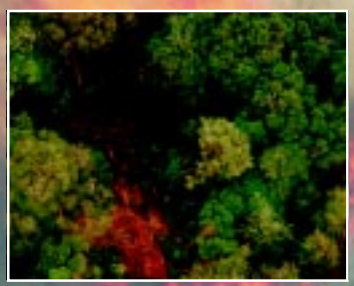

AERIAL SURVEY OF THE DESTRUCTION OF MT. KENYA, IMENTI AND NGARE NDARE FOREST RESERVES

Report prepared by

KENYA WILDLIFE SERVICE

August 1999

AERIAL SURVEY OF THE DESTRUCTION OF MT. KENYA, IMENTI AND NGARE NDARE FOREST RESERVES

FEBRUARY - JUNE 1999

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The back cover photograph is a composition of two photographs from the aerial survey.

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FOREWORD

Kenya is best known as a land of arid and semi-arid habitats with little forest. Sadly, the little that there is has been the focus of unplanned, usually illegal utilisation with disastrous consequences for bio-diversity, catchment and loss of soil. As a country, Kenya cannot afford to watch the remaining natural forests being destroyed. The forests are a critical and invaluable national asset that must be protected.

This report is clear and provides unequivocal data on the current situation. I hope that with such evidence, actions will follow to put an end to the wanton degradation of our nation's natural forests.

R.E LEAKEY

13 August, 1999

ACKNOWLEDGEMENTS

The aerial survey of Mt. Kenya, Imenti and Ngare Ndare forests was necessitated by the need to respond to public scrutiny and outcry on forest destruction. It is not possible to list all individuals, organisations and communities who expressed their deep concern. The Kenya Forests Working Group and administration submitted written requests to the Kenya Wildlife Service calling for the survey and the monitoring of forest destruction, respectively. The genuinely expressed concern and requests are gratefully appreciated.

The survey involved 53 intensive flight-hours over the forests in a two-seater Aviat Husky aircraft. This survey would not have been accomplished without the devotion and commitment of two people. Firstly, Mr. Bongo Woodley, Senior Warden Mt. Kenya, whose talented piloting skills and extensive experience in, and knowledge of the area made it possible to fly at very low altitudes above the mountain forest canopy and identify disturbances in the forests. Secondly, Mr. Christian Lambrechts from the Division of Environmental Information, Assessment and Early Warning of UNEP, who provided technical support during the survey and developed a Geographical Information System for Mt. Kenya forests. I am very thankful for all these.

The Forest Department made available its various Geographical Information System data sets to the survey. It also provided guidance and information during the ground-truthing exercise that followed the aerial survey. The support from the Forest Department is appreciated.

I would also like to sincerely thank UNEP for having allocated Mr. Lambrechts the time to work with me and also for allocating the much needed funds for printing the report.

FAO-Africover and GRID-Nairobi provided technical support in GIS data conversion. The Kuona Trust made its color printing facilities available to the survey. Their support is also appreciated.

Lastly but not least, the personal support and encouragement by both Dr. Richard Leakey and Mr. Nehemiah Rotich are gratefully acknowledged.

GIDEON N. GATHAARA

EXECUTIVE SUMMARY

The aerial survey of the destruction of Mt. Kenya, Imenti and Ngare Ndare forests was undertaken to provide a rapid systematic assessment and monitorable baseline information on these forests, as a sample to represent the other forests in the country. It was specifically carried-out in response to requests to Kenya Wildlife Service by various institutions, NGOs, including the Kenya Forests Working Group, conservationists and community groups.

Prior to carrying out the survey, consultations and awareness on the assessment were made with the Forest Department headquarters and field officers for purposes of organising the undertaking and to seek their support. The field work was carried out between February – June 1999 and was followed by ground validation.

Seven categories of forest threats were identified and details recorded and analysed. These include: Shamba-system, charcoal production, livestock grazing, logging of indigenous trees, growing of marijuana (*Canabis sativa*), landslides and fire occurrences.

The results have established that the whole of Mt. Kenya and Imenti forests are heavily impacted by extensive illegal activities leading to serious destruction below the bamboo/bamboo–podocarpus belt. Over 6,700 Camphor (*Ocotea usambarensis*) trees have been destroyed through logging whereas in the overall 14,662 indigenous trees have been cut. Over 75% of clear-felled plantations have not been replanted with tree seedlings, although all these areas are under the Shamba-system. Encroachment into edges of indigenous forests was recorded emanating from Shamba-system cultivated areas. Most of all the natural forests in the Lower Imenti have been destroyed and are under crop cultivation. In the lower part of the Upper Imenti forest, extensive past and on-going charcoal production was observed throughout this area, leading to extensive destruction of the indigenous forest. Marijuana (*bhangi*) cultivation is quite extensive totalling 200 hectares, and is being grown in the indigenous forest from the edges to deep inside and high up in the forest. The Ngare Ndare forest is impacted by illegal logging of Cedar, livestock grazing and fires. However, current pressures on this forest have not led to the same level of destruction as in many parts of Mt. Kenya and Imenti forests. Details of the results are provided in section VI.

The extensive destruction manifests negative long-term impacts, such as: disrupting wildlife habitat, destroying biodiversity, impairing water catchment and retarding forest sector development. All these would lead to impaired tourism development and retarded rural poverty alleviation. Furthermore, the destruction will lead to an increase in human / wildlife conflicts since the traditional migration patterns and habitats of the wild fauna have been greatly impacted.

A number of recommendations have been made in section IX in relation to this survey in order to provide the next building steps for intervention.

I. BACKGROUND

Human-induced threats to sustainable forest conservation and management in Kenya have reached critical levels, with long-term negative implications. The majority of the forests are now threatened by a wide range of destructive activities. In the recent past, the country has experienced widespread public outcry on the wanton and rampant destruction of its forests. Concerned parties, including institutions, NGOs, in particular the Kenya Forests Working Group, conservationists and community groups, have highlighted the need for a rapid assessment to inform stakeholders in general on the status and extent of forest destruction. The need to carry out a well documented survey on forest destruction has increasingly become necessary because, in many instances, public outcry on forest destruction, more often than not, results in counter-accusations and often becomes superficially refuted in the absence of concrete evidence.

Kenya Wildlife Service, cognisant of the urgency, financial difficulties and challenges that would arise in a country-wide study, recognised that the best way to respond to the need for a rapid assessment was to undertake a representative aerial survey. Mt. Kenya, Imenti and Ngare Ndare Forest Reserves were selected as the case study since they stand out prominently to illustrate the degradation wrought upon these valuable natural resources.

This report contains the results of the aerial survey carried out between February and June 1999. It briefly describes the surveyed forests and provides information on the methodology applied for the survey, some features pertaining to forest protection and aspects of forest plantation establishment in Kenya, as well as recommendations to address the current destruction of the forest reserves. It also recommends further aerial surveys to be undertaken for other threatened forests in the country.

II. GOAL AND OBJECTIVES

The main goal in carrying out the aerial survey mapping was to provide factual documentation of the extent and nature of specific and current human impacts on the forests of Kenya. The survey also provides both forest management personnel and stakeholders with baseline data for monitoring forest health and the effectiveness of policy and management decisions. Pursuant to this goal the specific objectives were to:

(a) Categorise the type, magnitude and pattern of forest destruction activities in Mt. Kenya, Imenti and Ngare Ndare forests as the chosen areas;

(b) Provide a well documented, systematic and factual assessment of the on-going forest destruction under survey;

(c) Identify and test a suitable and effective methodology to provide rapid baseline information on forest destruction that could be useful for better management;

(d) Enhance awareness of the current widespread forest destruction.

