# Baseline Survey of Woodland Utilization and Degradation Around Kakuma Refugee Camp

KEFRI/JOFCA PROJECT TECHNICAL REPORT NO.1

KENYA FORESTRY
RESEARCH INSTITUTE
(KEFRI)

# BASELINE SURVEY OF WOODLAND UTILIZATION AND DEGRADATION AROUND KAKUMA REFUGEE CAMP

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**Cover Photos:** Clockwise: Charcoal market at Kakuma Refugee Camp; Firewood market at Kakuma Refugee Camp; Women delivering charcoal at Kakuma refugee camp; and Harvested Prosopis for fencing destined for Kakuma Refugee Camp.

**Photos by:** J. Kariuki.

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# Summary

Kenya has over the years hosted a large number of refugees fleeing conflicts in their countries. Most of the refugees are hosted in camps located in Kakuma and Dadaab in the arid Northern parts of the country. A baseline study was carried out in Kakuma, Turkana district to assess the status of woodland degradation and fuelwood demand around Kakuma refugee camp, undertake analysis of institutions involved in exploitation of woodland resources and recommend mitigation measures. Kakuma refugee camp is located in a fragile environment and desertification was problem even before the arrival of the refugees. In an area where trees are the primary source of fuel, woodland degradation constitutes a problem for both locals and refugees. The study was carried out through woodland resource assessment and socio-economic survey. The resource assessment was done in five out of eleven administrative locations surrounding the refugee camp, and where firewood collection is active. Satellite imagery was also used to trace the sequence of vegetation degradation. A total of 19 plots were laid down in transects and vegetation status assessed. The socio-economic survey was done through structured questionnaires administered to 77 refugee and 72 local community members.

Results of the study showed that the presence of refugees in Kakuma area has negatively impacted the surrounding environment. There was a reduction in both densities of trees and other plants and, species diversity, the closer one gets to the camp. Satellite imagery before the establishment of the camp (1986) in subsequent years up to the year 2005 support the findings on the ground. Although they are not allowed to collect fuelwood, the demand created for wood energy by the refugees has led to proliferation of trade in firewood and charcoal between them and the local community. UNHCR provides about 20% of the refugees' energy needs through rations of firewood. The balance is sourced from the local community. Firewood and charcoal are the most popular sources of energy for the refugees, both providing about 95% of household energy needs.

To mitigate negative impacts of the refugees on the woodland resources, there is need to enhance the local community capacity in woodland resource management and rehabilitation, strengthen traditional environmental management systems, upscale rehabilitation efforts and enhance utilization of the invasive *Prosopis juliflora* for fuelwood and construction. There is also need to carry out study of the productivity of major tree species through deriving of biomass equations for the major tree species in order to assist in estimating the carrying capacity of land and allowable firewood extraction for sustainability.

Main recommendations include: Capacity building and ecological awareness within the communities and national institutions involved in natural resource management in the area; Woodland conservation and rehabilitation through up-scaling of current techniques, exploration of alternative vegetation recovery techniques and sourcing of fuelwood from southern Sudan and eastern Uganda. Other recommendations include facilitation of repair and replacement of the Maendeleo stoves and increase of their supply to the local community, use of alternative sources of energy such as wind and solar and utilization of the invasive *Prosopis juliflora* for fuelwood.

# ACKNOWLEDGEMENTS

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# LIST OF ACRONYMS

| | |
|---|---|
| **ACT** | Action by Churches Together |
| **FD** | Forest Department |
| **HOS** | Head of Sub-Office |
| **GoK** | Government of Kenya |
| **GIS** | Geographical Information System |
| **GPS** | Global Positioning System |
| **GTZ** | German Technical Co-operation |
| **IRC** | International Rescue Committee |
| **JOFCA** | Japanese Overseas Forestry Consultants |
| **KEFRI** | Kenya Forestry Research Institute |
| **LANDSAT** | Land Satellite |
| **LWF** | Lutheran World Federation |
| **SPLA** | Sudanese Peoples Liberation Army |
| **UNHCR** | United Nations High Commission for Refugees |
| **WFP** | World Food Programme |

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# 1.0. INTRODUCTION

The global refugee problem is massive and growing. In 1995 there were over 23 million refugees and a further 26 million people who were internally displaced within their own country (Owen and Grant, 1996). These refugee populations are found in most parts of the world but mostly in Africa, particularly east and Central Africa, which has a third of all refugees and two thirds of the internally displaced people. The environmental impact of these emergency settlements for refugees is often not recognized. In particular the use of wood and other biomass for fuel can be locally devastating as energy supplies are usually not among the first priorities addressed by relief agencies, which tend to focus initially on food, shelter, water and sanitation. Failure to make early arrangements for sustainable energy use and fuel wood supplies often means that, by the time the relief agencies come to address the problem, it acute. They are also unlikely to have the funds needed to determine and set up efficient long-term energy strategies for the refugee camps. Furthermore, scarcity of wood for fuel brings refugees into competition with local communities, and often leads to tension and even conflict.

Majority of refugees today are found in arid and semi-arid areas of the poorest countries of the world. The concentration of large populations in such areas leads to a tremendous strain on the fragile environments and on the meagre resources available. Under normal circumstances, local populations are free to move in search of more environmentally friendly areas. In the case of refugees, such liberty of movement is not usually available. Confinement of refugees within particular environments means that they must be cared for and assisted (GTZ/UNHCR, 1992).

Kenya has over the years hosted a large number of refugees fleeing conflicts in their countries. Most of the refugees are hosted in camps located in Kakuma and Dadaab in the arid northern parts of the country. The Kakuma Refugee Camp is located within Kakuma town in Turkana District. The camp was established in 1992 to cater for Sudanese refugees fleeing fighting between the Government of Sudan and the Sudanese People's Liberation Army (SPLA). In 1998, Kakuma II was opened primarily to cater for Somali refugees who were transferred from camps in Mombasa. In 1999, Kakuma III was opened to cater for more Sudanese refugees. However, Kakuma III has expanded to cater for refugees from other nationalities. By 2003, (Thor-Arne, 2003) *et al.*), the whole camp had expanded and covered an area of about 25 $km^2$. The number of refugees seeking asylum in Kakuma Refugee Camp had increased to over 80,000 by January 2007 (Table 1). Majority are from Southern Sudan (78%), Somalia (13%), and Ethiopia (6%). Other smaller groups include Burundians, Rwandese, Congolese, Eritreans and Ugandans (UNHCR).

The Refugee Policy of the Government of Kenya (GoK) currently provides for encampment of refugees. This arrangement provides for fewer opportunities for employment, business and local integration. This renders refugees more dependent on international humanitarian assistance for most of their survival and developmental needs.

*Table 1: Refugee populations in Kakuma refugee camp*

| Year | July 1996 | Aug 1996 | July 1997 | Aug 1997 | Oct 1998 | Jan 1999 | Aug 1999 | Jan 2007 |
|---|---|---|---|---|---|---|---|---|
| Population | 49822 | 33707 | 51487 | 47451 | 65115 | 69498 | 80117 | 80000 |

(Source – UNHCR 2007)

The United Nations High Commission for Refugees (UNHCR) is responsible for protection and assistance programmes in the camps whereas food aid is provided through World Food Programme (WFP). Lutheran World Federation (LWF) is a major partner agency in Kakuma handling camp management, food and non-food distributions, education and community services. International Rescue Committee (IRC) is responsible for implementation and management of health and nutrition programmes in the camp. It also provides programmes in savings and credit. GTZ-Rescue is responsible for firewood distribution and environmental rehabilitation within the camp.

In the developing world where woodfuel is the primary source of energy for most households, forest resources in and around the most heavily urbanized regions have been depleted. This phenomenon is no different from the situation in which large concentrations of refugees use fuelwood for cooking and wood for construction from the immediate surroundings. Current strategies to meet the cooking fuel requirements of refugees in Kakuma are focused upon the exploitation of local biomass resources. In a recent study, 94% of the refugees relied solely on firewood provided by UNCHR, which only met 30% of their total cooking energy requirements although the firewood distributed by UNHCR is intended to cover 35% of a family's needs (WFP, 2002). It is estimated that the daily firewood requirement per person in the refugee camps is 1.7 kilograms (Gitonga, 1996). For Kakuma this would translate to about 136,000 kg daily. Energy requirements are an important part of the refugee situation and severe shortages can lead to serious social and environments consequences. Measures being taken to reduce the impacts of refugees on the woodland vegetation fall into several inter-related categories, namely: nurseries and tree planting; woodlot protection and regeneration (greenbelts); distribution of improved stoves (Figure 1); environmental education and awareness creation (GTZ, 1992).

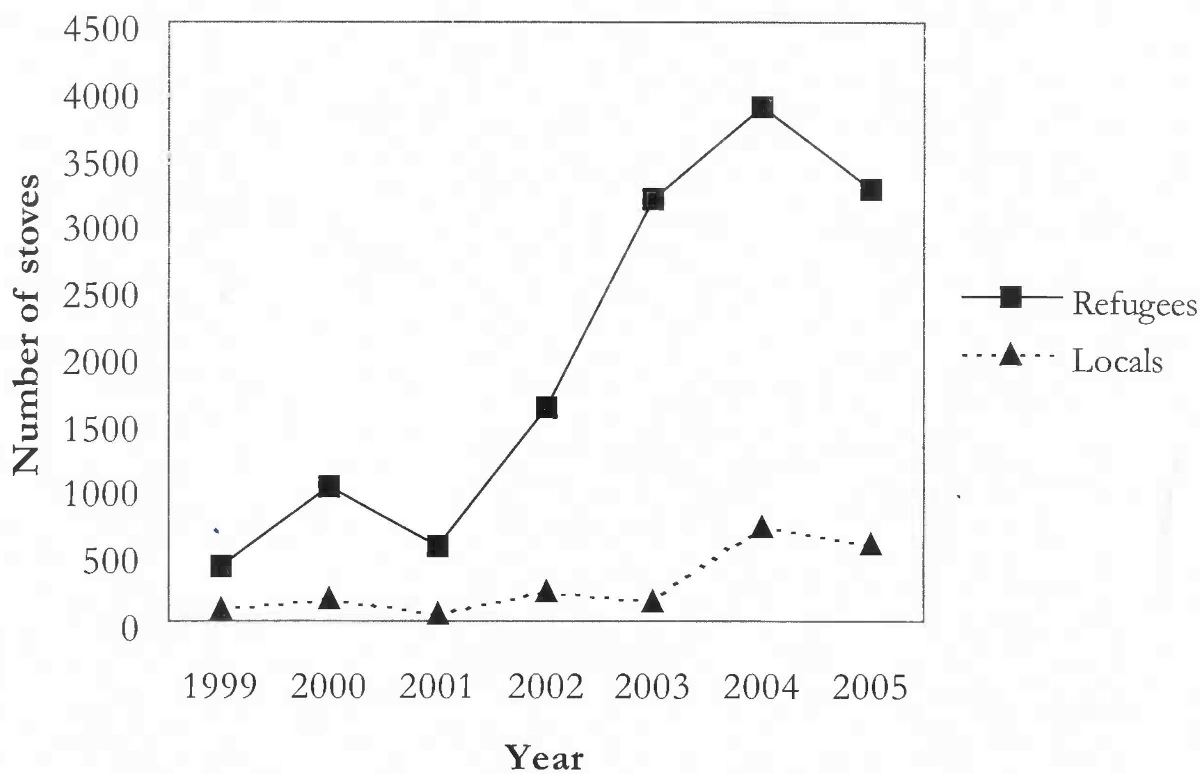



*Figure 1: Annual distribution of firewood saving stoves to refugees and the local community*

The area where Kakuma Refugee Camp is located was traditionally inhabited by the Turkana community whose livelihood depends on pastoralism. The sustainability of their existence has relied on their ability to move frequently across large areas. Kakuma refugee camp is located in a fragile environment and desertification was problem even before the arrival of the refugees. In an area where trees are the primary source of fuel, woodland degradation constitutes a problem for both locals and refugees. A study was undertaken to assess the status of woodland degradation around Kakuma refugee camp and recommend mitigation measures. The main objective was to carry out a baseline survey of woodland degradation and fuelwood demand around Kakuma refugee camp.

Specific objectives were:

- To assess impacts of Kakuma refugee camp on surrounding woodland vegetation
- To evaluate vegetation status around Kakuma refugee camp
- To undertake analysis of institutions involved in exploitation of woodland resources
- To assess the main factors influencing the rate of woodland utilization

# 2.0 METHODOLOGY

## 2.1. Study area

This study was conducted in three divisions of Turkana district namely; Kakuma, Oropoi and Turkwel, which form about a third of the District. The district borders three countries: Uganda, Sudan and Ethiopia. Its neighbouring districts in Kenya are West Pokot, Baringo Samburu and Marsabit District on the eastern shore of Lake Turkana (Figure 2). With nearly 77,000 km$^2$, Turkana is the largest district in Kenya. The district has a population of 497,779 ( GoK, 2002). The district lies between longitude 34° 0′ and 36° 40′E and between latitude 0° 30′ and 5° 30′ N (Figure 3). About 96% of the district falls under eco-climatic zones IV and VI i.e. the arid and very arid respectively (Adegi-Awuondo, 1990). Rainfall patterns and distribution are unreliable and erratic, with an annual average of 430 mm. The daily temperatures range from 24 °C to 38 °C (Government of Kenya, 1997). The main economic activity in the region is nomadic pastoralism. Livestock is kept mainly for food and sometimes sold or exchanged with other commodities.

The vegetation, mainly shrubs and acacia trees, is sparse. The district's low productivity and low population have led to its marginalization, poor status of social and economic services and infrastructure. The harsh climatic conditions and remoteness of the district has made the local community to be among the poorest in Kenya, with an absolute poverty of 74% (GoK, 2002). Recurrent droughts have exposed the local population to vicious cycles of famines.

