INDIGENOUS KNOWLEDGE AND PRACTICES IN BIODIVERSITY CONSERVATION: A CASE STUDY OF THE ILCHAMUS, BARINGO DISTRICT, KENYA.

BY

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DECLARATION

This Thesis is my original work and has not been presented for a degree in any other university.

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To ethnoscientists in their endeavour to restore indigenous models that are extremely instrumental in conservation.

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ABSTRACT

The main objective of this study was to establish the role of indigenous knowledge and practices in the conservation of woody plants' biodiversity, taking the Ilchamus of Baringo District as a case study. The determination of the land use/cover dynamics of the area, was also an integral part of the investigation. The study tested two working hypotheses, *viz*: (a) woody species densities do not manifest significant variation with their respective utilization intensities and (b) the assorted woody perennials preserved in the arable lands by the farmers are not significantly different.

Mapping was achieved through the use of two sets of imageries; the 1973 LANDSAT, Scene 181/60 and 1987 SPOT, Scene 136-349. The intersection of the two imageries using a computer-based Geographic Information System (GIS) enabled evaluation of the vegetation dynamics in the area. In the field the Point Centred Quarter method was used to assess species diversity, density and basal area along the transects.

Broadly, seven land use/cover classes were adopted: forest, woodland, shrubland, grassland, riverine forest, irrigated land and bare ground. The Chi-square distribution and Spearman's rank correlation were used to test the null hypotheses. Questionnaire administration facilitated collection of socio-economic data while the Shannon Weiner index was used to compute the species diversity. It is interesting, to note that forests were found to have expanded as from 1973 to 1995 by about 990 ha. From the study it appeared that irrigation water, the spread of *Prosopis* spp. (SW.) DC., as well as indigenous conservation practices had largely contributed to the observed increase. However, on the average, vegetation coverage declined by approximately 3201 ha over the same period.

The Ilchamus were found to practice a highly developed indigenous agro-forestry, with the most preferred tree species being, *Acacia tortilis*, Forssk, *Balanites aegyptiaca*, (L.) Del. and *Salvadora persica* L. Chi-Square test for the on-farm tree species was found to be significant

($P < 0.01$). These species were selected on the basis of their compatibility with crops and other uses like firewood, fencing and medicinal purpose among others.

Herds' diversification which had played an important role in spreading the exploitative pressure on the biological resources was a common practice among the Ilchamus. The Ilchamus depended heavily on plants for most of their daily needs like firewood, construction materials, and medicines. The people appreciated the importance of these biological resources and had thereby developed indigenous models geared towards their conservation. In fact the Spearman's rank correlation coefficient between the woody species density and their respective importance was significant ($P < 0.05$) with $r_s = 0.55$, suggesting commendable conservation efforts on the part of the Ilchamus. This study concludes that rural people have an immense reservoir of knowledge about their environment. In addition, they have well-developed indigenous structures geared towards conservation of the environment and particularly biological resources on which they depend heavily. However, due to their very low incomes the people often tend to engage in practices that are ecologically counterproductive.

Given the inadequate empirical studies of this nature in Kenya and elsewhere, scholars, policy makers and other relevant agents have not been able to appreciate fully the importance of indigenous knowledge in conservation. This research is therefore expected to contribute significantly through the documentation and evaluation of some aspects of these.

The study recommends the creation of an enabling environment for effective conservation through the uplifting of the socio-economic status of the Ilchamus and ensuring individual land tenure. Furthermore, the existing indigenous models of conservation need to be given the necessary emphasis through participatory approaches. The impact of *Prosopis* spp. needs to be addressed urgently in order to avoid ecologically-costly results. These, among other recommendations, are proposed by this study for further research and/or remedial measures.

ACRONYMS AND ABBREVIATIONS

AML	:	Arc Micro Language
ASAL	:	Arid and Semi-Arid Lands.
BFFP	:	Baringo Fuel and Fodder Project
BSP	:	Biodiversity Support Program.
CBS	:	Central Bureau of Statistics.
DDP	:	District Development Plan.
DRSRS	:	Department of Resource Surveys and Remote Sensing
ESRI	:	Environmental System Research Institute
FAO	:	Food and Agriculture Organization
GIS	:	Geographic Information System.
GoK	:	Government of Kenya.
GTZ	:	German Technical Aid, Eschborn.
IK	:	Indigenous Knowledge.
IPAL	:	Integrated Project for Arid Lands.
IUCN	:	International Union for Conservation of Nature and Natural Resources - The World Conservation Union.
KARI	:	Kenya Agricultural Research Institute
KWS	:	Kenya Wildlife Service
LUT	:	Look Up Table
MSS	:	Multi-Spectral Scanner

NMK	:	National Museums of Kenya.
RIV	:	Relative Importance Value.
RMS	:	Root Mean Square
SK	:	Survey of Kenya
Sp.	:	Species. (Spp.- Plural)
UNDP	:	United Nations Development Programme.
UNEP	:	United Nations Environment Programme.
UNESCO	:	United Nations Educational, Scientific and Cultural Organization.
UNICEF	:	United Nations Children's Emergency Fund .
WRAP	:	Water Resources Assessment Project.
WWF	:	World Wide Fund for Nature.

CHAPTER ONE

INTRODUCTION

1.1: STATEMENT OF THE RESEARCH PROBLEM

The principal objective of this study was to investigate the role of indigenous knowledge (IK) and practices of the Ilchamus in the use and conservation of woody plants' biodiversity. Traditionally, the Ilchamus have managed to coexist with their environment through sustainable use of the available resources. However, with increased population together with the ever increasing economic difficulties, environmentally-friendly practices which were traditionally feasible have become largely impracticable (IUCN, UNEP, and WWF, 1991). Thus with the changing social structures (as a result of the introduction of formal education and civil administration) indigenous systems that fostered sustainable use of natural resources are vanishing rapidly, thus making it necessary to document them before it is too late. Unfortunately, most of the past research activities on conservation have to a large extent ignored indigenous models of conservation. As a result, these indigenous systems have been marginalised. This has led to the adoption of technologies that have often failed to foster sustainable resource use, ignoring the very systems that have stood the test of time.