III. A BRIEF ON THE FOREST SECTOR

A. Overview

The total land area in Kenya is 582,644 Km^2 whose altitude varies from the coastal-forests at sea level to the forested mountains of Kenya, Elgon, Aberdares and the ranges of Cherenganis and Mau. The variability in altitude greatly influences changes in climate, natural vegetation and wildlife. This variability has far reaching implications on socio-economic and ecological interactions when the wider perspectives are taken into con-

sideration. The wide range of interactions and climatic conditions influence variations in agricultural potential across the country. Of the total land area, 20% is classified as medium to high agricultural potential, 10% potentially arable but subject to periodic drought. The rest is semi-arid or arid.

Forests and wildlife are critical natural assets for Kenya since the country is endowed with few other natural resources such as minerals. Forests, which comprise slightly less than 3% of the total land, are vital as both wildlife habitats and water catchment areas, and sources of water that support agriculture, the main GDP earner.

Indigenous closed canopy forests, and the wildlife therein, cover 1.2 million hectares whereas forest plantations area is approximately 160,000 hectares. These areas represent 10% of the high potential areas of Kenya. Forests and woodlands are important sources of economic, social and environmental benefits to the country especially for the local communities. They provide the rural population with building materials, softwood requirements for wood-based industries, 90% of the household energy consumption, fodder and fruits. Forestry and wood processing industries are estimated to provide direct employment to 35,000 people. In addition, forests provide catchment protection and are a major source of biodiversity.

Forests are a major habitat of wildlife which in turn is an important feature to the once thriving tourist industry that in 1995 accounted for 38% of foreign exchange earnings and contributed 8% of total employment in the country at that time.

B. Management

The agency with the direct mandate to spearhead forest sector development in the country is the Forest Department of Kenya; it takes the lead mainly in the field of forest management and extension services as provided by the forest policy and legislation. The main challenge that confronts the Department is the ability to respond effectively and promptly to people's increasing demands for forest products and services within the context of a rapidly changing 'environment'. This would only be effected fully in the long-term by: revising and putting in place the forest policy; enforcing new legislation; carrying out the requisite institutional restructuring; stakeholder participation, and seeking political goodwill.

C. Stakeholders

It has become widely acknowledged that comprehensive forestry development can no longer be pursued from a narrow perspective; rather, it should be promoted through multi-sectoral and integrated approaches as a measure to address the needs of all. Given this view, the main stakeholders in the forest sector and their area of interest, in brief, are listed as follows:

— KEFRI: research, training;
— NMK: research, cultural heritage and preservation;
— KWS: management, protection, tourism, focused limited research;
— Local community: resource owners, beneficiaries, indigenous property rights;
— Nyayo Tea Zone Corporation: rural employment creation;
— International community: donors, global interests;
— Universities: education;
— Conservation NGOs (local and international): lobbying, technical and financial support, training;
— Private sector: forest products and services business;
— Herbalists and other users: indigenous knowledge and herbal medicine.

New entry points to suit the needs for increased scope of stakeholders and their emerging needs shall be supported through implementation of new and revised policies and legislation.

VI. BRIEF DESCRIPTION OF MT. KENYA, IMENTI AND NGARE NDARE FORESTS

A. Overall description

Mount Kenya is located on the equator 180 Km north of Nairobi. It is a solitary mountain of volcanic origin with a base diameter of about 120 Km. Its broad cone shape reaches an altitude of 5199 m with deeply incised U-shaped valleys in the upper parts.

Mount Kenya area is characterised by two rainy seasons from March to June and from October to November. The amount of rainfall on the mountain ranges from 900 mm in the North to 2300 mm on the south-eastern slopes which are exposed to the dominant wind blowing from the Indian Ocean

Various vegetation zones can be distinguished on Mount Kenya. Forest vegetation covers the major part of the mountain. Most of the indigenous forest is protected within the forest reserves with some small areas falling within Mt. Kenya National Park. The three most important and closely linked forest reserves on Mt. Kenya are covered by this survey. They are Mt. Kenya, Imenti and Ngare Ndare Forest Reserves.

Due to the wide range of altitude that spans the indigenous forest (from 1200 m to 3400 m) and the major climatic differences between the slopes, the forest vegetation of Mt. Kenya is characterised by a high diversity of forest types.

B. Water catchment

Mount Kenya plays a critical role in water catchment for the country and is one of the five main "water towers" of Kenya with Aberdare Range, Mau Complex, Cherangani Hills and Mt Elgon, all providing most of the nation's water.

North east to south west Mount Kenya is the catchment for the Tana River, while the western and northern slopes form the catchment for the Ewaso Nyiro River. The Tana River is Kenya's largest river and drains into the Indian Ocean. Its course supplies water to numerous hydropower stations, as well as to major irrigation schemes such as Mwea rice scheme, Bura settlement scheme and Tana Delta irrigation scheme. The Ewaso Nyiro River drains into the Lorian swamps and is the main river crossing the semi-arid Laikipia plateau and the Samburu plains and deserts beyond.

Table 1: Water Discharge per Sub-catchment Area

Sub-catchment	Discharge	
	February 1984	***May 1984***
Peak zone	78 l/sec	43 l/sec
Moorland zone	6 l/sec	12 l/sec
Forest zone	42 l/sec	58 l/sec
Mountain Slope Zone	-38 1/sec*	-18 l/sec*
Savannah zone	-67 l/sec*	-31 l/sec*

Adapted from Decurtins, 1985

* Negative values indicate water absorption

The indigenous forest zone plays a predominant role in the water catchment function of Mt. Kenya. Like any other surface in the way of moisture-laden wind and clouds, indigenous forests cause precipitation in the form of rain and mist. But the actual surface of indigenous forests is much larger than any other surface, being composed of an intricate network of trunks and stems, branches and leaves. Because of this, these forests act like a net, catching more moisture than, for instance, forest plantation, bushland, cultivated areas or bare rock. Moreover, indigenous forest soils, due to their high organic matter content, absorb considerable quantities of water. Therefore, such indigenous forests act as a buffer: they store large amounts of water, slowly releasing it in the forms of streams and rivers, whereas other

surfaces have much less storage capacity and release water almost as soon as it has precipitated (Beentje, 1991).

This has been evidenced in a study of the Naro Moru River on the West slopes of Mt. Kenya (Decurtins, 1985) where most of the water in the dry season is provided by the sub-catchments of the peak zone (78 litres per second) and the forest zone (42 litres per second) (Table 1). The contribution of the peak zone in the case of the Naro Moru River is exceptional since the river has the most extensive glaciated area of all rivers around Mt. Kenya. Measuring campaigns were carried out in 1985 on nine other rivers (Decurtins, 1988). These campaigns confirmed the key role of the forest zone as water catchment.

C. Biodiversity

Mt. Kenya forests present a rich biological diversity, not only in terms of ecosystems but as well as in terms of species, in particular plant species.

The wide range in altitude clines and rainfall cline contributes to the highly diverse mosaic pattern of Mt. Kenya forests of which the following major types can be distinguished (Table 2).

The diversity in flora on Mt. Kenya is high. A number of studies of the flora and vegetation of Mt. Kenya and the mountain regions of East Africa have been undertaken since 1885. In the latest and more comprehensive study undertaken between February 1992 and August 1994 some 882 plant species, subspecies and varieties belonging to 479 generis of 146 families were identified on Mt. Kenya (Bussmann, 1994). Mt. Kenya has 81 plant species that are endemic (KWS, 1996).

Table 2: Mt. Kenya's major forest types

Major forest types	Location	Altitude (m)	Area (ha)
Newtonia Forest	East	1200 – 1800	3,500
Croton-Brachylaena-Calodendrum Forest	North East / South West	1450 – 1850	3,000
Croton Sylvaticus-Premna Forest	North (Upper Imenti Forest)	1500 – 1800	1,600
Juniperus Olea Forest	West / North West	1800 – 2300	7,300
Ocotea Forest	East / South	1900 – 2400	27,500
Mixed Podocarpus latifolius Forest	West / East	1900 – 2800	68,000
Juniperus-Nuxia-Podocarpus falcatus Forest	West	1950 – 2250	3,500
Bamboo zone	South West	2400 – 3000	80,000

Source: Beentje, 1991

The most common species of large trees on Mt. Kenya include Camphor (*Ocotea usambarensis*), Cedar (*Juniperus procera*), Wild Olive (*Olea europaea*), Meru Oak (*Vitex Keniensis*), Podo (*Podocarpus latifoli*us), East African Rosewood (*Hagenia abyssinica*), Croton (*Croton macrostachyus*), Mugumo (*Ficus thonningii*).

