ukoje?
8. What is a good forest? And a bad one?
 - a. Osnet ne mie kone? Anan ko ne ya?
 - b. Gani msitu mzuri? Gani msitu mbaya?
9. What local institutions do you know ? What do you think about them?
 - a. Ochon sukulisrek chebo gaa cheingen? Ne neibwati agto sukulisiek chuton?
 - b. Unajua taasisi gani karibu nawe unafikiaje kuhusiana na taasisi hizo?

III. Questionnaire for elders and key informants: Guideline

1. Village history

- Could you tell me something about the history of the village?
- Since when does the village exist?
- What is the meaning of [name of the village]?

2. Characteristic of the village

- How many households are in the village?
- What are the different income sources of the villagers?
- What is the average land size of the households here?
- What are the different tribes in the village? In which proportion?
- Could you show me the boundary of the village?

3. Village and forest

- Could you tell me something about the forest?
- What is the past of this forest?
- How did people use this forest before? How do they use this forest now?
- Has there been any exploitation in the forest? (By company) When?

4. Planting trees

- Who decides to plant trees in a household?
- Who decides to cut / harvest in a household?

Appendix E: Closed question for household

◇ Quantitatif Questionnaire ◇ A.Oddi & D.Kübler 2007

HOUSEHOLD (HH) QUESTIONNAIRE

Interview number: _____ Date: ___/___/07

Interviewee's name: _____

Village: _____

INTRODUCTION :

“Jambo. We are 2 students and we are doing an internship about the Mau region. We are especially interested in the opinion of the communities and their uses of the forest.

Do you know about the New forest Act and the community involvement?

[Write Answer]

If yes:	If no:
So you know that according to this act, now, communities will be involved in the forest management.	I can explain you briefly: Now, according to this act, communities should be involved in the forest management together with the FD and other stakeholders.

That's why we are ESPECIALLY interested in YOUR opinion. Could I ask you some questions? It is a confidential study and we won't give your name to anybody. You don't have to be worried about us. It is a short interview, it will last about 20 min.“

A. COMPOSITION OF HOUSEHOLD (HH)

1) Number of persons living in the HH? _____

Total	
Wife(s)	
Children, not yet in school	
Children in school, younger than 18	
Young adults in education, older than 18	
Children, younger than 18, finished with education	
Adults	

2) How many persons of the HH can work in the field? _____

B. HEAD OF HOUSEHOLD

3) Sex, *Tick* : 1 Male / 2 Female

4) Ethnic group:

5) Age of Head of Household (Yrs): *Tick*

- 1) Under 25
- 2) 25-34
- 3) 35-44
- 4) 45-54
- 5) 55-64
- 6) 65 and older

6) Is the head of HH a resident here?

1 Resident / 2 Absentee landlord

7) *If resident*, since which year? _____

8) Distance of the HH to the official forest boundary?

_____ km
_____ min by foot

C. LAND USE

9) How much land do you own?
_____ acres

10) How much land do you rent?
_____ acres

11) How much of the production is for sale?

Nothing	1
Less than ¼	2
¼ - half	3
More than the half	4

D. USES OF THE FOREST BY HOUSEHOLD:

12) a. How many animals have you got? *Read, Complete*

	Number
TOTAL	
Cattle	
Goats	
Sheep	
Donkey	
Others?	

b. How many of them do graze in the forest?
Read, Complete

	Number of Animals in the forest
Cattle	
Goats	
Sheep	
Donkey	
Others?	

c. For you, what is the importance of the forest for grazing? *Read, Tick*

- 1 Very important
- 2 Important
- 3 Moderately
- 4 Not important

13) How many [...] does **your HH** produce or harvest a week?

- **Medicinal products:** *Precise unit*

and, how many for domestic use? *Precise unit*

- **Honey:** *Precise unit*

and, how many for domestic use? *Precise unit*

- **Firewood** (*Circle unit: in headload, human back, donkey back*):

_____ (a week)

and, how many for domestic use?

_____ (a week)

- **Charcoal bags:** _____ (a week)

and, how many for domestic use?

_____ (a week)

- **Poles:** _____ (in donkey back a week)

and, how many for domestic use?

_____ (in donkey back a week)

- **Timber:** _____ (in donkey back a week)

and, how many for domestic use?

_____ (in donkey back a week)

- **Other uses?**

E. INCOME

14) How many persons do [...] in a month in your HH?