This research was therefore an attempt to place conservation in its rural context, with due recognition of the existence of immense but under-estimated indigenous knowledge. Specifically, attempts were made to determine how IK and practices have contributed to the conservation or loss of woody species. In this regard this study is expected to contribute towards an integrated conservation approach whereby positive attributes of IK could be harmonized with scientific methods of biodiversity conservation.

1.2.0: LITERATURE REVIEW

1.2.1: Cases Cited Outside Africa

A study carried out by UNEP (1992) on the land-cover changes in Vietnam attributed the process of rapid depletion of resources to the growing number of people who need space to live and fields to farm. Here many villagers had no option but to cut timber for cooking fuel. Elsewhere, large parts of the critical sites for genetic diversity of *Theobronia* sp. (cocoa) in Columbia, Ecuador and Peru have been destroyed as a result of agricultural expansion amongst other forms of exploitation (IUCN, 1990).

Franklin and Foreman (1987) observe that while a few years back much of the Pacific Northwest was blanketed with forest today only fragments of this are found. Many management strategies are therefore concerned with the degree to which the altered landscape structure and forest fragmentation influence wildlife, hydrology, susceptibility of forest to catastrophic disturbance by agents such as wind, fire and pest. This argument is based on the grounds that ecological stability and resilience depend much on the biological diversity. They further note that the fragmentation of natural forests affect ecological characteristics of the landscape, such as species diversity, game populations and abundance of species requiring interior forest conditions.

Plant resources provide a varied source of nutritional needs to rural communities. In one region of Peru, fruits of 193 species are regularly consumed, 120 of which are exclusively collected in the wild (Groombridge. 1992). The worldwide threat to biodiversity is through habitat destruction and modification that have adverse impact on species.

In developing countries. 80% of the people rely on indigenous plant species for medicines (Groombridge. 1992). For example. in Thailand most of the plants used in rural medicines are collected from forests. Plants are also commonly used in Indonesia for the production of "*Jam*" (herbal medicine).

Dore (1987), however. notes that rural communities in Indonesia have for a long time been governed by customary laws towards patterns of forest management through regulating peoples' rights of access to forest products. Tree planting or protection in the forest was done with subtle social pressures imposed on those who broke the set rules. The Coconucos and Yanaconas people of Columbia hold strong religious views about the preservation of an area that includes the Purace National Park (Redford and Stearman. 1993). This is based on the belief that the park is the dominion of the Spirit Being *Jucas* who is the source of all natural resources necessary for life.

In addition. the Kuna people of Latin America were the first to set aside a large area of intact rain forest as a nature reserve (Redford and Stearman. 1993). Their concern for setting aside this area derives from the belief in *spirit sanctuaries*. The scientific view has been that these beliefs are primitive. superstitious and largely irrelevant. According to Warren (1993), people of Kolli Hills in India are aware of deforestation, but their socio-economic priorities promote the cutting of trees, thus leading to the disappearance of some species. Wood (1994) however. noted that farming communities conserve and manage a significant range of plant biodiversity for food production, but there is very little institutional support for these important activities.

From the foregoing, it is clear that studies have tended to focus more on the use of biological resources and its implications, with general lack of keen attention to the factors that have led to such patterns. In addition, although the subject of indigenous conservation models has been addressed to some extent, it is clear that attempts to verify their sustainability is largely lacking.

1.2.2: Literature Cited within Africa

Analysis of climatic factors has shown that desert encroachment in Africa is not as a result of a natural change of climate, but is essentially the result of the impact of human activities on vulnerable ecosystems (Detwyler, 1971). Generally, crop land expansion, overstocking and firewood collection are the most damaging to the environment.

According to BSP (1993) the worldwide loss of biodiversity has accelerated in recent years. This trend is especially important in Sub-Saharan Africa where people depend on biological resources to a very large extent. Around 90% of the Ethiopian highland forests which harbour wild coffee (*Coffee arabica*) have been largely destroyed. This has consequently meant reduction in the genetic base of this crop.

The contribution of edible indigenous wood plants to the nutrition of people in Nigeria has remained largely unrecognized (Okafor, 1980). According to Roche (1974), a consideration of food balance sheets for many developing countries indicate that the quantity and quality of food available for consumption is far below that required for health, yet people in West Africa do not show obvious signs of malnutrition. He attributed this to the massive amount of proteins, carbohydrates and vitamins which are obtained from the wild but are unrecorded.

Indigenous plant resources have multiple uses in many parts of Southern Africa (Huntley, 1989). For instance, plants have been used as a source of fuelwood, medicine, building material, materials for craftwork, income and food supplements (e.g., wild fruits, vegetables among others). He however observed that such uses are interlinked with vegetation changes leading to decreased habitat diversity. This has widely led to counterproductive effects by reducing options of resources that provide a buffer against rural poverty during climatic extremes.

It is, however, interesting that various studies have noted cases of substantial contribution by indigenous knowledge and skills in biodiversity conservation. In Ghana sacred groves and taboos have exerted a notable restriction on plants and animals (Richards, 1985). Elsewhere, protected areas believed to be abodes of spiritual agents can still be found in the African continent (Environmental Protection Council, 1976). In Ghana, small patches of forest were set aside (normally close to settlements) as sacred lands which could not be touched and were strictly protected by customary laws (Ntiamoa-Baidu, 1991). Many rivers and streams which provide the main sources of drinking water for a village community were regarded as sacred and surrounding forest lands were protected on the basis that the spirits of the river resided in them. Elsewhere, patches of forests were protected because they supported wild animal species considered to be sacred (Ntiamoa-Baidu, 1991). Hence, Huntley (1989) concludes that a particular plant species or population may become a conservation target for various reasons.