Mt. Kenya has a wide variety of wildlife, but no comprehensive description of the forest fauna has been published yet, although Alpine fauna has been described by Coe and Foster in 1972 and by Young in 1993.

Moreau compiled a species list in 1944. The KIFCON Programme in conjunction with the National Museums of Kenya (NMK) published "Mammals of Mt. Kenya and its Forests, a Preliminary Survey" in 1993. The KWS Elephant Programme conducted a survey principally of large mammals (Reuling in 1992 and Litoroh in 1993). Individual species of large mammals have also been the subject of research: leopard and elephant (Vanleeuwe, on-going).

Six species of large mammal of international conservation interest occur within the Mt. Kenya forests - elephant (*Loxodonta africana*), black rhinoceros (*Diceros bicornis*), leopard (*Panthera pardus*), giant

forest hog (*Hylochoerus meinertzhageni*), bongo (*Tragelaphus euryceros*), black-fronted duiker (*Cephalephus nigrifrons hooki*).

Also present are about twelve species of ungulates, such as bushbuck (*Tragelaphus scriptus*), suni (*Neotragus moschatus*), red duiker (*Cephalophus harveyi*), grey duiker (*Sylvicapra grimmia altivallis*), defassa waterbuck (*Kobus ellipsi prymnus*), mountain reedbuck (*Redunca fulvorufula*) and cape buffalo (*Syncerus caffer*).

Various primates also occur, the common ones being the black-and-white colobus (*Colobus guereza*), sykes monkey (*Cercopithecus mitis*) and the olive baboon (*Papio anubis*).

D. Economic benefits

Total environmental accounting for all goods and services provided by a forest ecosystem continues to draw debate world-wide. In an attempt to attribute economic benefits to Mt. Kenya forests, Lucy Emerton assigned a total value of Ksh 2 billion per year (Emerton, 1997). This estimate excludes ecological, option and existence values. The bulk of this value is comprised of watershed catchment protection and domestic use benefits. She justified that it is not possible to make an overall statement about its economic profitability.

E. Tourism potential

Mt. Kenya has a very attractive scenery that is highly appreciated by tourists. Although Mt. Kenya is as yet undeveloped as a recreational and tourist destination, it attracts both domestic and international visitors, including climbers *en-route* to Mt. Kenya, walkers, bird-watchers and fishermen. During 1996 and 1997, there were a total of 14,000 (Emerton, 1997) visitors to Mt. Kenya National Park, 30 per cent of whom were overseas tourists. Surveys demonstrated that a high proportion of those visitors would be willing to pay entrance fees for the forest reserves of an average of Ksh 460 for residents and Ksh 1,100 for non-residents. The tourism potential of Mt. Kenya, if well developed, is high estimated at Ksh 50 million per year, and would go a long way in supporting economic development, including rural employment.

F. Cultural benefits

There are several cultural values attributed to Mt. Kenya by all the various groups of people living around the forest. The forest provides an important location for religion and other rituals for the people. A most interesting and unique characteristic attributed to the forest by the Embu, Meru and Kikuyu is that it is the traditional home of their God, Ngai, Murungu, whose presence is strongly associated with the peaks of Mt. Kenya. Prayers and rituals are carried out in several sacred areas in the forests in time of need, for example, to bring rain and bless the community. Many tree species including, *Ficus* ssp. *Indigofera erecta*, among others, are considered sacred and used in various ways. Other species are also used in many other ways, in particular, medicine and food, including honey production.

G. World Heritage Site

Mt. Kenya National Park was established in 1949 and became a Biosphere Reserve under the UNESCO Man and Biosphere Programme in 1978. Before then, Mt. Kenya forests had been declared as Forest Reserve in 1932. In 1997, Mt. Kenya National Park and the surrounding natural forests in the Forest Reserve were listed as a World Heritage Site. The World Heritage Committee inscribed Mt. Kenya on the list since it is internationally recognized as "one of the most impressive landscapes of Eastern Africa with its rugged glacier-clad summits, Afro-alpine moor lands and diverse forests, which illustrate outstanding ecological processes" (UNESCO, 21st Session of the World Heritage Committee, Naples, Italy, 1-6 December 1997). World Heritage Sites are unique and irreplaceable cultural and natural heritage areas of outstanding universal value, which are being granted specific protection to prevent their deterioration or destruction. Governments that are State Parties to the World Heritage Convention are primarily responsible to ensure the identification, protection, conservation and transmission to future generations of their cultural and natural heritage.

V. METHODOLOGY

The methodology of the aerial survey of the forests was derived from the long experience gained in aerial game counts carried out by KWS and DRSRS, where the area being surveyed is overflown by an aircraft following set transects.

The aircraft used in the forest survey was an Aviat Husky. The crew was composed of two persons, the pilot and the rear-seat observer (RSO). The airfield and base of operations was Mt. Kenya National Park HQ near Naro Moru.

The aircraft was equipped with a Global Positioning System (GPS) Trimble Pathfinder Plus Model which was able to track the flight path of the aircraft on a "rover file", and was set to record position every 10 to 15 seconds. The interval was adjusted according to how much memory remained in the GPS, this being a limiting factor. This recorded a detailed and accurate map of the actual flight paths and included the exact pattern of circling each time the aircraft left the transect in order to get a better look at the extent of damage or threat observed and recorded. Furthermore the exact position of each observation was recorded as a waypoint in the GPS waypoint file for later downloading into a Geographical Information System (GIS) database. All recorded information having been geo-referenced will serve as a baseline for future reference monitoring. The baseline information is deposited in the office of the KWS Forest Conservation Programme Coordinator.

Damages and threats to the forest observed were recorded as follows:

- Charcoal production
- Cultivation of marijuana (*Cannabis sativa*)
- Fire occurrences
- Shamba-system practices
- Grazing of livestock
- Logging of the following indigenous trees:
  - Camphor (*Ocotea usambarensis*)
  - Cedar (*Juniperus procera*)
  - Wild Olive (*Olea europeae*)
  - East African Rosewood (*Hagenia abyssinica*)
- Logging of other indigenous tree species
- Landslides

A. Survey blocks

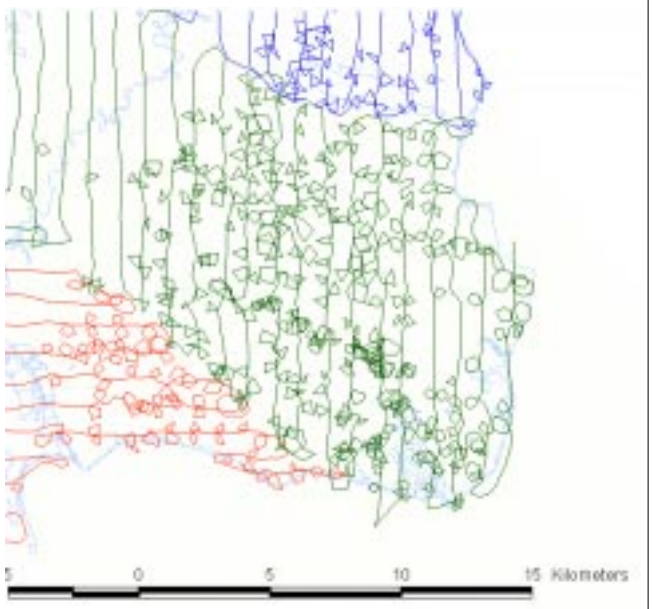
The area covered by the aerial survey included the entire Mt. Kenya Forest Reserve the Upper and the Lower Imenti Forest Reserves as well as the Ngare Ndare Forest Reserve. The area was divided into 9 blocks (Map 1). These blocks were demarcated by easily discernible boundaries such as rivers and roads, and for this reason provincial/district boundaries were not used. The survey required over 52 hours of flight time (Table 3, pg. 8).