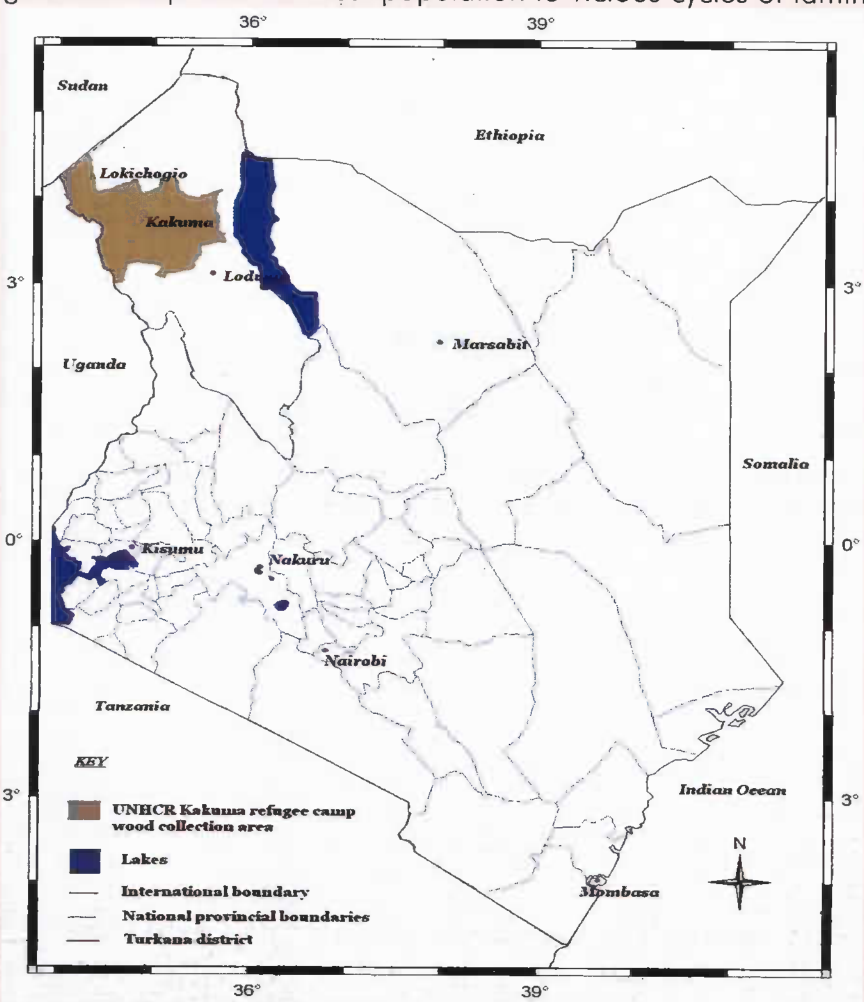
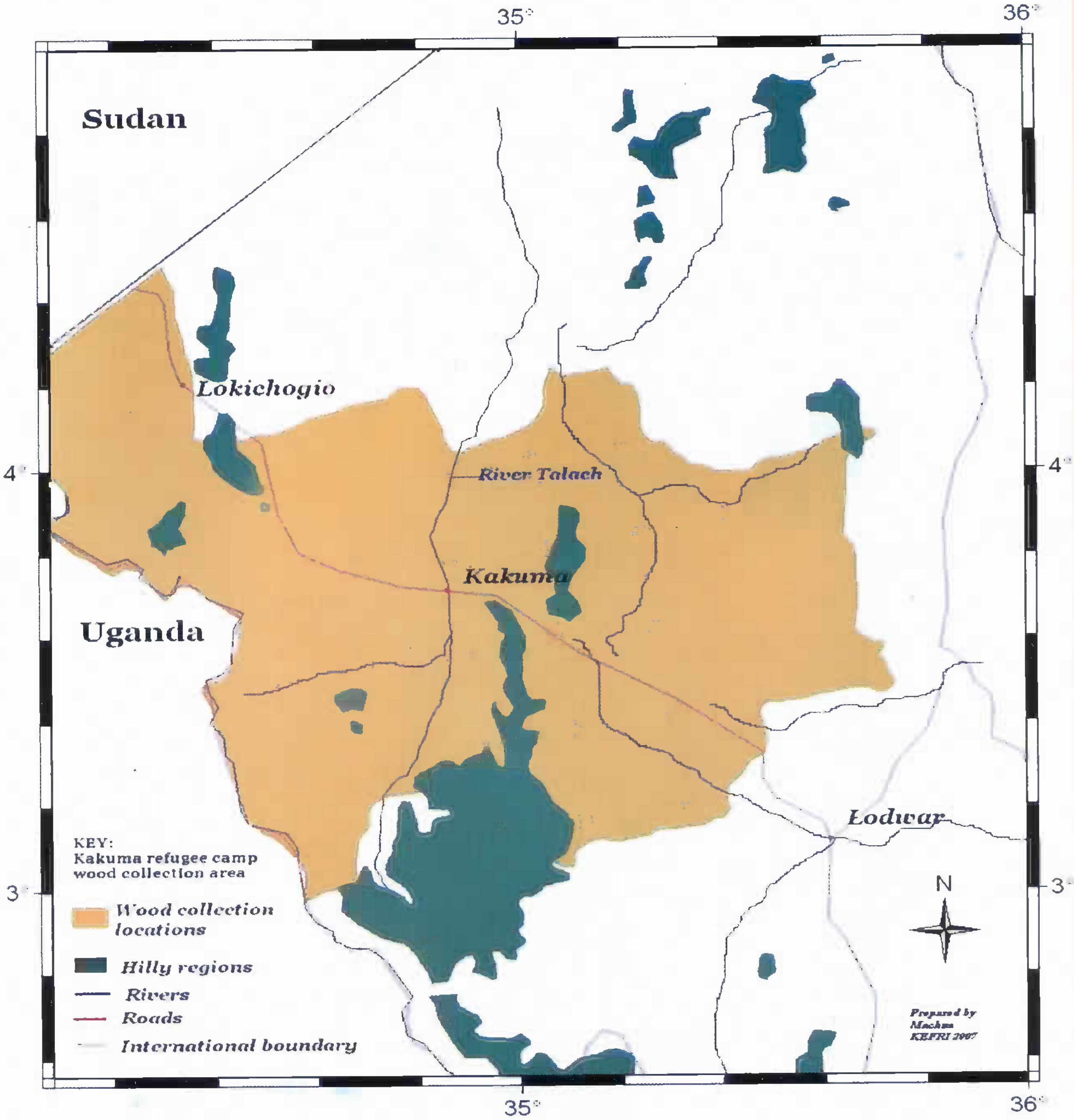



Figure 2: Location of study site within Kenya (Scale: 1:4,500,000)

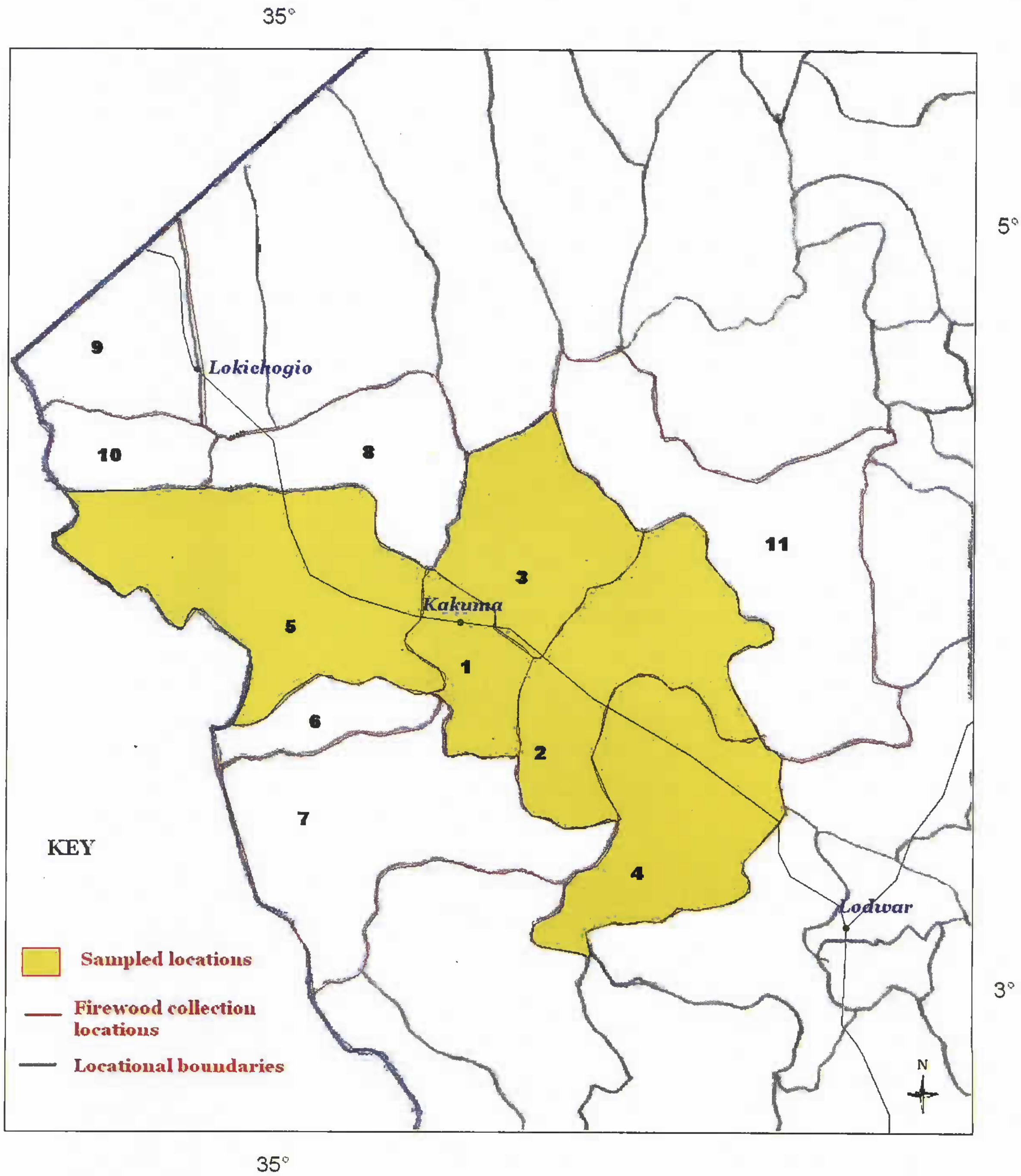



Scale: 1:1,200,000

Figure 3: Location of the study sites

## 2.2. Overall assessment of vegetation trends within the study area

Geographic Information Systems (GIS) was used to determine trends of temporal vegetation changes at various sites around Kakuma refugee camp. Geo-referenced Landsat colour composite images (Satellite imagery) of Kakuma region spanning nine years (1986 to 2005) were explored and interpreted. Ground truthing at several sites was subsequently carried out guided by the Global Positioning System (GPS).




Scale: 1:1,000,000

Figure 4: Locations selected within the firewood collection area
(1= Kakuma, 2=Nakalale, 3=Pelekech, 4=Lomeyan, 5=Kalobeiyei, 6=Loreng, 7=Letea, 8=Songot, 9=Lokichogio, 10=Loteteletit, 11=Kaeris)

## 2.3. Selection of sites

Firewood collection is active in eleven administrative locations around the Kakuma refugee camp. Of these, five were selected for the study (Figure 4). Within Kakuma location, plots were located in both riverine and woodland vegetation types whereas in the rest, all plots were located within the woodlands (Table 2).

*Table 2: Administrative locations with active firewood collection and the study*

| No. | Location | Division | Type of site | Status |
|---|---|---|---|---|
| 1 | Kakuma | Kakuma | Riverine | Selected |
| 2 | Nakalale | Kakuma | Woodland | Selected |
| 3 | Pelekech | Kakuma | Woodland | Selected |
| 4 | Lomeyan | Turkwel | Woodland | Selected |
| 5 | Kalobeiyei | Oropoi | Woodland | Selected |
| 6 | Loreng | Oropoi | Woodland | No |
| 7 | Letea | Oropoi | Woodland | No |
| 8 | Songot | Lokichogio | Woodland | No |
| 9 | Lokichogio | Lokichogio | Woodland | No |
| 10 | Loteteletit | Lokichogio | Woodland | No |
| 11 | Kaeris | Kaaling | Woodland | No |

## 2.4. Sampling design and plot layout and woodland resource assessment

A systematic sampling design with plot-transect was used in the study. Two 42-kilometre transects were laid down on either side of the refugee camp. One transect was laid from the camp eastwards, whereas the other from the camp westwards. On each transect, Five 50m x 20m main plots were located at 8-km intervals along the general direction of the main road. The main plots were marked along each of the two transects. The location of each plot was sited at least 200 metres from the main road. At each 8-km interval, the plot was on either side of the road at random. In addition, within the riverine ecosystem, two plots were laid out on each side of the refugee camp, to the North and South, respectively. Five other plots were located within areas of intensive firewood collection. The plots located along the riverine and the in areas of intensive firewood collection the woodlands were also used for ground truthing. In total, 19 plots were laid out (Figure 5).

The main plots were the sampling units for mature trees and stumps, where diameter of trees with minimum height of 1.3 m, and heights were recorded alongside the species names. Within the same plot, the number of cut stumps, height and diameter at the cut point were measured. Species of cut stumps were identified using bark characteristics. The sampling units for saplings were 20m x 5m plots nested at the center of the main plot. Heights of all saplings were assessed and the species identified. Seedling frequency of different species (Trees, shrubs), and percent vegetation cover (herbs and grasses) were assessed in two 5m x 2m plots randomly located at the diagonal corners of the main plot for indication of the regeneration potential of tree species and assessment of plant biodiversity (Figure 6).