Dupriez and Leener (1983) in their study on indigenous dry zone cultivation in Africa found the farming areas around villages strewn with trees which have been preserved by the farmers in arable areas of Senegal. In South-East Nigeria, farmers protect woody perennials in their arable lands, particularly *Acacia senegal*, *Acacia tortilis*, *Balanites aegyptica*, (L.) Del. and *Tamarindus indica* (Dupriez and Leener, 1983). These trees offer shade to crops and animals and also provide wood and forage.

Customary conservation practices have important implications for the maintenance or creation of habitat diversity in Southern Africa (Cowe, 1986). From the early nineteenth century, the Zulu King (Shaka) established exclusive hunting rights over the Dwesa-Manubi forest in the Transkei and the Mfolozi areas of Natal/Kwazulu and both of these areas are reserves today. Finally, the protection of vegetation at grave sites for religious and possibly aesthetic reasons, is well known in Southern Africa (Cowe, 1986). All these practices play a major role in maintaining diversity in a landscape greatly changed by man.

It is therefore clear that studies on indigenous knowledge in Africa are still scanty. Moreover, the studies cited above have only attempted to document the use of plants by the rural communities and some customary norms that restrict their exploitation. Thus there is no comprehensive assessment of the impact of these practices on the biological resources.

1.2.3: Literature in the Kenyan Context

There are cases of conservation efforts by the indigenous people in Kenya. The "*Mukau*" (*Melia volkensii*) tree has long been recognized by the Mbeere people as a valuable resource. Since it provides valuable timber, when the seeds germinate, perhaps from goats' droppings, they are protected and reared as individual property (Brokensha and Riley, 1980). Mbeere people have actually succeeded in germinating this plant (Chambers, 1987). Likewise, Gikuyus have always protected the "Mugumo" (*Ficus thonningii*) tree which is believed to be the centre of communion[1] for God and the people (Kenyatta, 1978).

Robertson and Luke (1993) observe that the Pokomo and the MijiKenda have traditions linked to some small patches of thick forests in the Tana River, Kilifi and Kwale districts. The patches were protected by customs and used for ceremonies. These Kaya forests were more extensive in the past, but today fragmented relics which still retain sacred significance are found.

Odegi-Owuondo (1990) notes that the Turkana pastoral economy was managed and sustained through a series of complex mechanisms. These included selective exploitation of ecological niches in an ecologically-conservative way. The diversification of domestic stock and splitting of the herds are some of these. Placement of herds in different ecological zones served to spread risks over a wider geographical area.

Jacobs (1980) notes that the Maasai have a system of reserved grazing with elaborate local terminologies to describe it. For instance, in the Meruishi area of Kajiado District there are 13 reserved grazing areas (**"Olopololi"**). These areas which were located near the "Manyatta" (collection of homesteads) was traditionally reserved for calf grazing. In recent times though, adult cattle and small stock have begun to utilize the **"Olopololi"**. Elsewhere, the knowledge of the Pokot about their flora is closely related to the value of the plants to their livestock and to the people in terms of food, medicine and materials (Barrow, 1986). These people attach much value to trees and would rarely cut a valuable tree. Trees are used on a sustained basis for a variety of purposes, such as for fodder and food, medicines, building materials, fuel, fencing as

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1 The tree was sacred hence, acted as a holy ground were people could communicate with their God.

well as acting as meeting points. Likewise, the Turkana have a well-developed indigenous knowledge of their flora and its uses (Barrow, 1988).

In Kenya documentation on IK and practices is far from complete. It is therefore important that studies on the IK systems of all ethnic groups are carried out to ensure adequate restoration of these invaluable models. Despite the notable conservation efforts cited in Kenya, the future of such indigenous models is now in jeopardy owing to the unmatched rapid change in both socio-cultural economic systems. This calls for concerted efforts from all disciplines with a view to restoring these conservation models.

1.2.4: Literature on the Ilchamus

The majority of livestock in the Njemps Flats are the unimproved local breeds of low-productivity (Little, 1980). The small East African goats are valued owing to their ability to produce milk even during dry seasons. Most of the sheep are the fat-tailed red Maasai breeds, although Dorper and Black Head Persian cross-breeds are also found (Little, 1981). Donkeys are of less economic benefits because their products are not popular. They are useful for transport of goods but with the introduction of bicycles, these have become less important.

For the Ilchamus, the plant world is divided into **"IlKeek"** (trees) and **"n-kujit"** (grass). Any life form more than two metres high is a tree (Heine, and Heine, 1988). The Ilchamus also have classified plants on a particular defined purpose, such as the habitat. Those that are growing in the Lake Baringo basin are referred to as **"IlKeek Loo Ilpurked"** (lowland trees) whilst those found in the mountain ranges surrounding the lake basin are called **"Ilkeek Loo Ildonyo"** or **"supuko"** (highland trees). The former are said to be bigger but of less medicinal value than

= latter which are conceived of as having diversified medicinal potential. However, this is a ntroversial issue.

Plants have been variously utilized. The parts used for human consumption include the alk, as in the case with **"Sapunwa"** (*Echinochloa prymidalis*) or the leaves, as in the case with ants referred to as **"n-diati"** (vegetables) but in most cases it is either the fruits, the roots or bers which are consumed (Heine and Heine, 1988). Some species like **"Ilong'eri"** (*Cynodon* p.), the most common variety of grass found in this area, are considered as the most important all plants since they ensure the survival of their animals (Were, 1986).