B. Selection of flight paths

Flight paths were selected so as to limit climbing or descending along each transect. They were run east-west (or vice-versa) or north-south (or vice-versa) depending on the main orientation of the contour line in each block (Map 2).

Transects were spaced from between 0.5 to 1 kilometre, depending on the extent of the damage encountered. In the higher parts of the Mt. Kenya Forest Reserve, which are dominated by undisturbed bamboo or bamboo and podocarpus stands, transects were separated by one kilometre. In areas moderately disturbed, closer transects separated by 500 metres were applied in order to better document the disturbance activities in the forest. In heavily disturbed areas, figures of eight were carried out alongside the transects to enable a more thorough survey of the disturbances (Figure 1). However, in the latter case, transects were separated by one kilometre and not 500 metres in order to avoid overlapping while flying the figure of eight between two adjacent transects.

Figure 1: figures of eight over the south eastern slopes



C. Data recording

The pilot was responsible for navigation and recording each observation into the GPS. The RSO was responsible for taking photographs, and recording on a data sheet the information related to each observation in consultation with the pilot. Jointly with the pilot, the RSO was to spot and assess disturbance in the forest.

GPS positions of observed disturbances are affected by the in-built imprecision of the GPS system, as well as the time lapse between eye observation and direct subsequent logging of the actual position into the GPS. As such, GPS position of disturbances may be slightly off the actual position on the ground and those GPS positions of disturbances on the edges of the forest reserves may appear on the maps slightly outside the boundaries.

The recording of disturbance was restricted to aircraft aerial visibility since disturbance concealed by the canopy was not seen. Tall trees, deep valleys, obscure angles and sunlit tree tops enhancing dark shadows all affected what the pilot and RSO actually saw and recorded. As such, the entire set of recorded observations provides an indication rather than the full extent of the actual disturbance.

For each observation, the following data were recorded: waypoint number as indicated on the GPS, type and extent of the disturbance, position relative to the aircraft (left or right), film and frame numbers as well as any comment made by the pilot or the RSO.

The extent of disturbances was estimated in terms of area in hectares for marijuana fields and extensively logged forest areas. The area of marijuana fields was estimated by counting how many football pitches (0.5 hectare) could fit in each of the fields under observation. To help eye estimation of the area of marijuana fields, a football pitch was overflown before surveying blocks where marijuana fields occurred. The same methodology was applied for small areas impacted by heavy logging.

For heavily logged forest areas of a large extent, a GPS position was taken for every kilometre of impacted area. The extent of heavily logged forest areas was estimated by multiplying the distance between two GPS positions (one kilometre) with 500 metres or one kilometre depending on whether the forest area surveyed was heavily damaged on half the width (500 metres) or the whole width (one kilometre) of the transect.

The eye area estimate methodology applied in this survey could be affected to some extent by human subjectivity and thus represents a weak point on precision.

Table 3: Flight time and count time (Mt. Kenya National Park airstrip - Naro Moru)

Date	Take off	Landing	Flight time (hours)	Count on	Count off	Count time (hours)	Block
25-Feb-99	14:30	18:24	3:54	14:40	18:08	3:28	N
26-Feb-99	11:27	15:05	3:38	11:36	14:50	3:14	W
26-Feb-99	16:43	18:41	1:58	16:48	18:33	1:45	NW
27-Feb-99	12:13	18:16	6:03	12:18	18:13	5:55	NW
28-Feb-99	9:36	14:55	5:19	9:43	14:45	5:02	SW
28-Feb-99	16:05	18:09	2:04	16:14	17:56	1:42	SW
1-Mar-99	11:11	14:28	3:17	11:31	14:17	2:46	SW
1-Mar-99	15:29	18:07	2:38	15:55	17:37	1:42	E
15-Mar-99	9:18	13:55	4:37	9:45	10:24	0:39	E, NE
				10:38	13:30	2:52	SE
18-Mar-99	17:00	18:45	1:45	17:13	18:32	1:19	SE, E
16-Apr-99	15:16	17:34	2:18	15:31	17:20	1:49	SE
17-Apr-99	10:33	16:35	6:02	10:57	15:06	4:09	E
				15:17	16:10	0:53	NE
18-Apr-99	10:15	16:56	6:41	10:35	11:00	0:25	NE
				11:05	11:36	0:31	NE
				11:45	13:58	2:13	I
				14:10	16:34	2:24	NE
15-Jun-99	11:03	13:20	2:17	11:15	13:04	1:49	NN
	Total flight time:		**52:31**	**Total count time:**		**44:37**	

D. Photo records

Most of the observations are illustrated by photographs. In particular, each Shamba-system and each marijuana field are documented by at least one photograph.

E. Data processing in the field

Immediately on landing, the RSO down-loaded the GPS rover files as well as the observation waypoint files into a lap-top computer using Trimble Pathfinder software. Maps of the flight lines and the observation waypoints were then printed to identify any double observations within each block and to cross check with the flight lines whether the surveyed area was completely covered.

F. Data interpretation and analysis

Further analysis was carried out in Nairobi. All data were copied from the data-sheets to an Excel spreadsheet where they were merged with the GPS data (position, date and time). All the Excel data records were then transferred into a GIS using the ArcView v.3.0 software. GIS data from KIFCON (1991) and COMIFOR (1996) were used to provide forest boundaries and forest cover types.

Once the photographs were developed and printed, they were used to cross check the information recorded on the data sheets. In addition, ground validation of information regarding the Shamba-system was carried out after the survey.

VI. RESULTS OF THE AERIAL SURVEY

A. Overall description of current threats to the forests

Mt. Kenya forests are heavily impacted by illegal activities in all areas below the bamboo/bamboo-podocarpus belt (Map 3).

Mt. Kenya and Imenti Forest Reserves

The moist *Ocotea* forests on the south and south eastern slopes are undergoing serious destruction through extensive illegal logging of Camphor trees. Logging activities affect most of the broadleaved mixed forests and have by now reached the bamboo belt. Over 6,700 logged Camphor trees were counted, in addition to some 5,500 hectares where heavy logging made it impossible to count felled trees individually. In the lower areas bordering the Nyayo Tea Zone alongside the forest boundaries, no recent logging of Camphor trees has been recorded as these areas have already been depleted in the past, however, other tree species are now being targeted. Some 76 landslides were found in the heavily impacted *Ocotea* forests. Alongside the Ruguti and the Thuchi rivers up to over 21 kilometres deep into the forest, 138 marijuana fields were spotted covering a total area of some 200 hectares.

In the past, large areas of indigenous forests on the western and north-western slopes were clear-felled to pave way for forest plantation development using fast growing species, such as *Pinus patula, Pinus radiata, Eucalyptus saligna* and *Cupressus lusitanica*. The fragmented natural forests surrounding and between the plantations and the forest boundaries are heavily impacted by human activities, which include logging of Cedar and Olive trees, among other species, livestock grazing and the production of charcoal. Over 75 per cent of the clear-felled plantations are not replanted. Even when crops are cultivated under the Shamba-system, most often tree seedlings have not been planted.

On the drier northern slopes, logging of Cedar, Olive and Rosewood trees combined with livestock grazing and fires are the main threats to the narrow forested area still remaining between the moorlands and the wheat fields of the so-called “forest gap” existing between Mt. Kenya Forest Reserve and Ngare Ndare Forest Reserve.