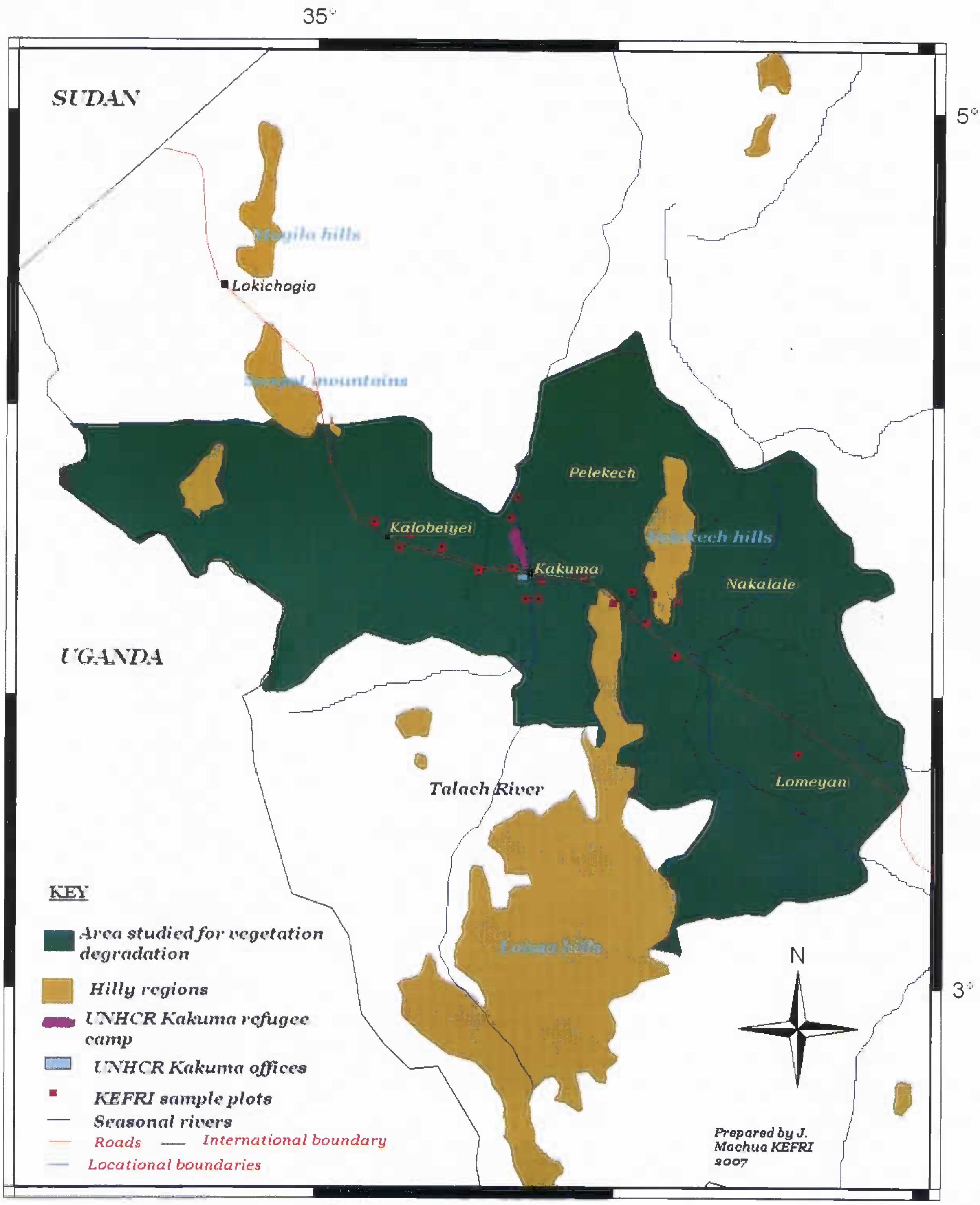



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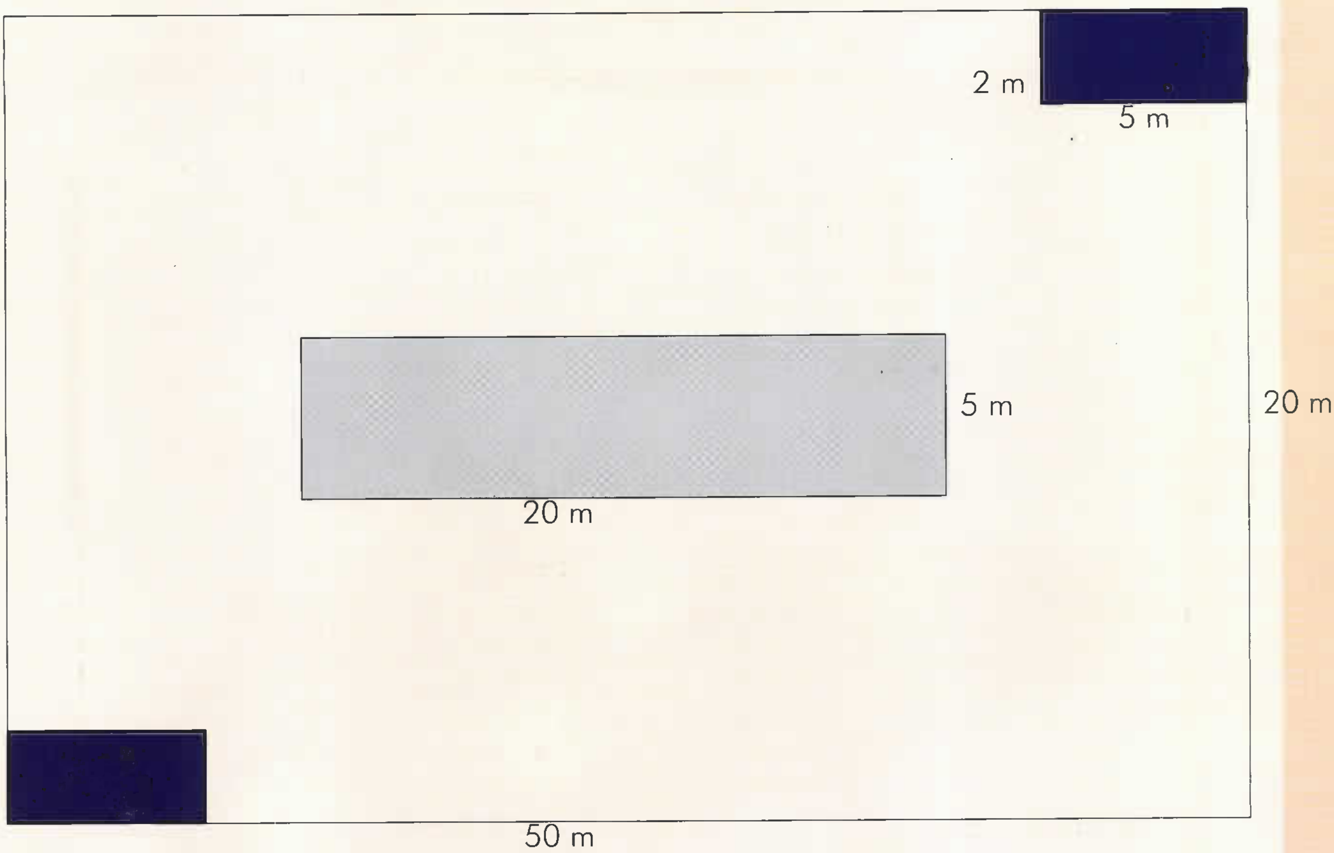
Figure 5: Distribution of sampling sites within the selected locations




KEY

Main plot of for assessment of all tree species and stumps (50 x 20m)
Sub-plot for assessment of saplings (20 x 5m)
Sub-plot for assessment of biodiversity (All plants) (2 x 5m) 2 plots

Figure 6: Plot layout used in the study (Modified Whittaker design)

## 2.5. Socio-economic survey

A Socio-economic survey was carried out among refugees, the local community using a checklists and pre-tested semi-structured questionnaires. In addition, interviews with staff working for development partners and government institutions involved in the management and conservation of woodland resources were conducted. A total of 150 randomly selected respondents consisting of 77 refugees drawn from the camp and 73 local community members living in Kakuma, Pelekech, Nakalale and Kalobeiyei locations were interviewed. The household was the sampling unit for the study. The information gathered included demographic characteristics of the respondent households, perceived status of the woodland resource utilization and constraints. In addition, the role of stakeholders involved in conservation and local capacity in woodland resources management was assessed. Primary data were complemented through observations and informal discussions.

## 2.6. Data analyses

Data collected in both woodland resource assessment and socio-economic survey were analyzed using SPSS and through cross tabulations using MS-Excel.

# 3.0. RESULTS AND DISCUSSION

## 3.1. Vegetation trends

The satellite imagery indicated a remarkable vegetation decline of the original vegetation over the years, particularly the riverine vegetation as depicted by changes in maroon colouration (Figures 7, 8 and 9). This was confirmed by ground truthing where composite colour was consisted over time. These were found to be undisturbed *Acacia tortilis* dominated vegetation. Consecutive satellite images for the years 1986, 2001 and 2005 for site A (A86, A01, A05) and site C (C86, C01 and C05) indicated areas where *Acacia tortilis* forest had gradually been degraded., *Prosopis juliflora* was found to have invaded these areas as indicated by letter D (Figures 8 and 9) for 2001 and 2005. For Nadapal (B86, B01 and B05) the satellite imagery indicated an increase in vegetation cover by 2001, which had disappeared by 2005. However, during the ground truthing, this was confirmed to have been a *Prosopis juliflora* invasion which was subsequently cleared through a "Work for Assets' program By 1986, the area presently occupied by Kakuma refugee camp (delineated by a yellow line in 2001 and 2005 images) was an *Acacia tortilis* riverine forest (Figure 7). The images show a temporal degradation by 2001. By 2005, the original forest had been replaced by the camp.