Among the plants used for fencing settlements and for livestock enclosures by the hamus, **"Itii"** (*Acacia mellifera*, Benth) and **"Ilchurei"** (*Acacia reficiens*, Wawra) are nsidered to be the most appropriate. An assorted number of plants are also used for house nstruction. Grass is widely used for roofing (Heine and Heine, 1988). *Cynodon* spp. being = main source for thatching purposes. A small part of the Ilchamus population are engaged in hing in Lake Baringo and for this purpose they use light boats (**"Ilka'dic"**) made from "sipei" *eschynomene elaphroxylon*, Taub.) The paddles {**"n-ka'rawo", "n-karawo-n"** (Pl)} are ually carved from *Commiphora* sp., **"n-kayyama-i"** (*Commiphora africana*). **"Ilapusekenyi"** *alotropis procera*) may also be used for this purpose.

The Ilchamus use herbal medicine more frequently than modern medicine (Heine and ine, 1988; and Were, 1986). The main reason for this is probably that modern medicine olves more financial outlays than herbal medicine. Thus most people go to hospital as a last ort. Wood fuel (fuelwood and charcoal) is the common source of energy for the Ilchamus dada and Otieno, 1990). It is estimated that for the district the per capita consumption of fuelwood is 4680 kg. per year based on an estimated daily consumption of about 13 kg (Odada and Otieno. 1990).

Most studies on the Ilchamus have addressed the aspect of IK on plants. However. these studies have tended to ignore the indigenous models that are aimed at conserving these resources. Besides. the impact of these IK and practices on the biological resources has not received much attention.

In summary. it is apparent that there are inadequate empirical studies about indigenous knowledge and practices in Kenya and elsewhere. hence the need to narrow this information gap. It is also clear that there is no comprehensive study that has ever been carried out about the indigenous knowledge and practices of the Ilchamus with regard to woody plants' biodiversity conservation. Besides. related studies carried out elsewhere in Kenya appear to have been mainly superficial and descriptive with hardly any quantitative analysis.

Studies of this nature are therefore at their rudimentary stages. For this reason. this research is expected to make a significant contribution to knowledge through the documentation and evaluation of aspects of IK models that are pertinent to the conservation and exploitation of natural resources by these people.

1.3: JUSTIFICATION OF THE STUDY

Biological diversity is necessary to provide the material basis of human life; at one level, to maintain the biosphere as a functioning system. and at another to provide the basic materials for agriculture and other utilitarian needs (Groombridge, 1992). This study on biodiversity conservation is therefore expected to contribute significantly towards a broader perspective on the subject, with particular emphasis on the socio-ecological aspects. Plants are integral biotic components of an ecosystem and therefore knowledge on the influence of people on botanical diversity is useful, and so is comprehension of the total diversity (Stork, 1986).

This research was based on a rangeland setting which is amongst the most fragile ecosystems, with their threshold of critical damage only reached after a marginal modification through human activities (Myers, 1984). Consequently, the loss of biodiversity has serious implications in such environments. This makes the study area a priority for significant scientific inputs geared towards promoting its sustainability. Otherwise, unplanned exploitation of such fragile rangeland would inevitably lead to desertification.

Moreover, ASALs which occupy more than two thirds of Kenya's land mass accommodate communities threatened by desertification and hence breakdown of their livelihood. The study area therefore gives a representative setting the findings on which could be used for planning land use systems in ASALs. The study area is also unique in that it borders an important lake of the Rift Valley (Baringo), which is drying up fast (pencol, 1981). This calls for research into factors which may have implications on the declining water levels of the Lake and particularly in this area where there has been very little scientific input in contrast to most of the other Rift Valley lakes.

Traditionally, scientific conservation strategies have ignored or under-utilized indigenous knowledge and practices. This has led to strategies which hardly address the intended problems. It is therefore important to realize that understanding of a group's indigenous conservation knowledge systems could play an important facilitating role in establishing dialogue between rural communities and development workers (Warren 1993). Finally, it is important to apply new methods of approach such as Remote Sensing and GIS for efficient assessment of natural resources.

1.4: OBJECTIVES

The principal objective of this study was to investigate the role of indigenous knowledge and practices in plant biodiversity conservation among the Ilchamus of Baringo district. The following specific objectives were pursued:

1: To generate the land use/cover dynamics over the years, using the Geographic Information System.

2: To determine the impact of indigenous knowledge and practices on woody species biodiversity.

3: To establish whether indigenous knowledge and practices have contributed towards plant biodiversity conservation.

1.5: HYPOTHESES

1: H_0: The woody species densities do not manifest significant variation with their respective utilization intensities.

H_1: Alternative.

2: H_0: The woody perennials preserved in arable lands by the farmers are not significantly different.

H_1: Alternative.

1.6: OPERATIONAL DEFINITIONS

AGROFORESTRY:

A collective term for systems and technologies of land use where perennial woody plants are deliberately cultivated on areas otherwise used for crops and/or stock rearing.

AML:

A high-level algorithmic language that provides full programming capabilities and a set of tools for building menus to tailor user interfaces for specific applications. AML includes an extensive set of directives and in-line functions that can be used interactively or in AML programs (macros) as well as functions that report on the status of ARC/INFO command parameter.

ARC:

A string of x,y coordinate pairs (vertices) that begin at one location and end at another. Connecting the arc's vertices creates a line.

BIODIVERSITY:

Is the total variety of living organisms (plants, animals, fungi, and microbes). Biologists have conveniently considered biodiversity from three angles; GENETIC diversity, SPECIES Diversity and ECOSYSTEM Diversity. **Genetic Diversity** refers to the variety of genes (biochemical units of hereditary information); **Species Diversity** is considered here as a measure of the total number of species in a given area; while **Ecosystem Diversity** refers to the variety of habitats (e.g forests, wetlands, coral reefs, rivers, savannas, deserts) within which species occur.

CONSERVATION:

This is taken here as the management of human use of the biosphere so that it may yield the greatest sustainable benefit to the present generation while maintaining its potential to meet needs and aspirations of future generations. Management is thus used interchangeably with conservation in this study.