The Upper Imenti Forest Reserve is also heavily impacted by large scale charcoal production and illegal logging. Over 1,800 charcoal kilns were counted in that forest. Most of the large areas of plantations clear-felled have not been replanted with trees. Potato fields that have not been inter-cropped with trees cover hundreds of hectares in those clear-felled forest plantation areas. The natural forest of the Lower Imenti is mostly decimated, with more than 90 percent of the tree canopy having been removed to provide land for crops, in particular potatoes, maize and beans.

Ngare Ndare Forest Reserve

The Ngare Ndare forest, with its extensive stand of cedar, is also affected by human activities although current pressures have not led to the same level of degradation as on many parts of the Mt. Kenya and Imenti Forest Reserves. The three major threats to this forest have been noticed: logging of Cedar, livestock grazing and fires.

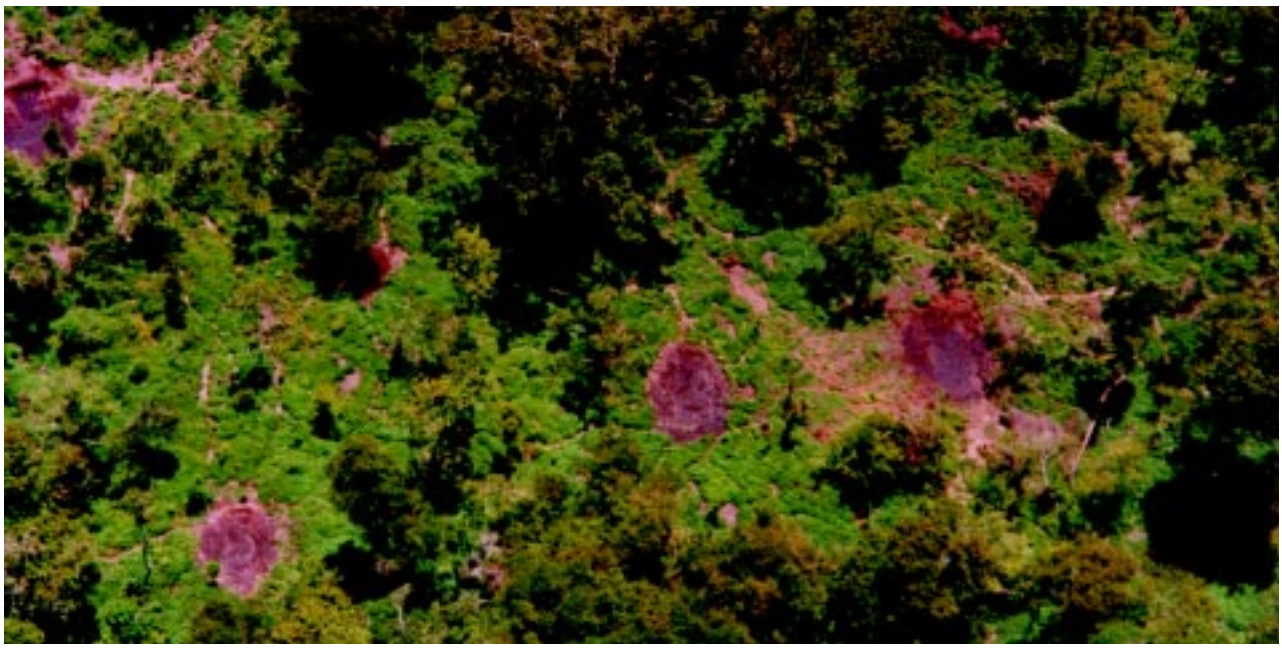
B. Charcoal production

Over 2,400 charcoal kilns were counted (Table 4). Some 1,800 were found in the Upper Imenti Forest Reserve leading to widespread destruction on the tree cover (Photographs 1 and 2). Most of the other charcoal kilns were seen in the fragmented natural forests on the lower western slopes of Mt. Kenya (Map 4). These fragmented forests are cornered between the forest plantations, including the Shamba-system and the human settlements lying just beyond the forest boundaries. Being located between areas with on-going human activities, these fragmented forests are more exposed to human pressure.

Photograph 1: Charcoal kiln and bags on the western slope

Table 4: charcoal production

Charcoal production	Extent (number of kilns)
Mt. Kenya Forest Reserve	622
Imenti Forest Reserves	1,842
Ngare Ndare Forest	1
Total	**2,465**



Photograph 2: Charcoal production in the Upper Imenti Forest Reserve

C. Cultivation of marijuana (*Cannabis sativa*)

Cultivation of marijuana in the indigenous parts of Mt. Kenya forests was recorded. 143 marijuana fields were spotted, covering a total area of approximately 200 hectares (Map 5). All marijuana fields were found alongside the Ruguti and the Thuchi rivers on the south-eastern slopes of Mt. Kenya (Map 5bis). They spread over 21 kilometres deep into the Forest Reserve. Five marijuana fields were spotted higher up in the pure bamboo stands. Marijuana fields are described in terms of area and status (Table 5). Identified status include: planted, partially planted, in preparation/ burned, old, overgrown/ abandoned, not planted and undetermined.

Photograph 5: Old marijuana field on a ridge

Photograph 3: Marijuana field on terraces

Photograph 4: Marijuana field in preparation

Table 5: Marijuana cultivation

Type of damage or threats	Extent	
	(Qty of fields)	(hectares)
Planted	25	18.7
Partially planted	33	54.2
In preparation / burned	53	48.3
Overgrown (by other vegetation)	21	41.0
Old	3	26.0
Not planted	2	4.5
Undertermined	6	6.0
Total	**143**	**198.7**

D. Fire occurrences

During the survey, 21 fire occurrences were spotted in the indigenous parts of the forests (Map 6), two of which were active (Table 6). Large burnings were found in the drier forest zones on the north western and northern slopes.

Table 6: Fire occurrences

Type of damage or threat	Extent (# of fires)
Fires (extinct)	19
Fires (active)	2
Total	**21**

Photograph 6: Impact of fire on the north western slopes

Photograph 7: Fire on the north western slopes (Gathiuru forest)

E. Shamba-system practices

Throughout historical time, the establishment of forest plantations in this country has, by-and-large, been achieved through the inter-cropping of tree seedlings with annual agricultural crops. This is a form of agroforestry practice in which management policy requirements call for the agricultural crops to be phased out in the third year of tree growth. By the third year, the tree canopy would usually out-shadow the normal growth of the agricultural crops. The "farmer" would then have to move out of the allocated plot and would be eligible for another plot, if available. This methodology was borrowed from the successful experience of establishing teak plantations through a similar practice, referred to as "the taungya system" in Burma; applied since the middle of the 19th century. During and since colonial times, Kenya adopted this system by giving it the name the "Shamba–system". Irrespective of the level of economy and technology of a country, successful establishment of plantations is one of the most expensive activities in forest sector development. The Shamba-system has been a strategy identified as a means to provide cheap labour - which later turned out to be totally free - in establishing forest plantations. At the same time, this would contribute to increased national food production and later led to creation of rural employment as the practice extended beyond resident workmen. The Shamba-system is nowadays referred to as "Non-Residential Cultivation".

Photograph 8: Natural forest between two Shamba-system areas, showing visible logging pressures on its edges

Photograph 9: Shamba-system not planted with tree seedlings but under potatoes in the Upper Imenti Forest Reserve (Mucheene forest)

Results of the survey

The survey recorded the status of forest plantation areas under the Shamba-system (Map 7). Four different statuses were identified: not planted with tree seedlings, partially planted with tree seedlings, planted with tree seedlings and not planted with tree seedlings and encroaching into natural forest (Table 7).