Plate 1: Typical vegetation around Kakuma

## Kakuma 1986

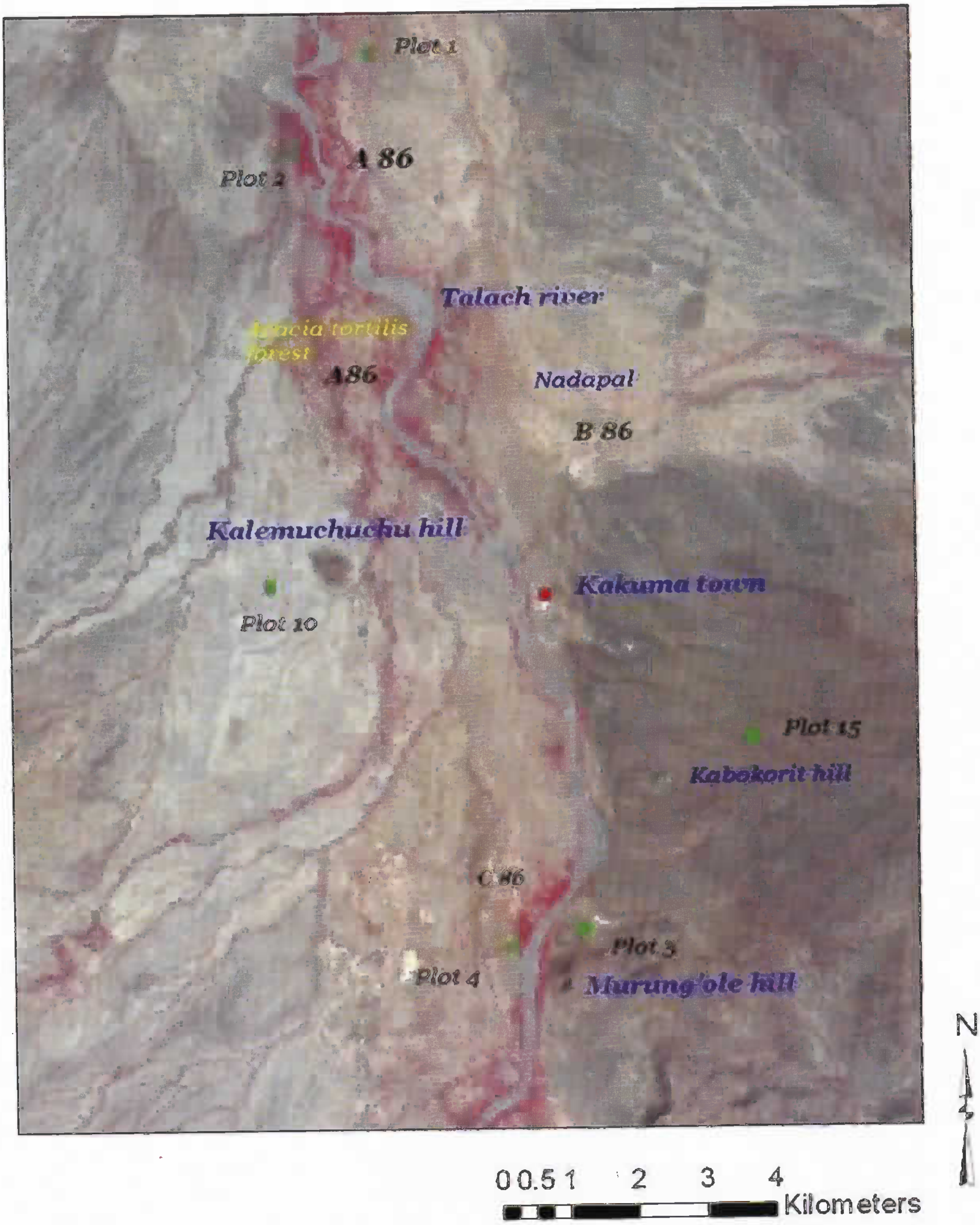



Figure 7: A 1986 LANDSAT colour composite imagery of Kakuma area

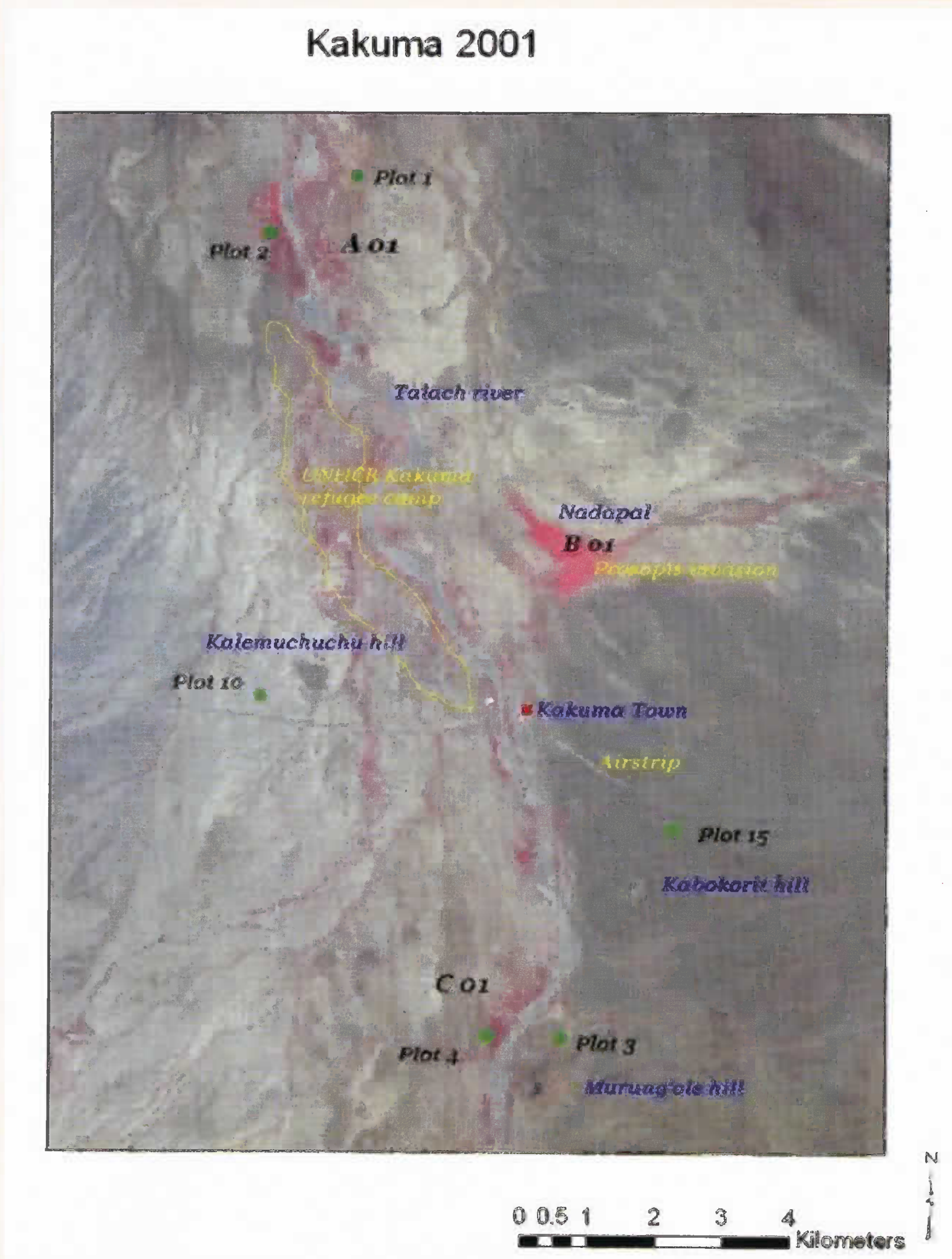



Figure 8: A 2001 LANDSAT colour composite imagery of Kakuma area

Kakuma 2005

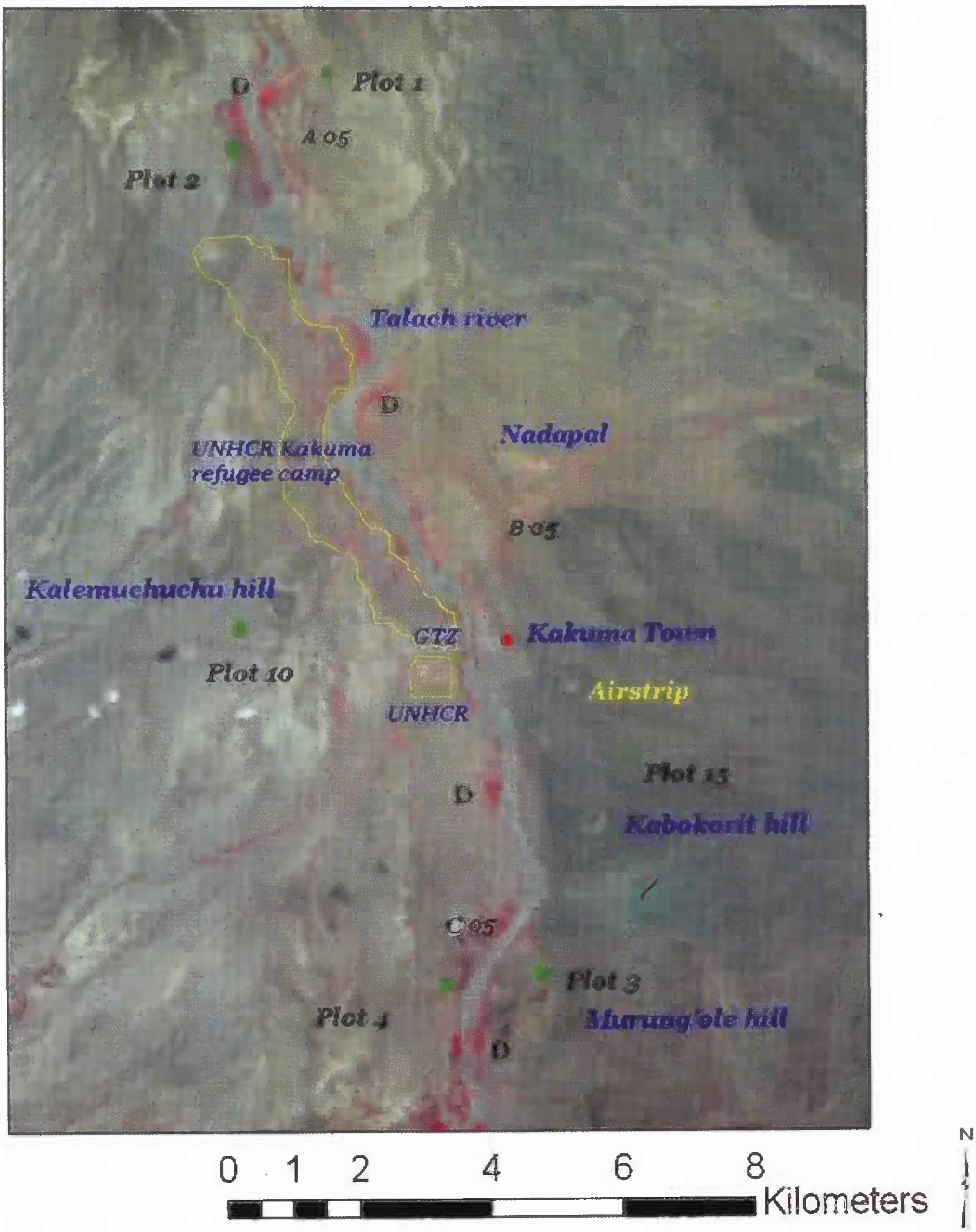



Figure 9: A 2005 LANDSAT colour composite imagery of Kakuma area

## 3.2. Vegetation status

### *3.2.1. Mature trees*

Sixteen tree species were found in the study area out of which *Acacia reficiens* and *A. mellifera* had a major occurrence in the woodlands. *A. tortilis* was mainly found within the riverine sites. Other species of notable occurrence were *Boscia coriacea* and *Salvadora persica* (Figure 10).

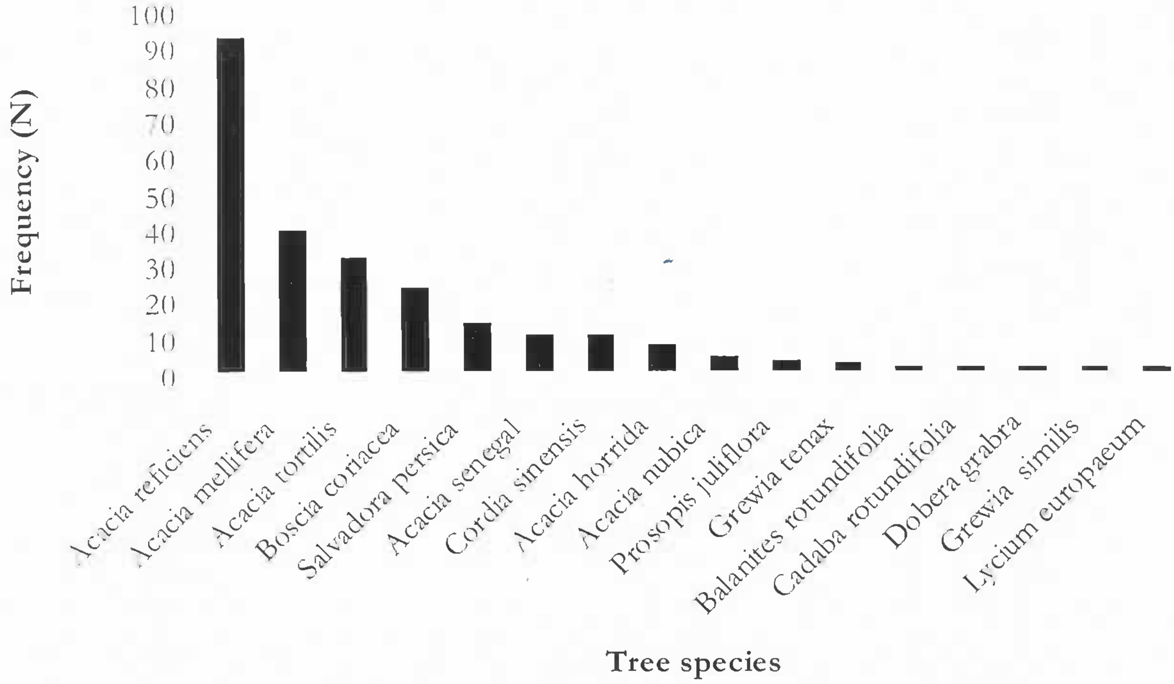



Figure 10: Frequency of mature tree species in all plots sampled

In the western zone of the Kakuma refugee camp, there was an increase in both number of tree species (tree species diversity) and tree density with increasing distance away from the camp (Figures 11 and 12). The same trend was also evident in the eastern zone (Figure 13), though not as pronounced as in the western side of the camp.

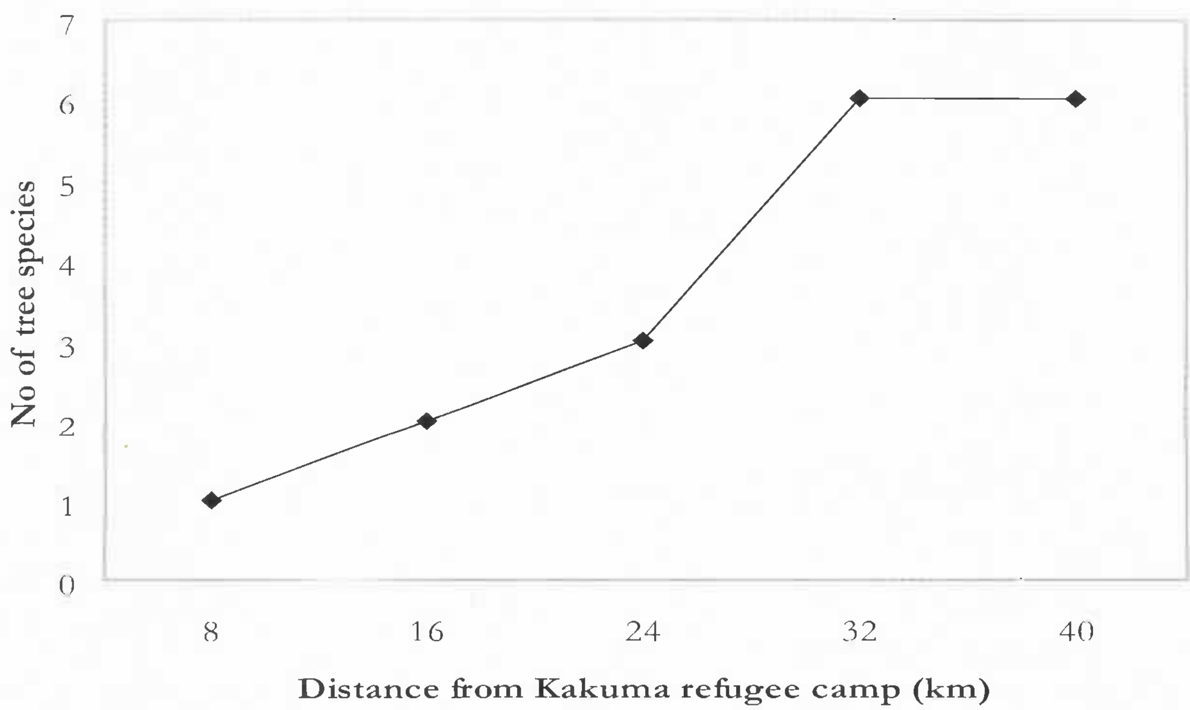



Figure 11: Number of tree species occurring with increasing distance west of Kakuma refugee camp