COVERAGE:

A digital version of a map forming the basic unit of vector data storage in ARC/INFO. A coverage stores map attributes as primary features (such as arcs, nodes, polygons, and label points) and secondary features (such as tics, map extent, links, and annotations).

DESERTIFICATION:

An impoverishment of arid and semi-arid ecosystems under the impact of human activities (UNEP, 1978).

DIGITIZER:

A device that consists of a table and a cursor with crosshairs and keys which is used to record the locations of map features as x,y coordinates.

EDGE MATCHING:

This is defined in this study as the editing procedure to ensure that all features that cross adjacent map sheets have the same edge locations.

EDIT:

Editing is the correction of errors within a computer file. a geographic data set. or a tabular file containing data.

HERBAL MEDICINE:

Locally prepared medicine from plants that is based on indigenous technology.

HOUSEHOLD:

This consists of a man. his wife and their children.

INDIGENOUS KNOWLEDGE (IK):

This is the local knowledge that is unique to a given culture or society. This knowledge is gained through inheritance. and it represents people's creativity, innovations and skills. **"Indigenous"** implies originating from, and naturally produced in an area, whilst **"Practices"** emphasizes the practical nature of their knowledge.

INTERSECT:

The topological integration of two spatial data sets that preserves features that fall within the spatial extent common to both input data sets.

LOOK UP TABLE:

1. A special tabular data file containing additional attributes for features stored in an associated feature table. The table can be an external attribute table or an INFO table that describes coverage features (ESRI. 1990).
2. An INFO look up table contains at least two items: the relate item and an item name either SYMBOL or LABEL.

MAP PROJECTION:

A systematic conversion of locations on the earth's surface from spherical to planar coordinates. Because the earth is in three-dimension, projection is used to depict it in two dimensions.

OVERSHOOT:

A portion of an arc digitized past its intersection with another arc.

REMOTE SENSING:

Acquiring information about an object without contacting it physically. This may be facilitated through the use of aerial photography, radar, and satellite imaging.

RMS ERROR:

The root mean square error (or tic registration error) is calculated when tics are used to register a map on the digitizer and during the TRANSFORMATION operation. The RMS value represents the amount of error between the original and new coordinate locations.

SCIENTIFIC MEDICINE:

Scientifically proven medicine.

SHRUB:

Shrub here refers to any woody plant less than three metres in height, and normally exhibiting multiple branching close to the ground with no obvious main stem (Berrie, 1987).

SUSTAINABLE DEVELOPMENT:

This refers to a form of development which is affordable, appropriate and generates its own momentum so that it can continue in case (donor) support is withdrawn.

TIC FILE:

The file used to store tic coordinates and tic IDs for a coverage.

TIC:

A Tic is referred in this study as a registration or geographic control point for a coverage representing known locations on the Earth's surface. Tics allow all coverage features to be recorded in a common coordinate system (e.g., Universal Transverse Mercator [UTM] meters or Straight Plane feet).

TOPOLOGY:

Topology is taken here to mean the spatial relationships between connecting or adjacent coverage features (e.g. arcs, nodes, polygons, and points). For example, the topology of an arc includes its from- and to- nodes, and its left and right polygons.

TRANSFORMATION:

This is the process that converts coordinates from one coordinate system to another through translation, rotation, and scaling.

TREE:

Any woody, single-stemmed plant more two metres in height. A tree has a conspicuous main stem (truck) and branches are limited to the upper part or there are no branches at all (Berrie, 1987).

UNDERSHOOT:

This refers to an arc that does not extend far enough to intersect another arc.

USER-ID:

This refers to a user-assigned identifier (ID) for a feature in a coverage. User-ID is used interchangeably with feature ID.