Table 7: Shamba-system practices

Status	Number of forest plantation areas	%
Not planted with tree seedlings	73	57
Partially planted with tree seedlings	14	11
Planted with tree seedlings	16	13
Not planted and encroaching into natural forest	24	19
Total	**127**	**100**

Photograph 10: Encroachment next to a Shamba-system on the south eastern slopes

Photograph 11: Shamba-system encroaching into natural forest in the south west (Kabaru forest)

Photograph 12: Shamba-system encroaching into natural forest on the south western slopes

F. Grazing of livestock

Livestock was predominantly found on the western and northern slopes of Mt. Kenya Forest Reserve, on the Upper Imenti Forest Reserve, as well as in Ngare Ndare Forest Reserve (Map 8). In total 4,258 heads were counted in the reserved forests. In the count, goats and sheep were grouped together under the category "shoats". In few cases, no distinction was made between cattle and shoats and both categories were merged into "Cattle/Shoats" (Table 8).

Table 8: Grazing of livestock

Livestock grazing	Mt. Kenya FR		Imenti FR		Ngare Ndare FR		Total
	No. of Heads	Average No. heads/herd	No. of Heads	Average No. heads/herd	No. of Heads	Average No. heads/herd	
Cattle	1,396	16	745	24	496	35	**2,637**
Shoats	531	31	270	25	560	56	**1,361**
Cattle/Shoats	260	12	0	-	0	-	**260**
Total	**2,187**	-	**1,015**	-	**1,056**	-	**4,258**

G. Logging of indigenous trees

The survey recorded fresh and old logging of indigenous trees in natural forest (Maps 9-13). Some of the most targeted species were identified separately. They include Camphor (*Ocotea usambarensis*), Cedar (*Juniperus procera*), Wild Olive (*Olea europeae*) and E.A. Rosewood (*Hagenia abyssinica*). Other indigenous tree species are grouped under the category "other indigenous tree species". In areas where logging was too intensive to enable the counting of logged trees individually, an estimate of the area affected is given and attributed to the dominant tree species targeted in that area. Fresh logging comprises logging that is assessed as being not more than three months old (Table 9).

Photograph 13: Logging of Camphor on the south eastern slopes

Table 9: Logging of indigenous trees

Tree species	Fresh logging		Old logging		Total	
	Number of trees	Area of heavy logging (ha)	Number of trees	Area of heavy logging (ha)	Number of trees	Area of heavy logging (ha)
Camphor	6,373	5,531	347	100	6,720	5,631
Cedar	1,313	1	319	11	1,632	12
Olive	227	6	14	6	241	12
Rosewood	5	0	19	0	24	0
Other ind. tree species	5,595	2,504	450	120	6,045	2,624
Total	**13,513**	**8,042**	**1,149**	**237**	**14,662**	**8,279**

Photograph 14: Logging of Camphor on the south eastern slopes

Photograph 15: Logging of Camphor. Heavily degraded area on the south eastern slopes.

Photograph 16: Logging of Camphor. Heavily degraded area on the eastern slopes.

Photograph 17: Fresh logging of Cedar and secondary vegetation regeneration on the north eastern slopes

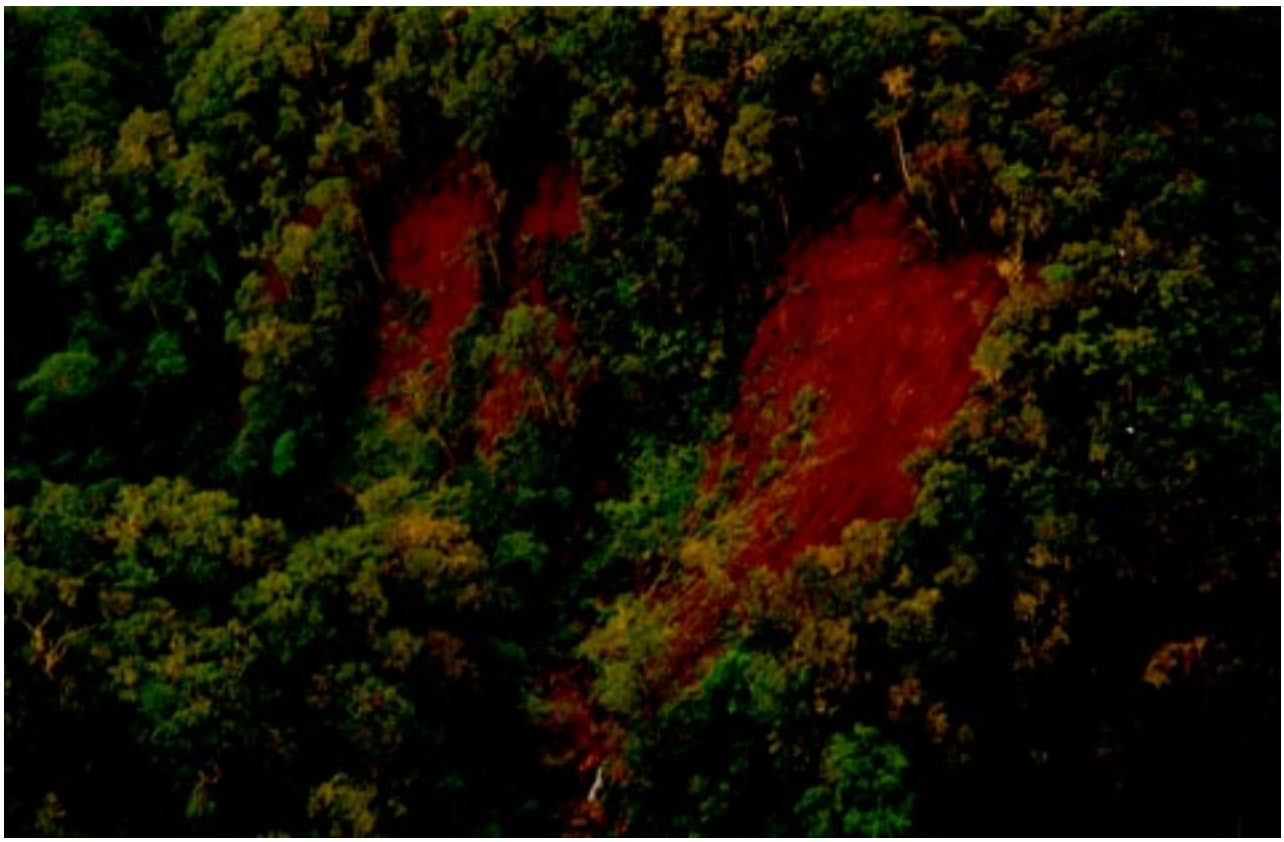
Photograph 18: Extensive destruction of the natural forest in Lower Imenti

H. Landslides

In total, 120 landslides were spotted and recorded (Map 14). Most of the landslides were found in the moist *Ocotea* forests in the southern and eastern slopes. The majority of their occurrence coincided with heavily logged areas (Table 10)

Table 10: Landslides

Type of damage or threats	Extent (number of landslides)
Landslides in heavily logged *Ocotea* forest	76
Landslides in other area	44
Total	**120**



Photograph 19: Landslides on the south western slopes

VII. SOME FEATURES PERTAINING TO FOREST PROTECTION AND ASPECTS OF FOREST PLANTATION ESTABLISHMENT

A. General overview

The aim of this section is to shed some light on a few salient features pertaining to forest plantations development as they relate to other aspects provided for, from time to time, with the intent of curbing forest destruction. Hopefully, this information will serve to provide a clearer understanding of why complications continue to persist to the present day in trying to resolve the issues at hand. This should also assist in re-evaluating previously instituted measures to control forest destruction in view of the emerging complications and implications that impact grievous threats to forest protection and conservation.

B. Shamba–system

There is justification to promote the Shamba-system, as outlined above in section VI on the Results of the Aerial Survey. The practice worked well until the late 1980s. However, serious problems associated with the practice have continued to emerge leading to unsuccessful implementation of the practice and contribution to the degradation of forests. The associated problems include:

- Abuse (corruption: "renting" land/plots to second parties; sabotage of planted seedlings by "farmers" to ensure continued presence on land);
- Extended farming that has suppressed timely plantation re-establishment;
- Poor enforcement measures due to inadequate supervision;
- Encroachment into indigenous forests;
- Increased pressure for shamba plot allocations as later politicised;
- Inability of the Forest Department to effectively monitor the Shamba-system, partly due to lack of resources.