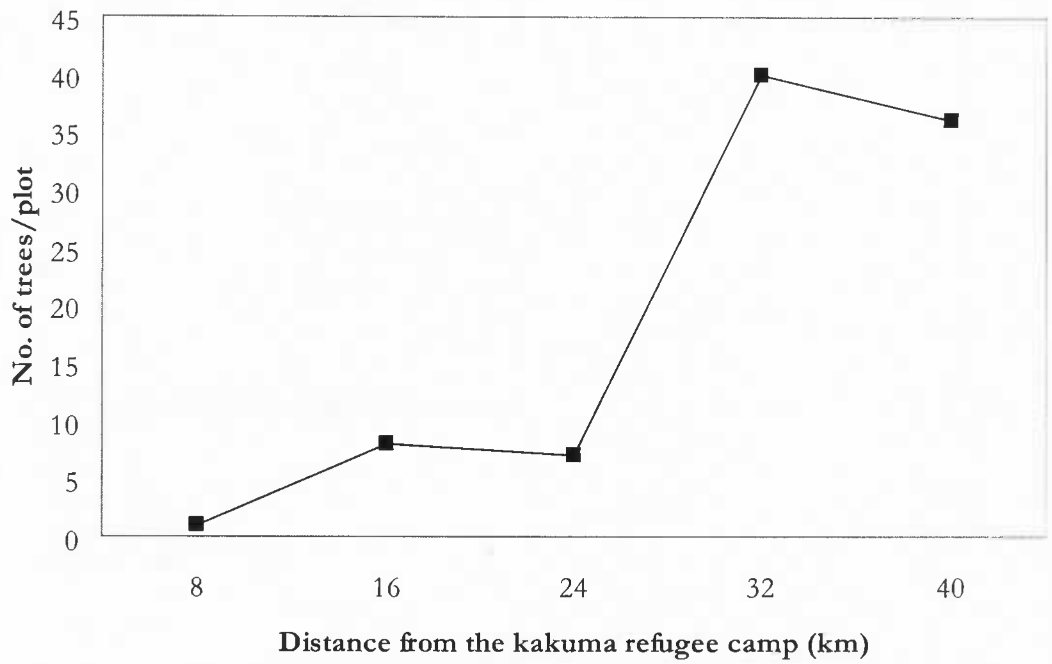



Figure 12: Number of trees (density) occurring with increasing distance west of the camp

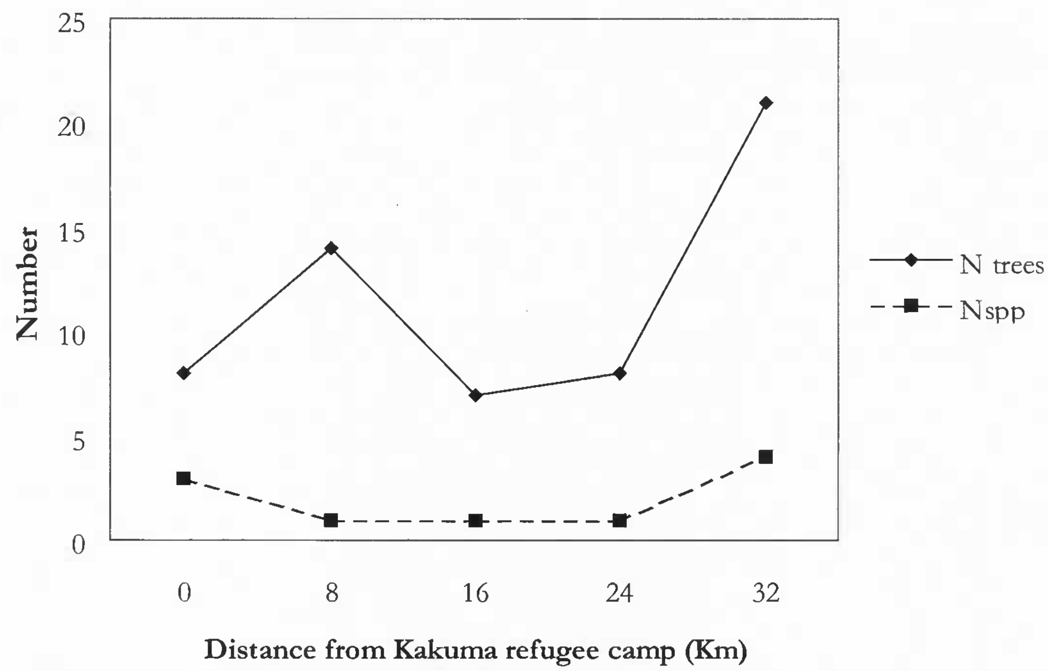



Figure 13: Tree species diversity and number of trees east of Kakuma refugee camp

There were marked differences in tree growth in the riverine and the woodland sites. For species that occurred in both sites, trees in the riverine sites were larger in size (Figure 14).and more densely populated compared to the woodlands, owing to the presence of seasonal water flow in the former (Figure 15)

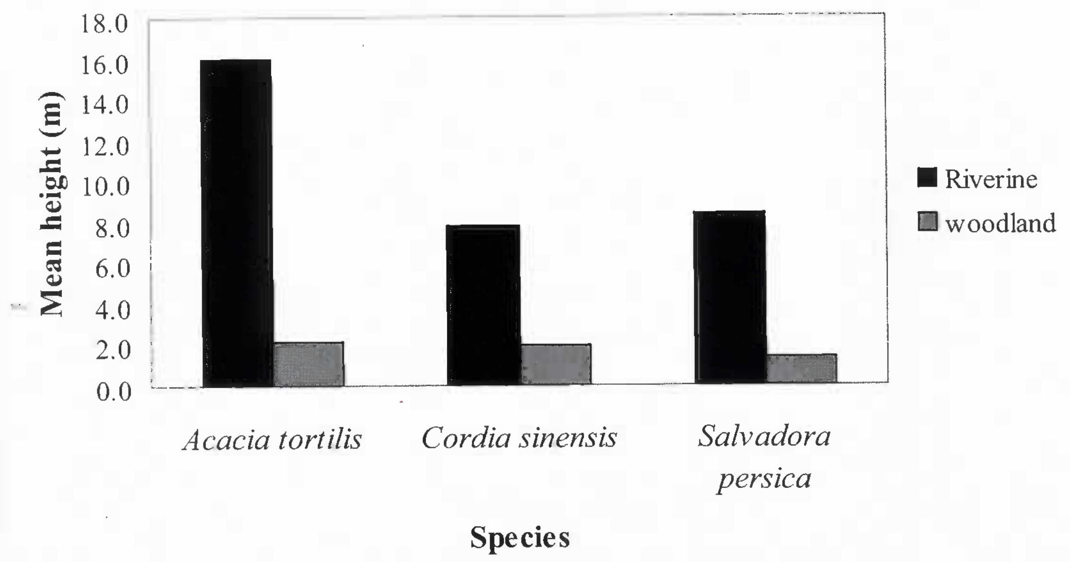



Figure 14: Mean height of selected tree species in both the riverine and rangelands

The density of tree species was less in the riverine compared to the open woodlands. The density per hectare in riverine sites was 78 trees/ha. compared to 144 for the woodlands. The dominant species in the riverine is *Acacia tortilis*, which tends to suppress other species from growing underneath.

### *3.2.2. Tree stumps*

Figure 15 shows the occurrence of stumps of various tree species in the sample plots. The occurrence of tree stumps was taken as an indicator of degradation. Although most firewood within the study area is collected as dry wood, there were some sites that had large number of stumps, particularly in charcoal burning areas. There was also evidence of complete burning of stumps during charcoal burning. Figure 15 also confirms that *Acacia reficiens* was the most exploited tree species. A number of cut stumps and debarking were also evident in some wood harvesting sites such as Pelekech. Observations suggested that debarking was used to induce drying of live trees for subsequent collection, as only dry firewood is acceptable for use in the refugee camps.


Plate 2: Exploitation of Kalobeiyei area.

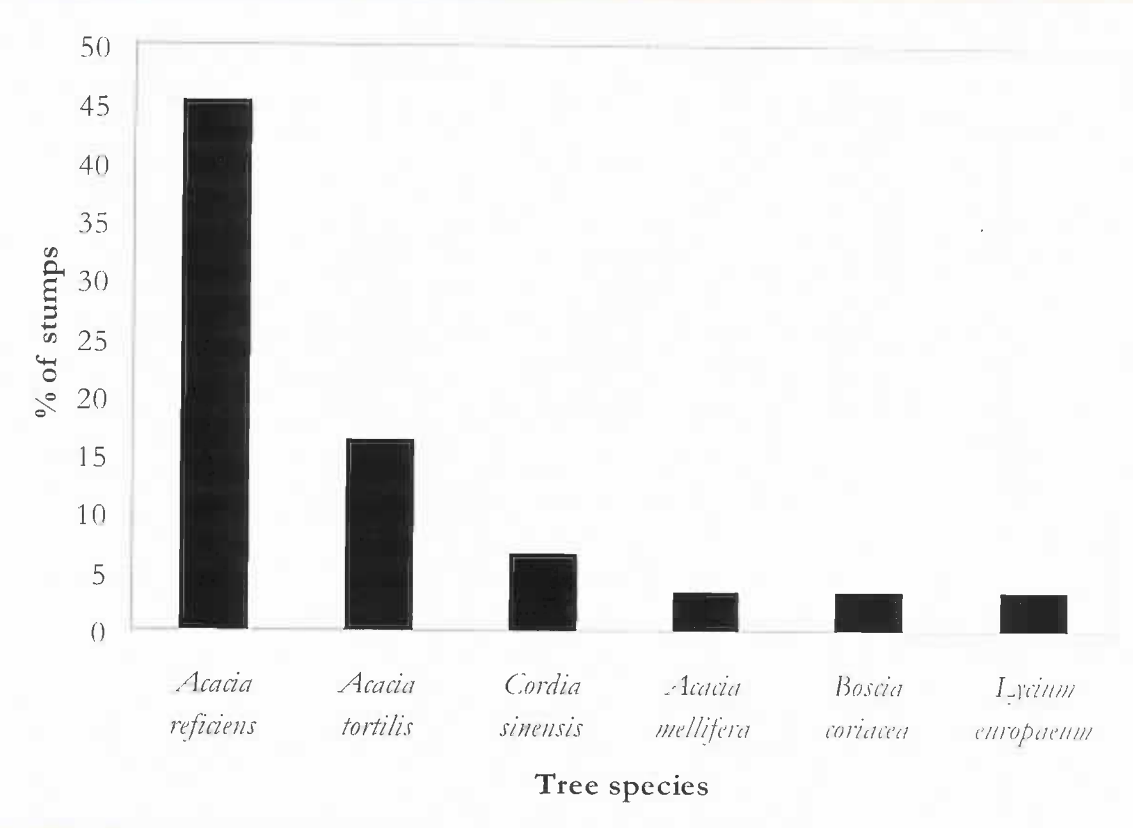



Figure 15: Occurrence (in %) of tree stumps of some species in the sampled plots

(a)

(b)

Plate 3. (a) Degraded woodland near Kakuma town and (b). Undisturbed woodland 40 km away

### *3.2.3. Saplings*

There were either none or very low counts of saplings in all the plots assessed. Only seven plots out 19 had between 1 and 7 saplings. The highest numbers of saplings were found near the refugee camps and were mainly *Prosopis juliflora* whose occurrence *is an indicator* of disturbance (Figure 16).

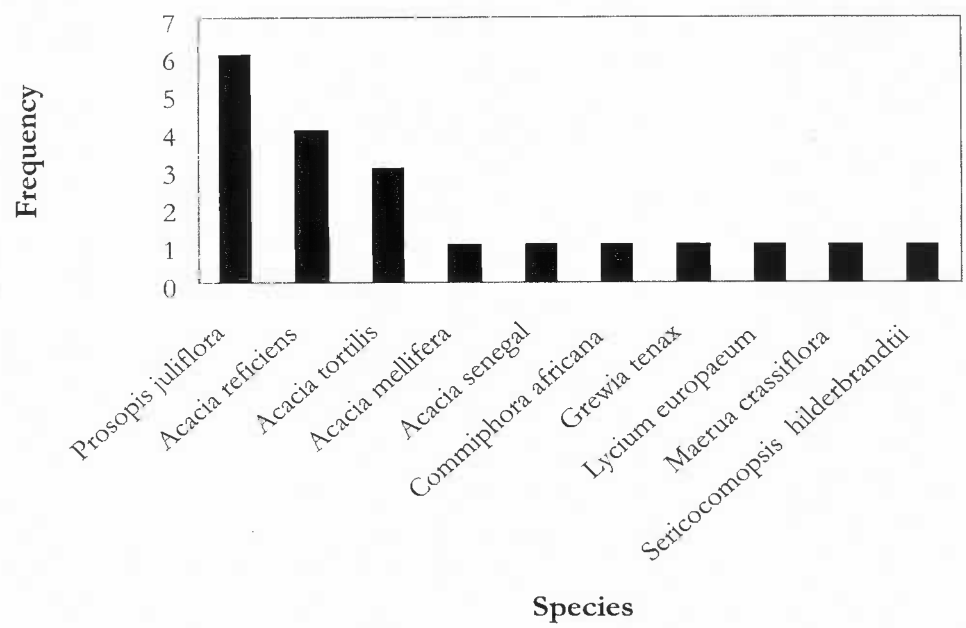
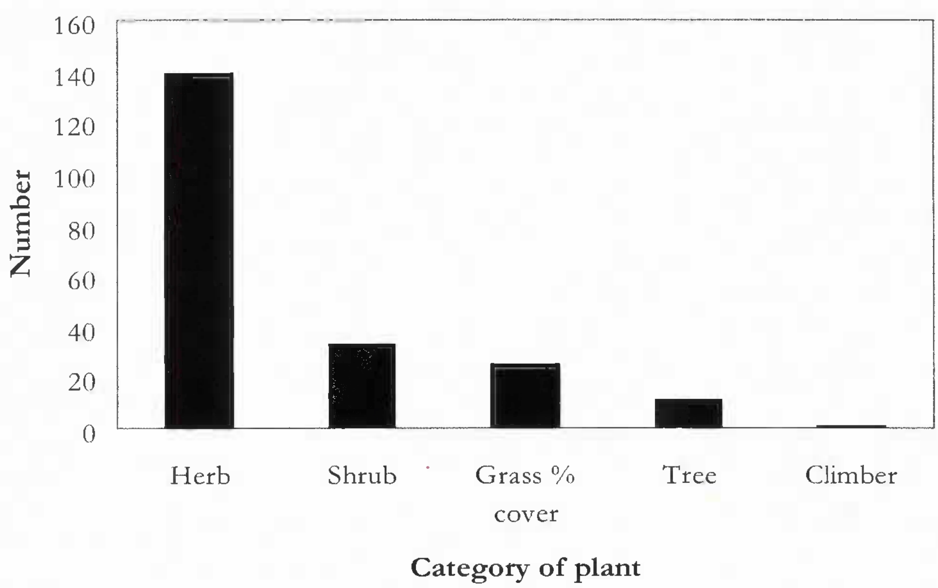



Figure 16: Mean number of tree saplings per plot within the study area

### 3.2.4. Tree seedlings and other plants

The results indicated that there was poor regeneration of tree species in most sampled plots. The most abundant plant species were herbs (Figure 17). There was evidence of extensive browsing of young tree seedlings especially in the open grazing areas.