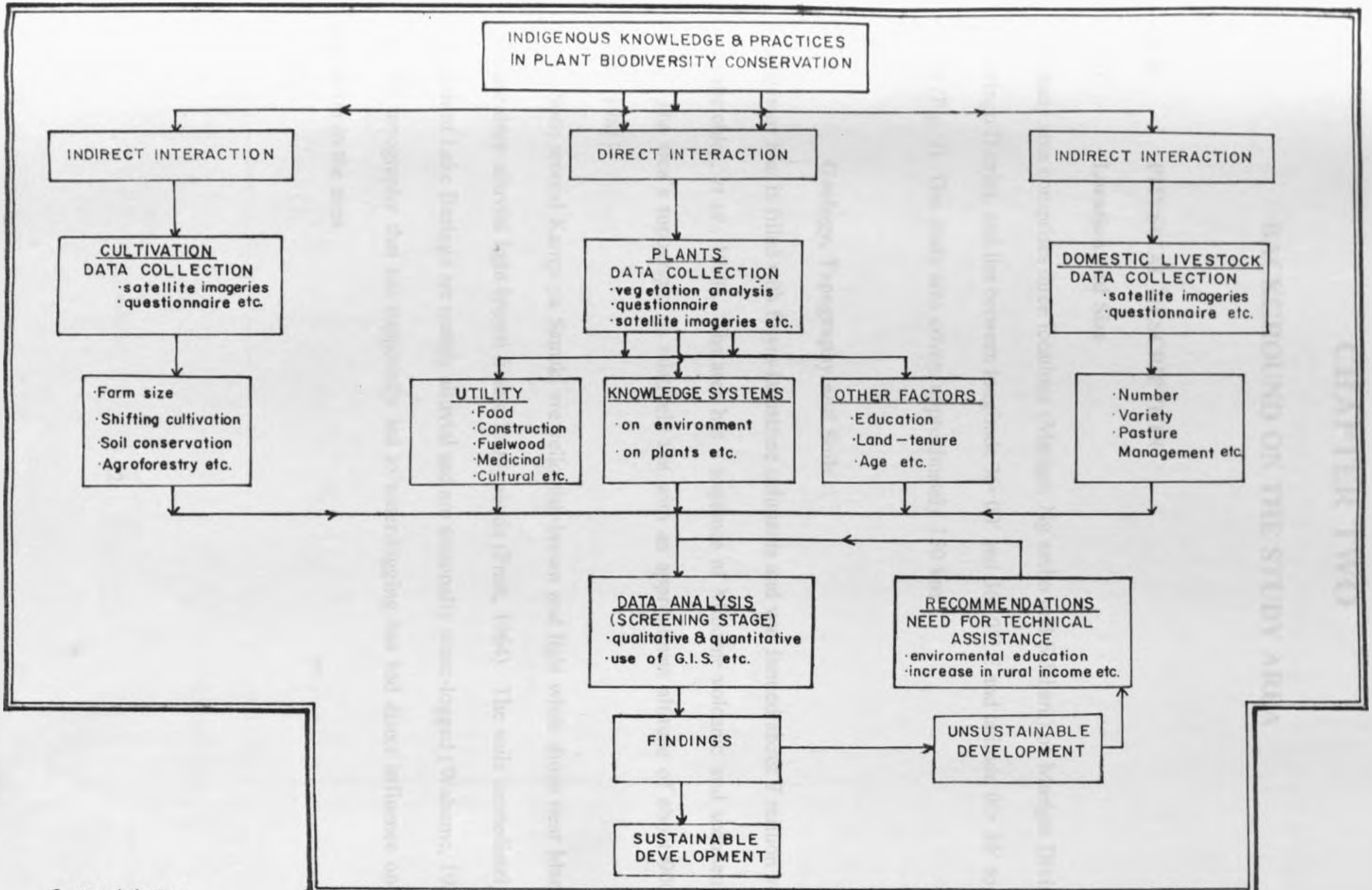
1.7: CONCEPTUAL FRAMEWORK

The framework lays emphasis on the concepts and organization within which the current study operates. This way, the study layout is presented to give readers a visual grasp of the rationale on which it was essentially based (Fig.1). An outline of important techniques (satellite imageries, questionnaire and vegetation analysis) for collection of relevant data is also provided.

As is clearly portrayed in the model, the use of biological resources (as a sources of construction material, food, etc.) has a direct impact on them. In addition, factors like land-tenure, education, etc., are also crucial to plant biodiversity conservation, while indigenous knowledge systems play an important role as well. On the other hand it is important to realize that some aspects of agriculture like farm size, shifting cultivation, and agroforestry are crucial for a more comprehensive pursuit of this topical subject. This contention is based on the fact that these aspects have an indirect impact on the woody plants' biodiversity.

At the data analysis stage, the validity of the indigenous knowledge and practices are tested and consequently calibrated to find out their sustainability. Thus, in the view of the findings, selected attributes of IK and practices are considered to contribute towards sustainable development. Recommendations based on the findings are also advanced to substitute or strengthen the weak IK and practices in order to ensure sustainability.

Rural communities have a potential which if supplemented with scientific knowledge would achieve practical and appropriate biodiversity conservation strategies. It is however important to note that neither the scientific nor the indigenous knowledge may succeed singly. Therefore there is urgent need for an integrated approach at all levels.



Source : Author

Fig. 1 : A conceptual framework to afford an illustrative summary of quantification and evaluation of some factors of IK and practices important for plant biodiversity

CHAPTER TWO

BACKGROUND ON THE STUDY AREA

2.1.0: PHYSICAL DESCRIPTION

2.1.1: Location and Size

The study area comprises three locations (Marigat, Ng'ambo and Salabani) of Marigat Division of Baringo District, and lies between longitude 36° 00' and 36° 05' E and latitude 00° 30' to 00° 36' N (Fig. 2). The study area covers approximately 150 km².

2.1.2: Geology, Topography and Soils

The *Njemps Flat* is filled with fluvio-lacustrine sediments and was formed about 7 million years ago (Sketchley, *et al*., 1978). The area has a sequence of Miocene volcanic and sedimentary rocks. The area's topography is relatively flat with an approximate altitude of about 900 m (Little, 1981).

Soils around Kampi ya Samaki are yellowish-brown and light while those near Marigat town are deep alluvial light-brown friable loamy sands (Pratt, 1964). The soils immediately to the south of Lake Baringo are mainly alluvial and are seasonally water-logged (Wahome, 1984). The flat topography that has supposedly led to water-logging has had direct influence on the vegetation in the area.