The above problems have forced the government to suspend the practice from time to time. The last ban was issued in 1988 and was recently reinstated in 1997 after a period of 9 years.

C. Grazing and charcoal production

Grazing in forests, as a matter of practice, is provided for in the Forest Act (Cap. 385). As a management tool, this practice enables suppression of weeds in forest plantations, facilitating faster growth of the young trees, and reduces biomass that could otherwise pose fire hazards in the dry seasons. However, grazing would be detrimental in young plantations, particularly during the first three to four years, depending on the site. As a rule, goats are not allowed in forests due to their detrimental grazing and browsing habits. In addition to those categories of livestock that would be licensed to graze in the forest areas, they must, as a rule, be accompanied by a herder.

In the past, the Government has been forced to suspend the practice once it has gotten out of hand whenever the applicable rules and regulations have been glaringly flawed.

Charcoal production inside forest reserves is under ban owing to the fire risk it presents to ecosystems and the destruction of the tree cover associated with traditional charcoal production methods. Any production of charcoal in forest reserves is, therefore, illegal.

D. Presidential Ban on the Exploitation of Indigenous Forests of 1986

One of the most significant directives issued with the main aim of curbing forests destruction is the Presidential ban on the exploitation of indigenous forests of 1986. By 1986, destruction of forests in Mt. Kenya had reached a critical level that necessitated the government to institute measures to bring the matter under control. This led to the closure of forest operations in Mt. Kenya and culminated to the countrywide Presidential ban in 1986. Because no specific legislation or written instruction exists to enforce the ban, its implementation has been problematic (Marshall 1994).

From time-to-time licensees would put up a case claiming to be allowed to remove materials prefelled and paid for, that they had not been able to collect by the time the ban was announced. Individual cases were authorized on occasion but complications emerged as authorisation was abused and fresh logging took off again. Even though the ban was issued way back in 1986, individuals have continued to apply for permits that have been approved as recently as this year.

In order to meet market demand for timber following the ban, the Government has issued permits for the importation of indigenous timber from Tanzania and Uganda. This arrangement has been misused by dealers who have been using these permits as a cover to trade in the local market timber harvested illegally from Kenyan forests. The shortage in supply of indigenous timber created by the ban also prompted the market to respond by a price increase, which provided a further lucrative incentive for poaching high value indigenous trees, in particular, Camphor.

E. Presidential Pronouncement on Management of Indigenous Forests and Forest Plantations in 1997

In 1997, while addressing a *baraza* in Samburu, H.E the President announced that the management of indigenous forests would be vested with KWS, whereas the management of forest plantations would be undertaken by the Ministry of Natural Resources on a commercial basis. As no clearly defined government instructions or specific guidelines were made as a procedural follow-up for implementing the pronouncement, some confusion arose about which institution was ultimately responsible for the management of the indigenous forests.

F. Policy and Legislation

The forest sector is guided by Sessional Paper No.1 of 1968 (the Forest Policy) and the Forest Act (Cap. 385). It has become evident that there is an urgent need to revise the forest policy and legislation to bring them in line with the needs of today. Thus there is need to harmonize cross-sectoral policies and legislation that relate to natural resources. In enforcing new policies and legislation, it is apparent that institutional arrangements must be addressed. The much talked about restructuring would require careful consideration, and decisions should be implemented in a timely manner.

VIII. DISCUSSION OF RESULTS

A. Type, Magnitude and Pattern of Forest Destruction

The forest destruction recorded and analysed by the study fell under seven categories: fires, charcoal production, cultivation of marijuana, Shamba-system practices, livestock grazing, logging of indigenous trees and landslides. All these categories of destruction, apart from landslides, are directly human induced.

Fires and charcoal production:

Over 20 fire occurrences were reported, mostly in the open and dry natural forest areas. In forest management, it is known that most of the fire occurrences are caused by either arsonists or honey-gatherers and other forest users. Fire activities were evident in marijuana fields under preparation or burned. These activities are not included in the fire count. Charcoal production in forest reserves has been prohibited given the fire risks it presents to forest ecosystems and the associated extensive destruction of the tree cover. Intensive charcoal making, in various stages of production, was observed in the lower parts of the Upper Imenti Forest Reserve, whereby significant areas of indigenous forests have been destroyed. In the rest of the forests, charcoal production was mostly confined to forest boundary areas in the vicinity of farming communities.

Marijuana cultivation:

Marijuana cultivation and trafficking in Kenya is completely illegal. Marijuana fields are concentrated in the south eastern slopes along the Ruguti and Thuchi rivers. Growing of marijuana has been undertaken in a very comprehensive way to the extent that some of the fields are well terraced. Although some of the fields are located close to the reserve boundaries, their existence deep inside and high up in the forest is a strategy to prevent easy detection. The fields spread out in spots of areas ranging from 0.25 to 7 hectares. Some of them are close to each other while others are rather spread out. The total area of 198 hectares under marijuana cultivation is quite devastating since it entails total clearing of all indigenous forests, contributing to biodiversity loss and destruction of water catchment. In addition it has greatly interfered with wildlife habitat and migration patterns, more so because of the permanent presence of people guarding the fields.

Shamba-system and livestock grazing:

While Shamba-system and livestock grazing are provided for in the forest policy and legislation, they have come under Presidential ban on different occasions due to widespread abuse and mismanagement, to the detriment of sustainable forest sector development. These two practices are not under ban currently, but they have gone way out of control. Over 75 percent of clear-felled forest plantation areas are not under tree growing, either replanting was not successful or not undertaken at all. During ground validation foresters indicated that it takes nowadays between 5 to 10 years before replanting clear-felled forest plantations. The 1984 ban on Shamba-system, recently lifted, contributed to replanting backlog. During the survey, some of the Shamba-system plots were observed to have clear demarcation of some form of fence delineation, giving the impression of permanent crop cultivation. Of major concern is the high percentage (19%) of Shamba-system areas encroaching into surrounding natural forests. Riverine natural forests surrounded by Shamba-system areas are under particular pressure, where significant cutting of indigenous trees was observed. In addition, some large encroachments into natural forests also occur in the higher forest zones.

Logging of indigenous trees:

Large scale logging of indigenous forests exists today more than ever before despite the Presidential ban of 1986 which is still in force. The magnitude of forest destruction is very high, reported at over 14,000 trees within a very short span of time. Destruction of indigenous trees is still going on today at a high rate in Mt. Kenya even after the survey period. The results of the survey have illustrated that poaching of indigenous

trees is highest in the case of Camphor (*Ocotea usambarensis*) at 6,720 trees, which represents 46 per cent out of the 14,622 indigenous trees observed to have been cut. The *Ocotea* forest type, dominated by the Camphor tree species, occurs mainly in the wettest slopes, namely in the eastern and southern versant. This forest type occurs also in the Aberdares, Nyambeni Hills, and the Taita Hills. However, the *Ocotea* forest of Mt. Kenya is the largest block still in existence. This forest type is under extreme pressure. The situation in the Ngare Ndare forest is less alarming than in Mt. Kenya and Imenti forests. The fact that Ngare Ndare forest is fenced and benefits from the security patrols organised by Lewa Downs Estate has most likely contributed to the mitigation of human pressures in that forest. Logging also impacts heavily on the other unique forest types. Near Meru and on the south western slopes of the mountain, the *Croton-Brachylaena-Calodendrum* forest occurs; it is a rare type of forest in Africa with a total area of 6,200 hectares, of which 50 percent are to be found in Mt. Kenya. The *Newtonia* forest type occurs on the eastern slopes at lower altitudes (1200-1800m) near rivers and at lower forest edges. This is a rare forest type in Kenya and it is represented in Mt. Kenya by rather impoverished remnants that are very sensitive to any disturbances. The *Croton Sylvaticus-Premna* forest type near Meru in the upper Imenti forest at altitudes of 1500-1800m is only known to occur at this site. The *Juniperus-Olea* forest type occurring in the Western and Northern slopes are dominated by valuable hardwood species of Cedar (*Juniperus procera*) and East African Olive (*Olea capensis*).