(Tree refers to tree seedlings)

Figure 17: Distribution of tree seedlings and other plant species per plot in the study area

There was evidence of increase in species diversity with increasing distance from the camp. The number of species per plot varied from 7 to 15 with the least diversity of species found closer to the camp on both the eastern and western transects. This indicates that degradation has affected diversity of plant species in the study area (Figures 18 and 19).

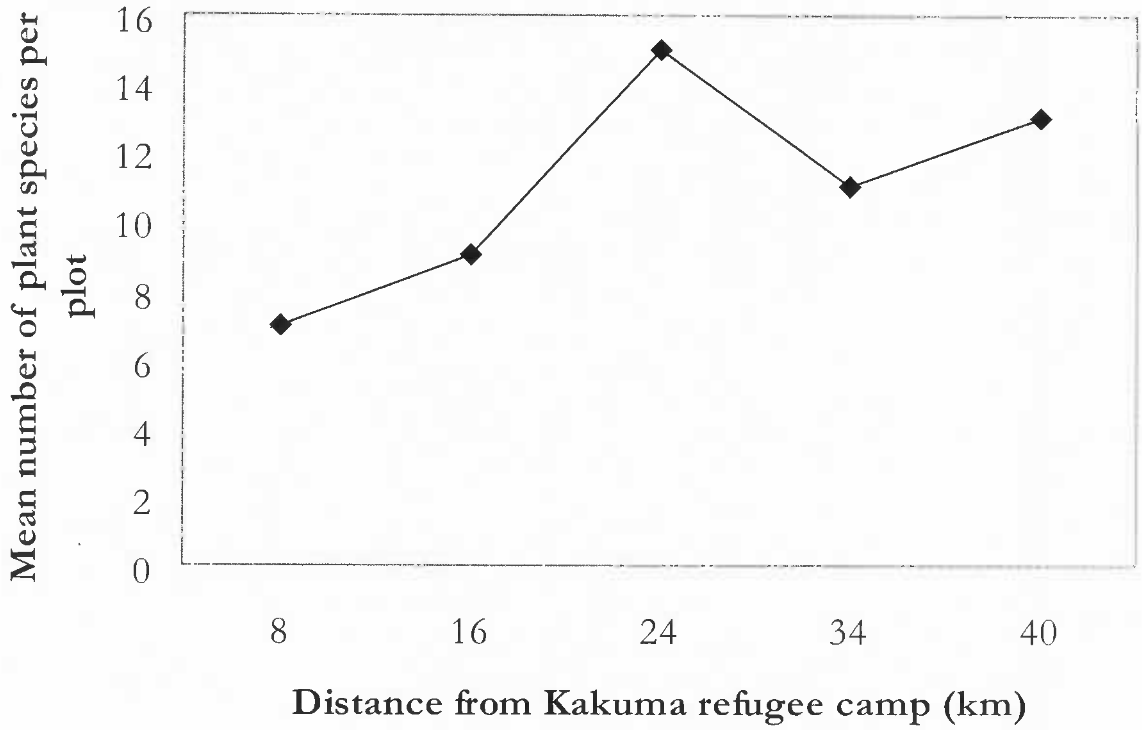



Figure 18: Plant species diversity with increasing distance west of the Kakuma refugee camp

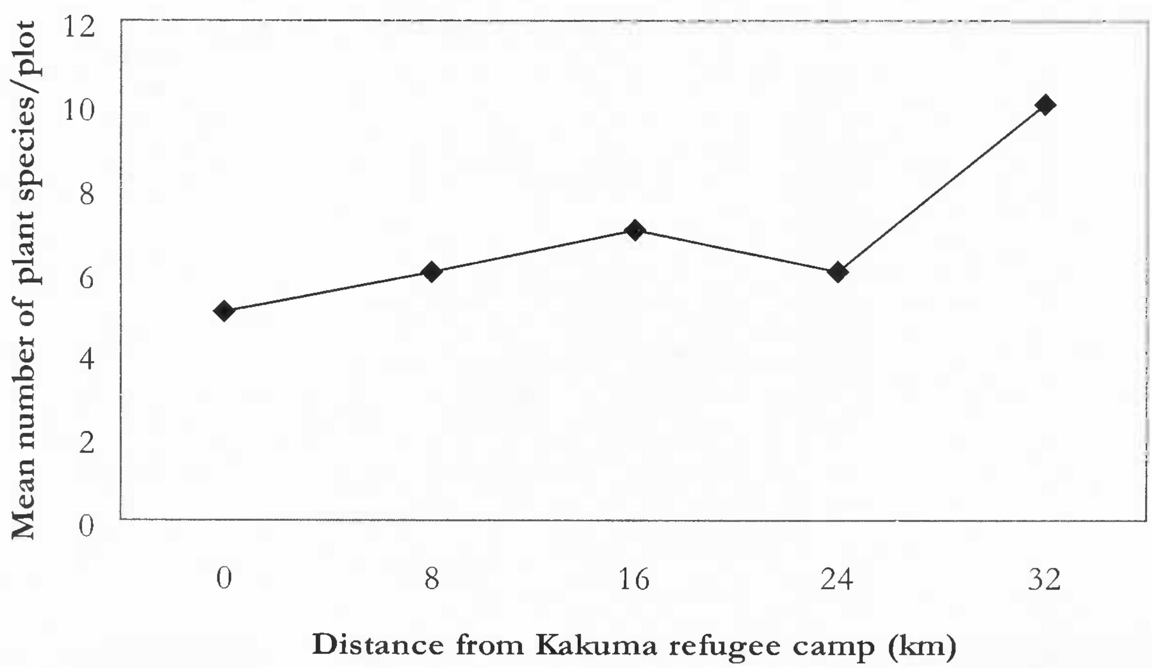



Figure 19: Plant density with increasing distance east of the Kakuma refugee camp

Plate 4(a) Charcoal and firewood destined for Refugee camp

Plate 4(b) Charcoal burning in woodland

## 3.3. Socio-economic status

### *3.3.1. Refugees*

A total of 77 respondents consisting of Sudanese, Somalis, Ethiopians, Congolese, Burundians and Rwandese were interviewed. . The time of stay in the refugee camps ranged from 1 to 14 years, with an average of 6 years. Eighty four percent of the respondents were women. The results showed that 83% of all respondents were married. The majority of the respondents (58%) were aged between 26-45 years (Figure 20). The average household size was six people.

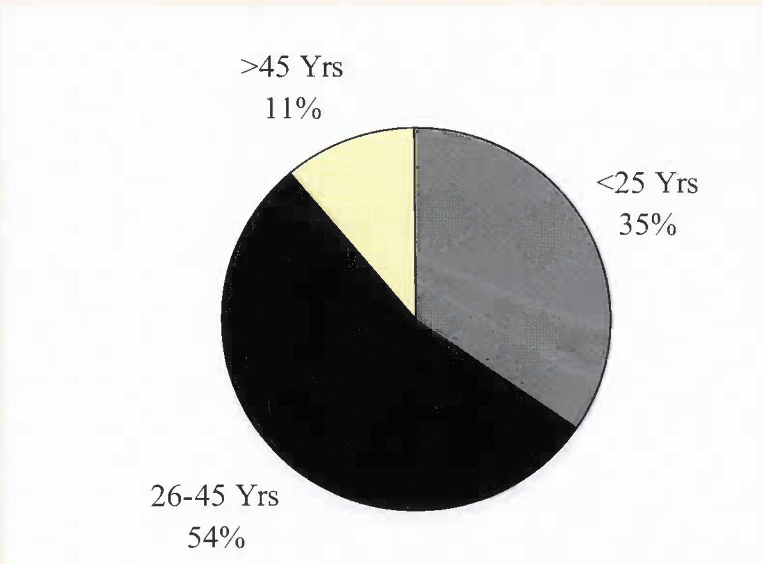



Figure 20: Age categories of respondents

The results indicated that 34% of the respondents had no formal education, 43% had primary, 20% had secondary and 4% had tertiary levels of education.

### *3.3.2. Local community*

The host communities are the Turkana people whose way of livelihood is pastoralism. The respondents consisted of 86% female and 14% male. Most of the respondents were married (89%). Half of the respondents were in 25–45 years age category, 22% were below 25 years and the rest were above 45 years. The majority of the respondents had no formal education (93%). The average family size was six individuals.

The average household income per month was Ksh. 3,000 (US$ 43) derived from sale of firewood and charcoal, livestock (Figure 21). Other sources of income included employment as shop attendant and commuter bicycle cyclists (*Bodaboda*). Trade in firewood and charcoal contributes considerably towards sustaining the livelihood of the local community. As a result of nation-wide drought in the year 2005 the local people lost most of their livestock leading to an influx into Kakuma town. This has led to an increase in fuelwood trade by the local people.

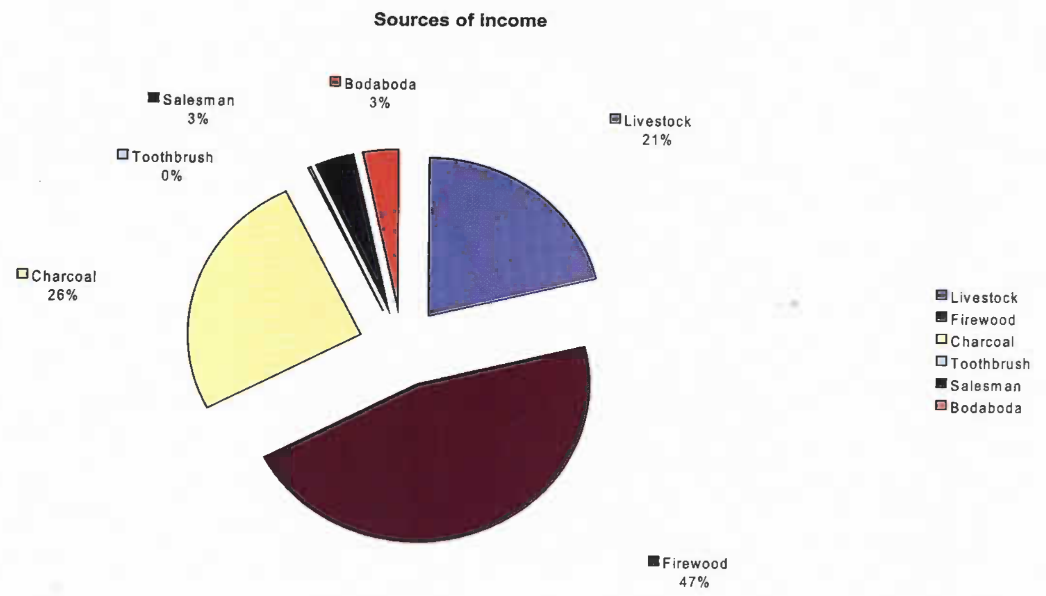



Figure 21: Main sources of income for the local community

## 3.4. Local woodland resource management

### *3.4.1. Perceived and existing management systems*

The woodland is under communal ownership as a trustland. The institutions perceived by the local community as responsible for sustainable resource utilization are the government of Kenya (35% of respondents), UNHCR through GTZ (by 22%) and the local community (by 43%). The local community plays the dual role of resource management and ownership as reported by 93% of the respondents. Ninety four per cent of the respondents reported that resource management is mainly through a traditional system where each family/clan is given the responsibility over a piece of land in the riverine zones (*Ekwar*) or within the rangelands (*Epaka*). The traditional system has worked well in ensuring sustainable resource management and conservation in the area.

### *3.4.2. Species and use*

The survey revealed that the woodland resources are used as a source of firewood, charcoal, construction material, fodder and medicinal purposes. A total of 38 tree and shrub species were mentioned during the interviews for these uses. The main tree and shrub species were *Acacia tortilis, A. reficiens, A. mellifera, A. senegal, Salvadora persica, Cordia sinensis, Commiphora africana* and *Boscia coricea*. Whereas *Acacia tortilis* is the most preferred for fuelwood and charcoal burning, its restriction along the riverine sites limits its usage. However, *Acacia mellifera* and *A. reficiens* were the most used owing to the ease of their availability within the extensive woodlands. Herbs and grasses were also singled out in the resource survey (Appendices I and II).