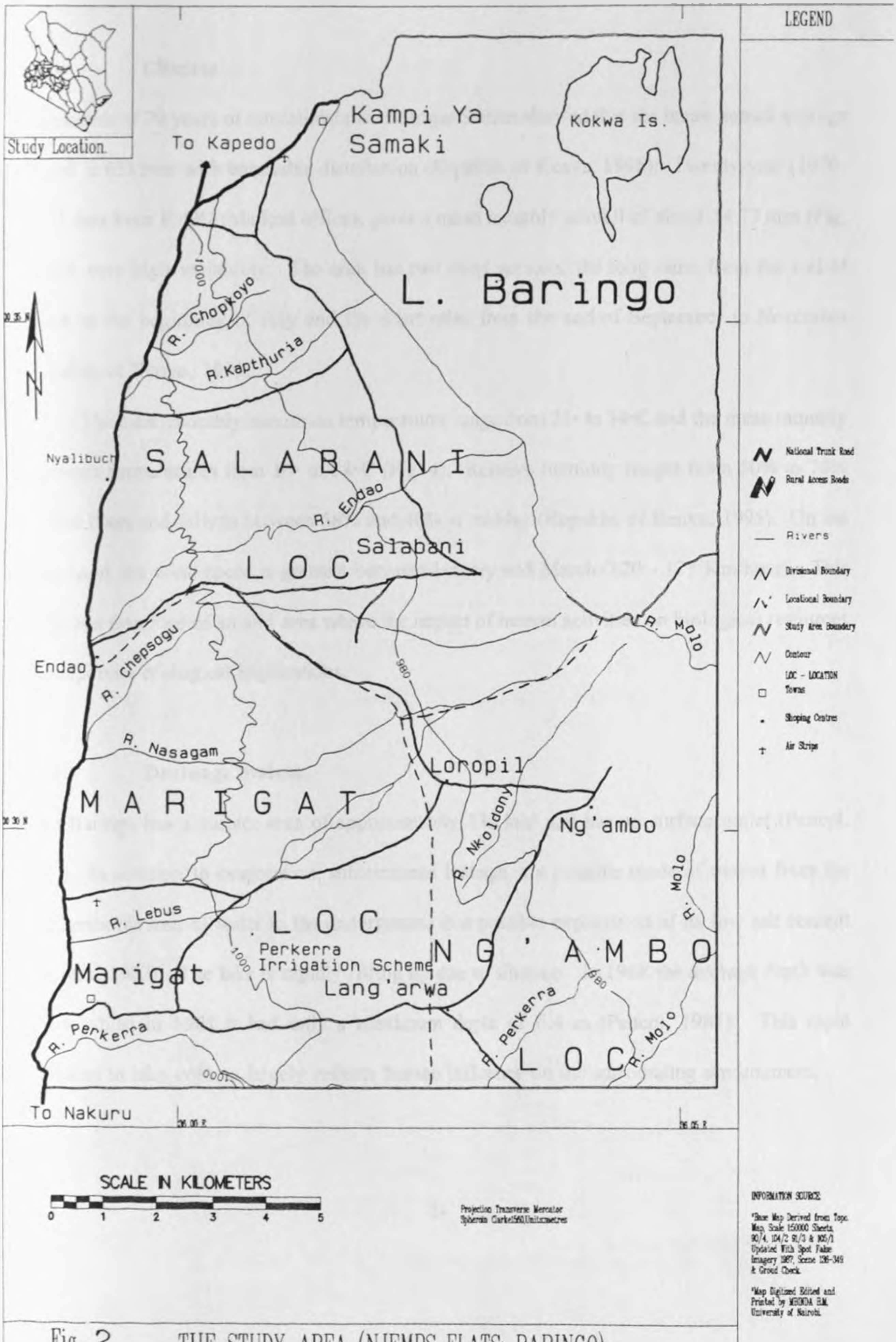


Fig. 2 THE STUDY AREA (NJEMPS FLATS; BARINGO): PHYSICAL FEATURES

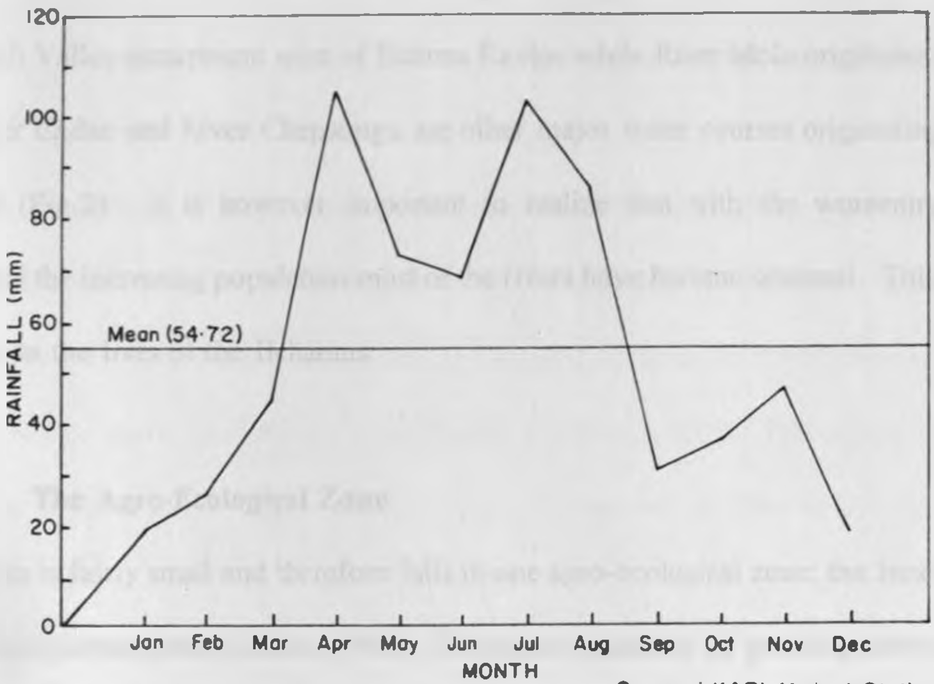
2.1.3: Climate

An analysis of 29 years of rainfall data for Marigat Station showed that the mean annual average rainfall is 653 mm with unreliable distribution (Republic of Kenya. 1995). Twenty-year (1970-1991) data from KARI (Marigat office), gives a mean monthly rainfall of about 54.77 mm (Fig. 3) with very high variability. The area has two rainy seasons: the long rains from the end of March to the beginning of July and the short rains from the end of September to November (Republic of Kenya, 1995).

The mean monthly maximum temperatures range from 31° to 34°C and the mean monthly minimum temperatures from 16° to 18°C (Fig. 4). Relative humidity ranges from 50% to 70% at 0600 hours and falls to between 56% and 40% at midday (Republic of Kenya. 1995). On the other hand, the wind speed is greatest between January and March (120 - 127 Km/hour). This study was therefore of an arid area where the impact of human activities on biological resources has important ecological implications.