1) **Casual labors:**

If somebody which ones?

2) **Regular labors:** *Exp: work for tea company, family in city*

If yes, which

ones? _____

Business:

- 3) Transport of forest products

Wait and if yes,

which products? _____

- 4) Something else like income? *If yes, what?*

F. TREES

- 15) Which species do you use for [...]?

Complete with number

Medicine	P o l e s	Timber	Charcoal	Firewood

- 16) How many trees have you in your farm?

- 17) Which species? *Complete with number*

- 18) If it was possible, which species would you like to plant in your farm? *Complete with number*

- 19) 1. How is the forest? *Read, tick*

- 1 Better than before 2 Worse than before
 3 The same

Ps; before= since he/she lives here

- 19) 2. How is the forest?

- 1 Very degraded
 2 Degraded
 3 Medium
 4 Good
 5 Very good

- 19) 3. Explain your 2 answers

- 20) According to you which human activities can disturb the balance of the forest? Why? (Most important first)

Human activities	Reasons
1.	
2.	
3.	
4.	
5.	

G. DIVERS

- 21) Do you own a [...]?

Type of goods	Year of purchase
TV	
Tape/Radio	
Power-saw	
Bicycle/	
Van / motor cycle	

Respondent's comments and questions (the enumerator allow the respondent time to ask questions and make comments)

Close the interview by thanking the respondent

☺ Thank you !!!!

Appendix F: Principal Component Analysis and its Data treatment (Kettaneha & Berglundb, 2003)

PCA and data treatment

Principal Component Analysis is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences. PCA is a technique for simplifying a dataset, by reducing multidimensional datasets to lower dimensions for analysis. It can be used for dimensionality reduction in a dataset while retaining those characteristics of the dataset that contribute most to its variance, by keeping lower-order principal components and ignoring higher-order ones.

The treatment of data is composed of 5 stages:

1. Verification of the data coherency in order to validate the quality of the data base
2. Application of the Kaiser-Meyer-Olkin (KMO) test:

- The KMO test measures the sampling adequacy which should be greater than 0.5 for a satisfactory factor analysis. The KMO statistic assesses one of the assumptions of Principle Components Analysis – namely whether there appears to be some underlying (latent) structure in the data. This is also referred to as *Sampling Adequacy*.
- (Ignorance of the Bartlett's test because the sample is more than 5 cases per variable)

3. Principal Component Analysis (PCA).

Choose and analyse the axes with the highest eigenvalues (also called latent root). The eigenvalues are related to the amount of variation explained by the axis.

4. K-means clustering depending on the results of ACP: The k-means method is a widely used clustering technique that seeks to minimize the average squared distance between points in the same cluster.

5. The obtained clusters are analysed with basic statistic tools

Source: Kettaneha N. and Berglundb A., 2003. PCA and PLS with very large data sets 2005. *Computational Statistics & Data Analysis*, 48 (1), 69-85.

Appendix G: Grid to transcribe the 20 opened questions interviews (first stage)

	General information	Pivot-Words
Interview		
Gender		
Village		
Resident		
For how many years?		
Land size		
General Activities		
Forest: domestic use or for sale		
Anything about forest		
Images with forest		
Changes in the forest		
Good Forest		
Bad Forest		
State of the forest		
Source of degradation		
Proposed solutions		
About KFS		
Interesting point		

Appendix H: Formula used to analyse the forest inventories

I. Determination of the Basal Area (BA) with Bitterlich method

BA= Number Living Trees * Basal Area Factor (BAF)

where BA is in m²/ha;

and BAF is dependant of the width of the angle count and the distance to eyes.

II. Determination of the sample size adapted adapted from Dreyfus course (Engref 2007)

The degree of confidence of an inventory is linked with the coefficient of variation.

The coefficient of variation is a description of the relative variation in a population. The coefficient of variation (CV) removes this noise by expressing the variation (standard deviation) as a percentage of the mean value:

$$CV = \frac{s}{\bar{x}} * 100$$

where:

s: standard deviation of the population

x: mean of the population

Remark: The CV for volume/ha or stand basal area in a well managed plantation may be about 40%, while in a natural (native) forest, the CV may exceed 100%.