Landslides:

120 landslides were observed in the natural forests in the survey area. The majority of the landslides were found to coincide with the heavily logged *Ocotea* forests in the southern and south eastern slopes. Most of the landslides appeared to be recent occurrences, most likely associated with the El-Niño event of 1997-98. However, the high occurrence of landslides in heavily logged areas suggests a possible correlation with extensive cutting of trees through trigger effect.

The magnitude of forest destruction has been established to be very high. In addition, a clearly defined pattern of destruction is self-evident in the reported seven categories, and it is well illustrated in maps 4 to 14. The established pattern would assist the management in identifying and strategising intervention measures. The latest comprehensive indigenous forest inventory report of 1994 recommended that all the forests should be given a resting time of not less than 15-20 years to allow them to recover. Moreover loss of habitat through forest destruction when combined with incessant poaching of most species is detrimental to the movement and range of wildlife that is as much under threat from such activities as the forest itself.

B. Methodology for Rapid and Systematic Assessment

The methodology used to carry out the aerial survey, as described in section V, was applied for the first time in Kenya to provide a rapid and systematic approach to closely survey an entire forest to the level of individual tree and livestock count. It also made it possible to estimate areas of focused activities e.g. Shamba-system and marijuana cultivation. The methodology applied has established baseline information very useful for further monitoring. Specific spot cases and category of destruction activities can now be closely monitored. Geo-referenced photographs enable cross-checking and further discussion of the type and extent of observed disturbances. They also provide factual evidence of destructive activities, and hence help to reject superficial refutations. Special forest operations shall be strengthened by this methodology and the current documentation produced in this survey. This shall assist both in developing strategies and back-up.

IX. CONCLUSIONS AND RECOMMENDATIONS

The survey has established monitorable baseline information on the on-going extensive destruction of Mt. Kenya, Imenti and Ngare Ndare Forest Reserves. It clearly illustrates that these forests are under extreme threats emanating from charcoal production, overgrazing, extensive illegal logging of indigenous tree species, abuse of the Shamba-system and pronounced encroachment into indigenous forests, including large-scale growing of marijuana. Clearly, effective and long-term measures to ensure forest protection are not in place at the moment. Sustainable forest management is faced with various difficulties that should be resolved urgently, both in the short as well as in the long-term. The difficulties can be attributed to: policy, legislation, institutional arrangement, finance and good governance in management. If timely protection measures are not put in place, these forests, the integrity of which is already in great jeopardy, could be decimated early in the next century. Of further concern is the numerous rare, endemic, threatened and endangered flora and fauna species and critical habitats. It is therefore recommended that:

Short-term measures

- Similar aerial surveys should be carried out for all other threatened forests;
- Best means to destroy all marijuana growing fields in the forests should be identified immediately through concerted and well coordinated efforts of all government arms;
- All Shamba-system areas encroaching into indigenous forests should be stopped forthwith;
- Special operations should be carried out in the forests to round up illegal material and bring to law those apprehended;
- The Government should provide support documentation with specific instructions and guidelines on all Presidential directives, other measures that have been issued, and those that will be issued in future, focusing on improved forest conservation and protection. This measure would facilitate harmonised and coordinated implementation of the directives, such as the 1986 Presidential ban on cutting of indigenous trees and the 1997 Presidential statement on management of indigenous and plantation forests.

Short/long-term measures

- The Shamba-system should be restricted to sites designated for tree planting within the year under plan and supervision should be stepped up. If the abuse of the Shamba-system persists, the system should be suspended;
- A crash replanting programme should be embarked upon in all clear-felled areas;
- Intervention measures should be identified and put in place to intercept transit illegal forest products and to address control in the local market of targeted indigenous tree species. This should involve all government arms and also seek support from the Lusaka Agreement Task Force;
- The applied methodology should be developed further to enable its wide application as a rapid monitoring tool;
- Further focused and detailed studies should be undertaken on, among others, the root causes of forest destruction and corresponding intervention measures, including the promotion of stakeholder participation (including local communities) in forest management and protection;
- All concerned stakeholders should actively seek political goodwill and support for the sustainable management and conservation of the remaining Kenya forests.

Long-term measures

- Kenya should provide a comprehensive list of rare, endemic, endangered flora and fauna species and critical habitats and should develop long-term strategic intervention measures both at the local and international levels;
- Forest areas destroyed should be rehabilitated;
- The boundaries of Mt. Kenya World Heritage Site should be revised in order to, *inter alia,* include all non-disturbed natural forests (see map 16);
- Integrated management plans for the World Heritage Site and the overall ecosystem should be developed using the zoning concept, followed by implementation;
- The revised forest policy should be assigned with a parliamentary sessional paper number and the revision of the legislation should be finalised forthwith, accompanied by requisite restructuring.

ABBREVIATIONS

COMIFOR:	Conservation and Management of Indigenous Forests (for Mt. Kenya)
DRSRS:	Department of Resource Surveying and Remote Sensing
FAO:	United Nations Food and Agriculture Organization
GIS:	Geographical Information System
GPS:	Global Positioning System
GRID:	Global Resource Information Database
KEFRI:	Kenya Forestry Research Institute
KFWG:	Kenya Forests Working Group
KIFCON:	Kenya Indigenous Forest Conservation Project
KWS:	Kenya Wildlife Service
NGO:	Non-governmental Organization
NMK:	National Museums of Kenya
RSO:	Rear-Seat Observer
UNEP:	United Nations Environment Programme
UNESCO:	United Nations Educational, Scientific and Cultural Organization

REFERENCES

Beentje, H.J., 1991. *Forest of Mount Kenya – Vegetation and Human Uses*, in: "Proceedings of the International Workshop on Ecology and Socio-Economy of Mount Kenya Area, Nanyuki, 5-12 March 1989"

Bussmann, R.W., 1994. *The Forests of Mount Kenya (Kenya) – Vegetation, Ecology, Destruction and Management of a Tropical Mountain Forest Ecosystem*, Dissertation zur Erlangung des Doktorgrades der Universität Bayreuth durch den Fachbereich Biologie, ChemieGeowissenschaften, Bayreuth, 1994

Decurtins, S., 1985. *Hydrogeographical Investigations on Mt. Kenya and its W and NW Slopes*, Laikipia Reports No.5, Institute of Geography, University of Berne.

Decurtins, S., et al., 1988. *Resources of River Water in Eastern Laikipia: River Water Potential and Rural Water Supply in Eastern Lakipia (Kenya) for Small Scale Farming*, Laikipia Reports No.12, Institute of Geography, University of Berne.

Emerton, L., 1997. *An Economic Assessment of Mount Kenya Forest.* A report prepared for EU Project 7 ACP KA009: Conservation and Management of Indigenous Forests. African Wildlife Foundation, september 1997.

Marshall, N.T. & Jenkins M., 1994. *Hard Times for Hard Wood: Indigenous Timber and the Timber Trade in Kenya.* Traffic International, Cambridge, 1994.

Annex: Maps 1 to 16

Map 1:	Survey blocks
Map 2:	Flight lines
Map 3:	Overall threats to the forests
Map 4:	Charcoal kilns
Map 5:	Marijuana fields
Map 5bis:	Zoom on marijuana fields
Map 6:	Fire occurrences
Map 7:	Shamba-system
Map 8:	Livestock
Map 9:	Logging of Camphor
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