### *3.4.3. Overexploited tree species*

A total of 26 tree and shrub species were reportedly threatened within the 20 km radius from the refugee camp. The main ones include *Acacia tortilis* (80.0% of respondents), *A. elatior* (47.7%), *A. reficiens* (43.3%), *Cordia sinensis* (43.3%), *Salvadora persica* (38.3%), *A. mellifera* (30.0%) and *Ziziphus mauritiana* (30.0%) (Appendix III). The perceived sources of threats as reported by the local community include over exploitation (51%) flooding (44%), Prosopis invasion (13%) and ecological factors (4%).

## 3.5. Fuelwood supply and demand

### *3.5.1. Dynamics of fuelwood supply*

Refugees are provided with firewood on quarterly basis at an average of 10 kg per person or 57 kg per household. . The firewood ration lasts for an average of seven days at the rate of 8 kg per household or 1.78 kg per person per day representing 10% of the fuelwood demand by the refuges. It was reported that 74% of the respondents supplemented their firewood requirements through purchase either as bundles (42%), head loads (Plate 5a) 47%) and bicycleload (11%). Seventy seven percent of respondents purchased charcoal. About 75% purchased in basins and 4% in two kilogram packages. The average price of firewood was KSh.135 per head load, which could last for 4 days while charcoal was retailed at an average price of KSh. 139 per basin weighing an average of 10 kg and lasting for an average of five days.

(a).

(b).

Plate 5: Firewood and charcoal in the market within Kakuma refugee camp

The respondents (54%) reported that firewood was available within their settlements areas. Major problems faced during firewood collection were thirst, distance and insecurity (Table 3). Observations indicated that good quality firewood could only be obtained beyond the 20 km radius from the refugee camp.

The prices for firewood increased considerably during the rain seasons as reported by 85% of respondents. The results indicated that 89% of the respondents supply fuelwood directly to the refugees, 22% to GTZ through contracts and 44% to the Kakuma urban population.

Table 3: Problems experienced during firewood collection

| Problem | % Response |
|---|---|
| Thirst | 32.4 |
| Distance | 31.4 |
| Insecurity | 17.8 |
| Accident | 10.8 |
| Diseases | 3.2 |
| Rape | 3.2 |
| Floods | 1.1 |

### 3.5.2. Sources of energy for cooking

Firewood and charcoal were the most important energy sources for cooking. Firewood was the main source of energy for the local community as attributed to 75% of the respondents while the refugees use both firewood charcoal in almost equal proportions. Other sources were solar energy for the refugees and livestock dung for the local community (Figure 22).

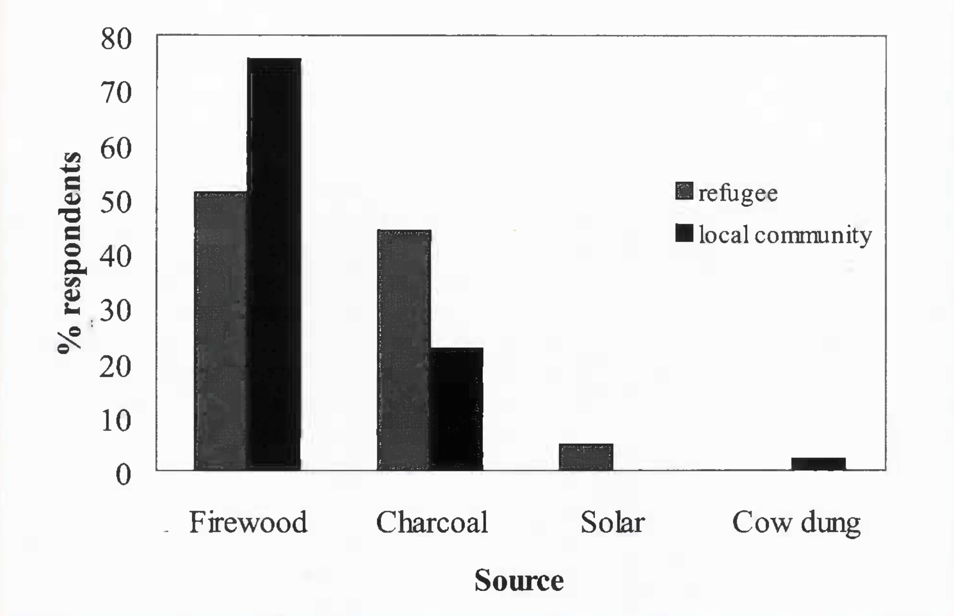



Figure 22: Energy sources for cooking

### 3.5.3. Cookers

The three stone stoves (Plate 6A) were reported to be the most popular devices for cooking in the local communities (79%) whereas the energy saving stove (Maendeleo; Plate 6C) was used by about 50% of the refugee households (Figure 23). The local improved stove (Plate 6B) was also used among the refugee community. Ninety nine percent of the refugees reported that the amount firewood received from GTZ was inadequate. Some of the constraints experienced by refugee were general lack of diversity in the source of energy (7.8%) and inadequate supply or renewal of improved cooking stoves.

### 3.5.4. Types of food

Nangalia, whole grain and ugali were the main meals prepared by the local community whereas whole grain and ugali were preferred by the refugees (Table 4).

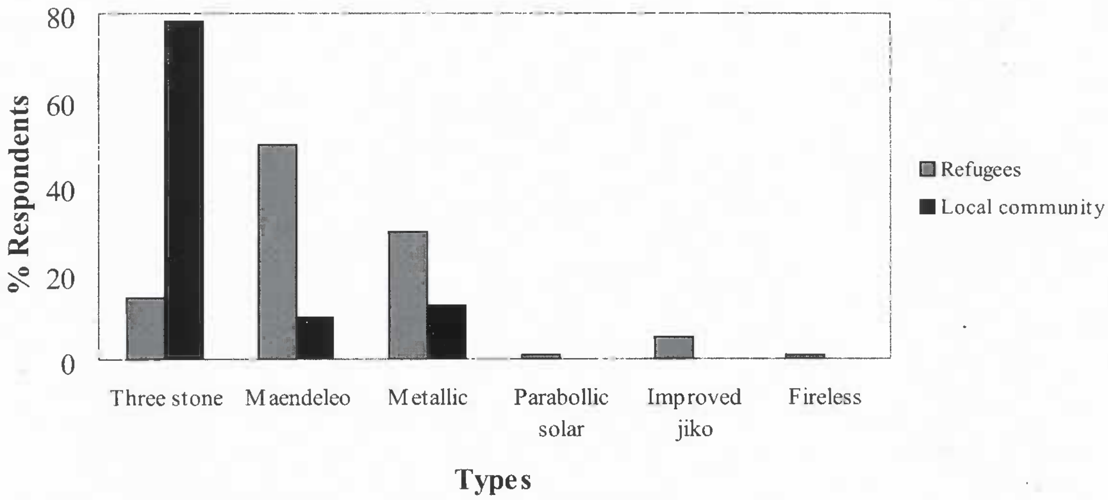



Figure 23: Types of cooking devices

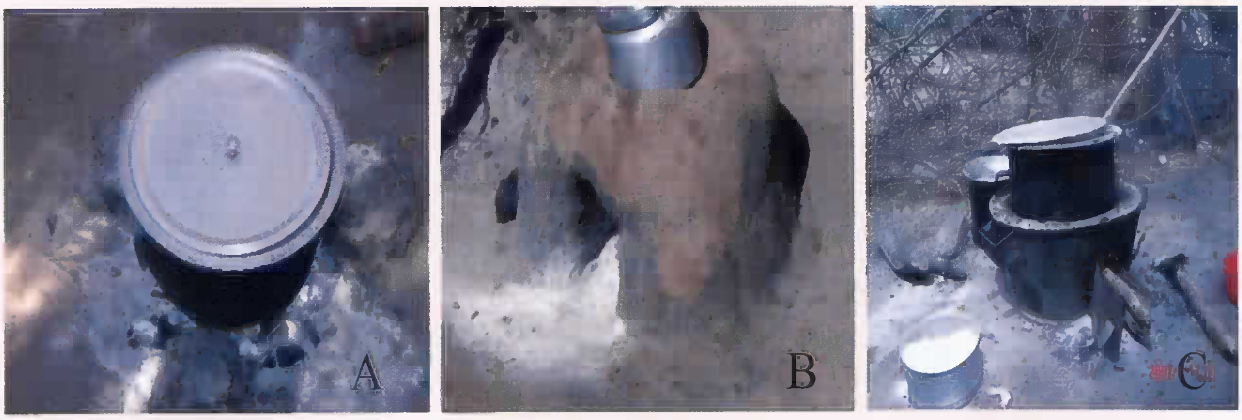



Plate 6: Types of cookers used (A=Three stones, B=Improved local stove, C= Maendeleo stove)

Table 4: Common foods cooked by the Refugee and local communities

| Food stuff | Refugees (%) | Local community (%) |
|---|---|---|
| Whole grain | 24.4 | 32.7 |
| Ugali | 25.3 | 28.1 |
| Nangalia | 0 | 33.2 |
| Porridge | 9.8 | 1.5 |
| Rice | 8.0 | 1.0 |
| Canadian peas (Ardes) | 7.6 | 2.0 |
| Chapati | 12.4 | 1.5 |
| IAnjera | 10.7 | 0 |
| Pasta | 1.8 | 0 |

### *3.5.5. Sources of energy for lighting*

Kerosene was the most popular source of lighting among both refugees (84%) and local communities (53%). Firewood was also a significant source of energy for lighting among the local community (Figure 24).

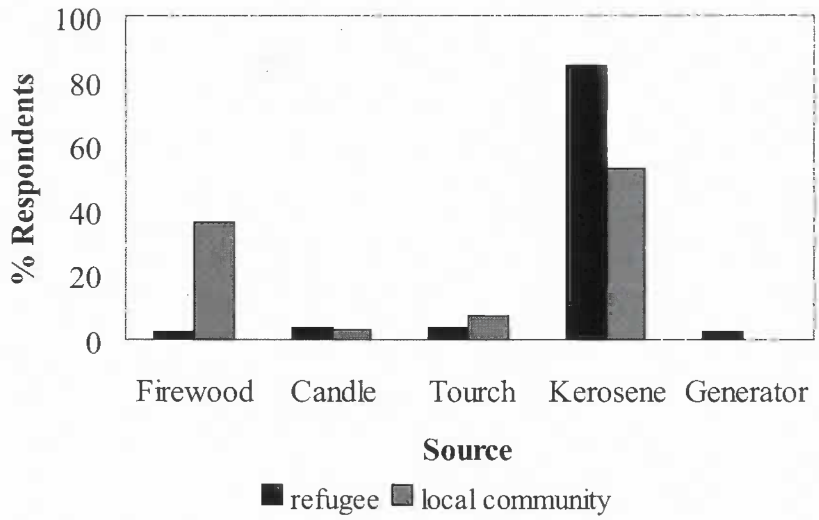



Figure 24: Energy sources for lighting

### 3.6. Rehabilitation activities and tree planting initiatives

Tree planting activities was initiated by GTZ in the refugee camp and so far 56% of the respondents reported their involvement in tree planting. Among the respondents, 49%, had enhanced tree survival through construction of micro catchments, manuring and frequent watering. Tree planting was practiced by 47% respondents of the refugee communities. The measures to enhance tree planting included awareness on tree management (32%), reliable source of water (25%), source of seedlings (36%) and protection against damage (6%).

GTZ has been instrumental in organizing for extension, training and awareness activities on tree planting within the refuge camp. 26% of the respondents reported to have benefited from such training since 2003. Seedling are provided to both refugees and local community from nurseries distributed throughout the camp (Plate 5). Some of constraints highlighted include lack of reliable sources of water, lack of awareness on tree planting (16%) and sources of seedlings (4%), rampant cases of poverty (12%).

Table 5: Popular tree species planted within Kakuma area

| Local name | Botanical name | % Response |
|---|---|---|
| Neem | *Azadirachta indica* | 84 |
| Ekalale | *Ziziphus mauritiana* | 31 |
| Edome | *Cordia sinensis* | 75 |
| Eterai | *Prosopis juliflora* | 13 |
| Epeduru | *Tamarindus indica* | 19 |
| Etiir/Ewoi | *Acacia tortilis* | 6 |
| Ebenyo | *A. mellifera* | 9 |
| Eregai | *A. reficiens* | 3 |
| Ekunoit | *A. senegal* | 3 |

Plate 7: Tree nursery within the refugee camp

GTZ in collaboration with the Forest Department have organized a series of training activities among the local communities on tree planting and management. It was established that 33% of the local communities had benefited from this training between the years 2000 and 2006.

The main causes of environmental impacts of refugees in Kakuma Division can be seen in the context of degradation of the woodland vegetation. The resources are most impacted on through high demand for fuelwood created by the presence of a large number of refugees. A major demand created is firewood to meet household energy and for commercial purposes, particularly in the camp. Firewood markets operate in the camps where vendors sell on a daily basis as well as in the common markets just outside the camp areas, which serve as outlets for income earning and commodity exchange. Charcoal burning is most common among local communities, particularly those close to big towns. This was observed by the bags of charcoal on sale along the Lodwar-Kakuma road and also within the refugee camp and the surrounding areas.

# 4.0. RECOMMENDATIONS AND WAY FORWARD

## Capacity building and ecological awareness

- Enhance the local community capacity in woodland resource management and rehabilitation.
- Strengthen and facilitate presence of national institutions dealing with natural resource management in the area to carry out integrated extension services.