The required output from many inventories is an unbiased estimate of the mean size or value of a parameter with an indication of the precision or reliability of that estimate. Thus, the inventory designer must be able to provide an estimate of the mean value and an estimate of the possible range of values that would occur if another sample of the same size were taken. The range due entirely to the sample taken, is termed the sampling error. Often the desired precision of the inventory is determined in terms of the sampling error. The number of samples required to meet this sampling error is calculated as:

where:
$$N = (t_{1-\alpha/2} * \frac{CV\%}{e\%})^2$$

- e denotes the maximum sampling error desired (20%);
- t the student t value (about 1 or 2 for relatively large samples and with probability levels p=0.33 and 0.05 respectively). If we supposed than N> 30, $t_{1-\alpha/2}$ is close to 2;
- n the number of samples required.

II. Density of the stand calculated with the N-tree method results:

The estimate of trees per acre from N-trees sampling with m sample points is:

$$T_A = \frac{1}{m} \left(\frac{n-1}{n} \right) \sum_{i=1}^m \frac{n}{A_i}$$

where

R_{ni} = distance to n-tree in m,

$A_i = \pi R_{ni}^2$ area of plot i in m²,

m = number of n-tree plot locations,

T_A = estimated number of trees per ha

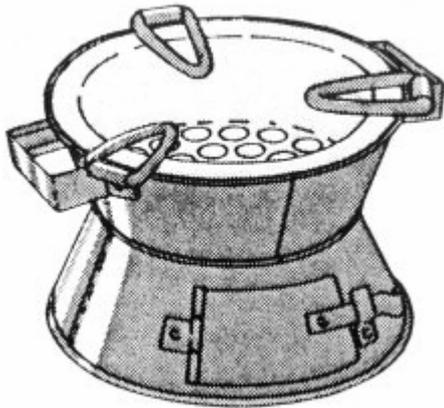
n = Number of N-tree in the plot locations

III. Relative Density (RV) calculated via N-tree method results:

This value corresponds to the importance of a species x according to the total number of individuals, in a sampling area (Latreille & al., 2003).

$$RV = \frac{\text{Number of individuals of the species x}}{\text{Number total of individuals in the sampling area}} \times 100$$

Appendix I: To promote the Kenyan Ceramic Jiko



Kenya Ceramic Jiko

Image source: www.handsontv.info

It reduces the cost of fuel and decreases cooking time so it is ideal for families that do not have much money and are busy with other activities. Because of its shape, the stove's heat is directed right under the cooking pot: water boils faster and longer using the improved jiko. (International Development Research Centre (IDRC), 1996). The ceramic jiko lasts about 30 months with lots of use, longer than the metal jiko. The outside casing is made of metal and is produced by local craftspeople. The ceramic inner lining is produced by large and small enterprises, including several women's groups.

The cost of the jiko can be recovered in two to three months because of the savings in fuel costs.

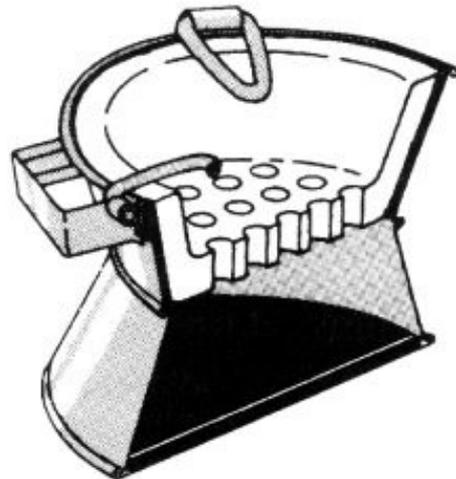
With 70,000 of these new improved jikos in active use it is estimated that 206,000 tonnes of wood and 570,000 hectares of forests can be saved every year in Kenya. Images: www.handsontv.info

Potential users

The domestic ceramic jiko can be used by rural and urban low income families that use fuelwood or charcoal for cooking.

The Kenya Ceramic Jiko is made of a ceramic liner fitted inside a metal case. The new stove, called the ceramic jiko, uses half the fuel that the older jiko stove uses. It is lightweight - it only weighs 3.6 kilograms - and it is easy to carry around (International Development Research Centre (IDRC), 1996).

The Kenya Ceramic Jiko could be widely and easily adopted because it is modelled on the traditional Kenyan metal stove design and requires no change in the methods of cooking or stove use.



Cross Section of the Kenya Ceramic Jiko

Appendix J: Categories of the IUCN Red List of threatened species (IUCN, 2007)

I. Classification

EXTINCT (EX) - A taxon is Extinct when there is no reasonable doubt that the last individual has died.

EXTINCT IN THE WILD (EW) - A taxon is Extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.

CRITICALLY ENDANGERED (CR) - A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future, as defined by any of the criteria (A to E) as described below.

ENDANGERED (EN) - A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future, as defined by any of the criteria (A to E) as described below.

VULNERABLE (VU) - A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the criteria (A to E) as described below.

LOWER RISK (LR) - A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories.

II. Example with two species of Mau

Species	Classification IUCN	Year assessed	Assessor
<i>Prunus Africana</i> (Hook f.) Kalkman (ROSACEAE)	VU A1cd	1998	World Conservation Monitoring Centre
<i>Juniperus procera</i> Hochst. ex Endl (CUPRESSACEAE)	LR/nt	1998	World Conservation Monitoring Centre

More precisely concerning the categorie **VULNERABLE (VU)**; a taxon is recognised as Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future, as defined by any of the following criteria (A to E):

- A) Population reduction in the form of either of the following:
- 1) An observed, estimated, inferred or suspected reduction of at least 20% over the last 10 years or three generations, whichever is the longer, based on (and specifying) any of the following:
 - a) direct observation
 - b) an index of abundance appropriate for the taxon
 - c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

- d) actual or potential levels of exploitation
 - e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.
 - 2) A reduction of at least 20%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on (and specifying) any of (b), (c), (d) or (e) above.
- B) Extent of occurrence estimated to be less than 20,000 km² or area of occupancy estimated to be less than 2000 km², and estimates indicating any two of the following:
- 1) Severely fragmented or known to exist at no more than ten locations.
 - 2) Continuing decline, inferred, observed or projected, in any of the following:
 - a) extent of occurrence
 - b) area of occupancy
 - c) area, extent and/or quality of habitat
 - d) number of locations or subpopulations
 - e) number of mature individuals
 - 3) Extreme fluctuations in any of the following:
 - a) extent of occurrence
 - b) area of occupancy
 - c) number of locations or subpopulations
 - d) number of mature individuals
- C) Population estimated to number less than 10,000 mature individuals and either:
- 1) An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, or
 - 2) A continuing decline, observed, projected, or inferred, in numbers of mature individuals and population structure in the form of either:
 - a) severely fragmented (i.e. no subpopulation estimated to contain more than 1000 mature individuals)
 - b) all individuals are in a single subpopulation
- D) Population very small or restricted in the form of either of the following:
- 1) Population estimated to number less than 1000 mature individuals.
 - 2) Population is characterised by an acute restriction in its area of occupancy (typically less than 100 km²) or in the number of locations (typically less than five). Such a taxon would thus be prone to the effects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critically Endangered or even Extinct in a very short period.
- E) Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

ABSTRACT

In Kenya as in many developing countries, some communities are living near the forest and depend on it. In the Mau Forest (Kenya), forest degradation is more common than forest improvement. The illegal exploitation of wood; as well excessive and destructive, is threatening the balance of the natural resource. As a result of that, forest cover has been deeply depleted in many parts of Mau forest. The objective of this study is to contribute to the success of the Forest Restoration in Eastern Africa, Indian Ocean Islands and Madagascar (Foreaim) project which will propose solutions to improve the state of forest resources.

In the context of the new Forest Act 2005 in Kenya, communities can be involved in the management of the forest. To restore the forest it is important to empower them, but before empowering communities, it is necessary to understand how they use the forest and what the causes of the forest degradation are. In this research, uses, forest practices and perceptions of forest communities are identified in order to understand their influence on the forest resources. Three villages with a different socio-economic context were studied: Nyakinyua, Bonde and Chepsir Tea Zone. Inventories of the forest adjacent to these three villages were carried out in order to link the identified uses and practices of the forest with its state.

The local population harvests trees for domestic uses but also as an income source. The main destructive activities are charcoal burning, farming and grazing in the forest. The communities' perception of the forest varies according to the environment and the forest uses. In Nyakinyua the forest state is alarming because it is intensively used. Beyond being degraded, some parts of the forest are deforested. In Bonde, the resource is relatively abundant but the uses are intensive. In Chepsir, the villagers depend less on the forest for their livelihoods and the forest is well conserved.

To restore the forest two main strategies are proposed: the *non residential cultivation* and *on-farm forestry*.

KEY-WORDS: Forest degradation – Rehabilitation – Forest Community – Mau Forest (Kenya) – Joint Forest Management – Perception – Practices