## Woodland conservation and rehabilitation

- KEFRI to undertake studies on estimation of biomass (through biomass equations) for major tree species used for firewood.
- Drill more boreholes, wells and build community dams.
- Strengthen traditional environmental management systems.
- Undertake research in vegetation degradation and rehabilitation.
- Explore cheaper alternatives for vegetation recovery techniques
- Upscale rehabilitation efforts.
- Undertake periodical environmental audits of the refugee camps.
- UNHCR to spread firewood sourcing to include southern Sudan and eastern Uganda to avoid concentrated impacts on smaller areas and to allow for vegetation recovery.
- Upscale and improve management options for invasive *Prosopis juliflora*.
- Strengthen local community groups

## Fuelwood demand and supply

- GTZ to facilitate repair and replacement of the Maendeleo stoves and to increase their supply to the local community.
- Expand and increase frequency of firewood stakeholder meetings.
- UNHCR to explore alternative sources of energy such as wind and solar.
- Enhance or put in place structure for pricing fuelwood through stakeholder meetings.
- GoK through KEFRI to introduce more efficient charcoal production technologies.
- GoK through KEFRI to enhance utilization of the invasive *Prosopis juliflora* for fuelwood and construction.
- A certain proportion of fuelwood supplied to the Kakuma refugee camp be made up of *Prosopis juliflora*

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# APPENDICES

## Appendix I:

A checklist of trees, shrubs, herbs and grass of degraded woodland around Kakuma refugee camp in Turkana district

| | Botanical name | Local name | Family | Habit | Uses |
|---|---|---|---|---|---|
| 1 | *Abutilon hirtum* | Etoo | Malvaceae | Shrub | - |
| 2 | *Acacia tortilis* | Ewoi/Etir | Mimosaceae | Tree | Firewood, charcoal,construction fruits medicine,curving |
| 3 | *Acacia horrida* | Eyellel | Mimosaceae | Shrub | Firewood, charcoal,medicine,co nstruction |
| 4 | *Acacia mellifera* | Ebenyo | Mimosaceae | Shrub | Firewood, charcoal,construction, gum |
| 5 | *Acacia nubica* | Epetet | Mimosaceae | Shrub | Firewood,charcoal,medicine,con struction,gum |
| 6 | *Acacia reficiens* | Eregai | Mimosaceae | Shrub | Firewood,charcoal,fodder,Medici ne,construction gum |
| 7 | *Acacia senegal* | Ekunoit | Mimosaceae | Shrub | Firewood,charcoal, gum/ resin,fr uits,medicine,construction |
| 8 | *Acalypha indica* | Louyongoroko | Euphorbiaceae | Shrub | - |
| 9 | *Achyranthes aspera* | - | Amaranthaceae | Shrub | Fodder |
| 10 | *Aerva javanica* | Ekwanga | Amaranthaceae | Herb | - |
| 11 | *Aloe turkanensis* | Echuchuka | Aloaceae | Shrub | Medicine |
| 12 | *Amaranthus graecizens* | Epespes | Amaranthaceae | Herb | Medicine,fodder |
| 13 | *Aristida mutabilis* | Adour | Graminea | Grass | Fodder |
| 14 | *Asparagus africana* | Esikarakiru | Asparagaceae | Shrub | Medicine |
| 15 | *Balanites rotundifolia* | Ebei | Balanitaceae | Tree | Firewood, charcoal, fruits,curving |
| 16 | *Barleria acanthoides* | Logolilo | Acanthaceae | Shrub | - |
| 17 | *Becium filamentalis* | - | Labiatae | Herb | - |
| 18 | *Boscia coriacea* | Erdung | Capparaceae | Tree | Firewood,charcoal,fodder ,fruits |
| 19 | *Brachiaria deflexa* | Amanakuri | Graminae | Grass | Fodder |
| 20 | *Cadaba rotundifolia* | Epuu | Capparaceae | Shrub | Firewood, charcoal,construction |
| 21 | *Cenchrus ciliaris* | Amerukwa | Graminea | Grass | Fodder |
| 22 | *Chloris virgata* | Epenek | Graminea | Grass | Fodder |
| 23 | *Cissus quadrangularis* | Lobara | Vitaceae | Climber | Medicine |
| 24 | *Commicarpus plumbagineus* | Lokuchin | Nyctaginaceae | Herb | Fodder |
| 25 | *Commiphora africana* | Ekadeli | Burseraceae | Tree | Fodder,curving, |
| 26 | *Cordia sinensis* | Endome | Boraginaceae | Tree/ Shrub | Charcoal, firewood,fruits |
| 27 | *Crotolaria diflersii* | Emeret | Papilionaceae | Shrub | - |
| 28 | *Digitaria gayana* | - | Graminea | Grass | Fodder |
| 29 | *Dobera grabra* | Edapal | Salvadoraceae | Tree | Firewood,charcoal, fruits,constru ction,curving |
| 30 | *Duorsprema eremophilum* | Emekui | Acanthaceae | Herb | - |
| 31 | *Euphorbia gossypina* | - | Euphorbiaceae | Shrub | - |
| 32 | *Euphorbia granulata* | Lokile | Euphorbiaceae | Herb | - |

| | | | | | |
|---|---|---|---|---|---|
| 33 | *Euphorbia magnicapsula* | Emuss | Euphorbiaceae | Shrub | Medicine |
| 34 | *Evolvulus alsinoides* | Eosin- aikenyi | Convolvulaceae | Herb | Fodder |
| 35 | *Grass F* | - | Graminea | Grass | Fodder |
| 36 | *Grass G* | - | Graminea | Grass | Fodder |
| 37 | *Grewia similis* | Ekeli | Tiliaceae | Shrub | Firewood, fruits |
| 38 | *Grewia tenax* | Engomo | Tiliaceae | Shrub | Firewood,fruits |
| 39 | *Heliotropium longiflorum* | Esigirat | Boraginaceae | Herb | Fodder |
| 40 | *Hibiscus ovalifolius* | Nauru-kasikou | Malvaceae | Herb | Fodder |
| 41 | *Indigofera arrecta* | Emartoi | Papilionaceae | Herb | - |
| 42 | *Justicia odora* | Loppara | Acanthaceae | Shrub | Fodder |
| 43 | *Justicia caerulea* | Naukuchin | Acanthaceae | Herb | Fodder |
| 44 | *Leucas jamesii* | Ekareterete | Labiatae | Herb | - |
| 45 | *Lycium europaeum* | Ekabekeke | Solanaceae | Shrub | Firewood |
| 46 | *Ocimum staminosum* | Lusiru | Labiatae | Herb | Medicine |
| 47 | *Pavetta ariverana* | Ekwanget | Rubiaceae | Herb/ Shrub | - |
| 48 | *Plectranthus Ignarius* | Akarau | Labiatae | Herb | - |
| 49 | *Polygala sphenoptera* | Emaret | Papilionaceae | Herb | Fodder |
| 50 | *Portulaca oleracea* | Elete | Portulacaceae | Herb | - |
| 51 | *Portulaca quadrifida* | Ekadae | Portulacaceae | Herb | - |
| 52 | *Prosopis juliflora* | Eterai | Mimosaceae | Tree | Curving, fence,medicine |
| 53 | *Salvadora persica* | Esekon | Salvadoraceae | Tree | Fence,construction,firewood,fruit s,curving |
| 54 | *Sanseviera intermedia* | Emojo | Agavaceae | Shrub | - |
| 55 | *Seddera hirsuta* | Lomanang | | Herb | Fodder |
| 56 | *Sericocomopsis hildebraedtii* | Ekabonyo | Amaranthaceae | Herb | Fodder |
| 57 | *Sesamothamnus rivae* | Loborea | Euphorbiaceae | Shrub | - |
| 58 | *Setaria verticillata* | Etanako | Graminea | Grass | Fodder |
| 59 | *Solanum coagulans* | Esikilele | Solanaceae | Herb | - |
| 60 | *Talinum portulacifolium* | Ekalibochat | Portulacaceae | Herb | - |

## Appendix II:

Reported uses of common trees (% respondents) and shrubs around Kakuma refugee camp

| | Local name | Botanical name | | | | | Gums & resins | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Ewoi/Etiir | *Acacia tortilis* | 9.2 | 90.7 | 23.8 | 23.5 | | 85.2 | 1.4 | | 50.6 |
| 2 | Eregai | *Acacia reficiens* | 6.4 | 39.7 | 50.8 | | 3.8 | 14.5 | | | 37.0 |
| 3 | Edurukoit | - | | | | | | | 36.1 | | 36.1 |
| 4 | Ekuruchanait | *Acacia eliatior* | | | | | | | 36.1 | | 36.1 |
| 5 | Ekadeli | *Commiphora africana* | | | | | 1.9 | | 68.1 | | 35.0 |
| 6 | Edome | *Cordia sinensis* | 23.6 | 23.3 | 42.9 | 67.6 | | 34.4 | 8.3 | 11.1 | 30.2 |
| 7 | Esokon | *Salvadora persica* | 29.2 | 20.5 | 39.7 | 51.5 | 1.9 | 26.2 | 5.6 | 33.3 | 26.0 |
| 8 | Ekalale | *Harrisonia abyssinica* | 22.2 | 19.2 | 7.9 | 57.4 | | 45.9 | 2.8 | | 25.9 |
| 9 | Ekunoit | *Acacia senegal* | 8.3 | | 20.6 | 1.5 | 96.2 | 19.7 | 2.8 | | 24.9 |
| 10 | Esenyanait | *Acacia eliatior* | 52.8 | 76.7 | 7.9 | 2.9 | | 19.7 | 2.8 | 11.1 | 24.8 |
| 11 | Ebenyo | *Acacia mellifera* | 48.6 | 30.1 | 33.3 | | 5.8 | 13.1 | 1.4 | | 22.1 |
| 12 | Eterai | *Prosopis juliflora* | 26.4 | 15.1 | 23.8 | | | 13.1 | | | 19.6 |
| 13 | Edweite | | | | | | | | 18.1 | | 18.1 |
| 14 | Edapali | *Dobera grabra* | 4.2 | 2.7 | 4.8 | 54.4 | | 18 | 2.8 | | 14.5 |
| 15 | Edung | *Boscia coriacea* | 5.6 | 2.7 | 1.6 | 38.2 | | 6.6 | | 22.2 | 12.8 |
| 16 | Engomo | *Grewia tenax* | 2.8 | | 9.5 | 19.1 | | 13.1 | 13.9 | | 11.7 |
| 17 | Epeduru | *Tarmarindus indica* | | | | | | | 11.1 | | 11.1 |
| 18 | Ekabonyo | *Sericocomopsis hidebraedtii* | | | | | | | | 11.1 | 11.1 |
| 19 | Emuss | *Euphorbia magnicapsula* | | | | | | | | 11.1 | 11.1 |
| 20 | Lorodo | *Cissus rotundifolia* | | | | | | | | 11.1 | 11.1 |
| 21 | Elamach | *Balanites glabra* | 9.7 | 6.8 | 3.2 | 26.5 | | 8.2 | 1.4 | | 9.3 |
| 22 | Epat | *Grewia fall* | | | | 8.8 | | | | | 8.8 |
| 23 | Ebei | *Balanites rotundifolia* | 5.6 | 5.5 | 1.6 | 14.7 | | 19.7 | 1.4 | | 8.1 |
| 24 | Emeyan | *Berchemia discolor* | 2.8 | 4.1 | | 8.8 | | 3.3 | 19.4 | | 7.7 |
| 25 | Eroronyit | *Balanites aegyptica* | | | | | | | 2.8 | 11.1 | 7.0 |
| 26 | Erut | *Maerua subc* | | | | 7.9 | | 1.6 | | 11.1 | 6.9 |
| 27 | Epuu | *Cadaba rotundifolia* | 5.5 | 2.7 | 12.7 | | | 1.6 | | | 5.6 |
| 28 | Etesiro | *Calotropis procera* | | | | | | 1.6 | 8.3 | | 5.0 |
| 29 | Epetet | *Acacia nubica* | 2.8 | | 1.6 | | 9.6 | 1.6 | | | 3.9 |
| 30 | Eteleleit | *Alchornea fruticosa* | 2.8 | 2.7 | | | | 3.3 | | | 2.9 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | Ekali | *Grewia bicolor* | | | | 2.9 | | 1.6 | 4.2 | | 2.9 |
| 32 | Esikinait | *Heliotropum longiflorum* | 2.8 | | | | | | | | 2.8 |
| 33 | Ereng | *Cadaba farinosa* | 2.8 | | | | | | | | 2.8 |
| 34 | Elim | *Adenia leenbeckii* | 4.2 | 2.7 | | | | | 1.4 | | 2.8 |
| 35 | Eyelel | *Acacia horrida* | 2.8 | | 1.6 | | 3.1 | | | | 2.5 |
| 36 | Epongai | *Grewia villosa* | | | | 1.5 | | | | | 1.5 |
| 37 | Lokurumo | *Conostomium quadrangulare* | | | | | | | 1.4 | | 1.4 |
| 38 | Esuguru | *Tribulus cistoides* | | | | | | | 1.4 | | 1.4 |

# Appendix III:

## Reported threatened trees species and shrubs

| No. | **Botanical Name** | **Local name** | **% Response** |
|---|---|---|---|
| 1 | *Acacia tortilis* | Ewoi | 80.0 |
| 2 | *Acacia elatior* | Esanyait | 47.7 |
| 3 | *Acacia reficiens* | Eragai | 43.3 |
| 4 | *Cordia sinensis* | Edome | 43.3 |
| 5 | *Salvadora persica* | Esekon | 38.3 |
| 6 | *Acacia mellifera* | Ebenyo | 30.0 |
| 7 | *Ziziphus mauritianum* | Ekalale | 30.0 |
| 8 | *Cadaba rotundifolia* | Epuu | 15.0 |
| 9 | *Acacia senegal* | Ekunoit | 10.0 |
| 10 | *Dobera grabra* | Edapal | 6.7 |
| 11 | *Berchemia discolor* | Emayan | 5.0 |
| 13 | *Acacia nubica* | Epetet | 5.0 |
| 14 | *Grewia bicolor* | Ekali | 3.3 |
| 15 | *Lantana virbunoides* | Etetel | 3.3 |
| 16 | *Adenia leenbeckii* | Elim | 3.3 |
| 21 | *Grewia tenax* | Engomo | 1.7 |
| 24 | *Calotropis procera* | Etesiro | 1.7 |
| 26 | *Acacia horrida* | Eyellel | 1.7 |