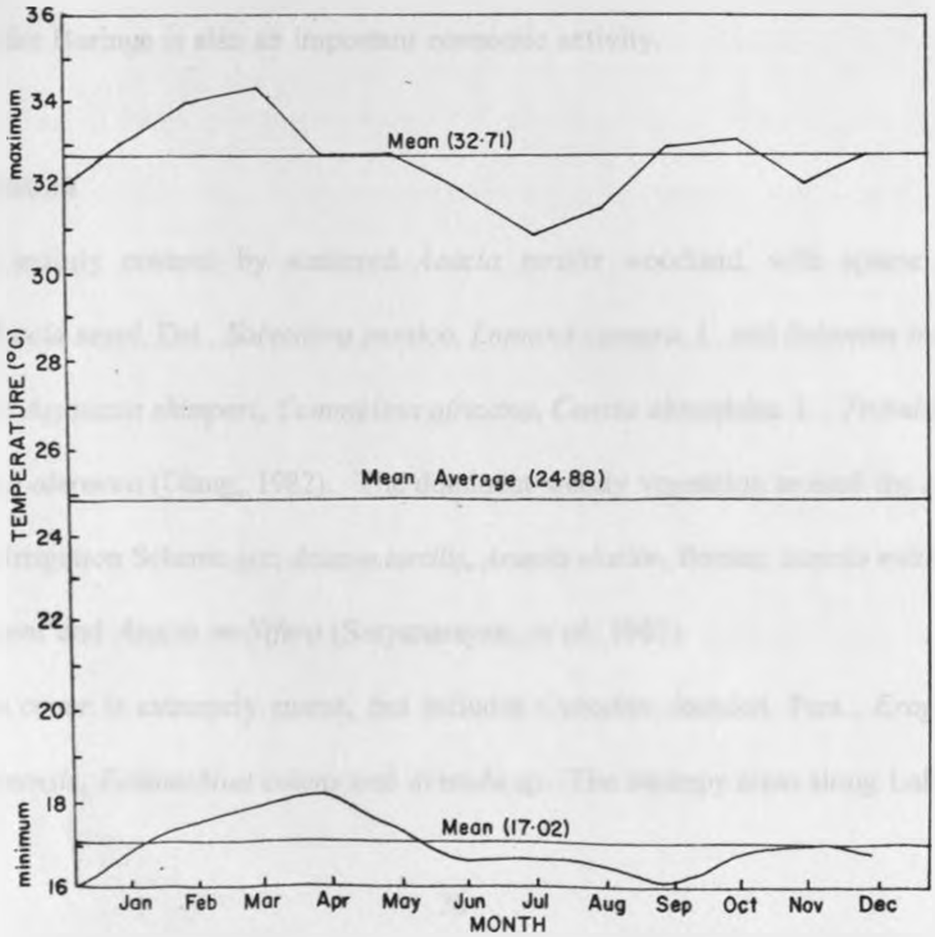
2.1.4: Drainage System

Lake Baringo has a surface area of approximately 130 km² and has no surface outlet (Pencol. 1981). In addition to evaporation, subterranean leakage is a possible mode of output from the lake hence the loss of water to the underground is a possible explanation of its low salt content (Sogreah, 1982). The lake is rapidly filling up due to siltation. In 1968 the average depth was 7.3 m whilst in 1981 it had only a maximum depth of 6.4 m (Pencol, 1981). This rapid reduction in lake volume largely reflects human influence on the surrounding environment.



Source : KARI, Marigat Station.

Fig. 3 : Mean monthly rainfall – 1970 – 1991



Source : KARI, Marigat Station.

Fig. 4 : Mean monthly maximum and minimum temperature – 1970 – 1991

Several streams drain into the lake, the largest being Perkerra and Molo. Perkerra River drains the Rift Valley escarpment west of Eldama Ravine while River Molo originates from Mau Forest. River Endao and River Chepsongu are other major water courses originating from the Tugen Hills (Fig.2). It is however important to realize that with the worsening climatic conditions and the increasing population most of the rivers have become seasonal. This has direct implications on the lives of the Ilchamus.

2.1.5: The Agro-Ecological Zone

The study area is fairly small and therefore falls in one agro-ecological zone; the Inner Lowland Ranching Zone (Jaetzold and Schmidt, 1982). This zone is suitable for growing cotton, sorghum and cowpeas. However, the ranching of cattle and goats is the most important economic activity. Fishing in Lake Baringo is also an important economic activity.

2.2: Vegetation

The area is mainly covered by scattered *Acacia tortilis* woodland, with sparse *Balanites aegyptica*, *Acacia seyal*, Del., *Salvadora persica*, *Lantana camara*, L. and *Solanum incanum*, L. Forbs include *Asystazia shimperi*, *Commelina africana*, *Cassia obtusifolia*, L., *Tribulus terrestis* and *Portulaca oleracea* (Olang, 1982). The dominant woody vegetation around the margins of the Perkerra Irrigation Scheme are; *Acacia tortilis*, *Acacia elatior*, Brenan, *Acacia nubica*, Benth, *Acacia reficiens* and *Acacia mellifera* (Satyanarayan, *et al.* 1967).

Grass cover is extremely sparse, but includes *Cynodon dactylon*, Pers., *Eragrostis* sp., *Erichloa fatmensis*, *Echinochloa colons* and *Aristida* sp. The swampy areas along Lake Baringo and those along River Molo are mostly dominated by grasses such as *Echinochloa haploclada. Chloris virgata. Cynodon dactylon. Brachiaria* sp., *Tetrapogon spathaceus* and *Dactloctenium aegypticum* (Olang. 1982).

There is usually considerable growth of ephemeral herbs after rains e.g. *Portulaca* sp. and *Tribulus terrestris*. These herbs are an important source of fodder for livestock. However these are only available for a very short time in the wet season. Otherwise, for most part of the year there is virtually no ground cover from either perennial grass or herbs. The vegetation varieties reviewed offer options for the Ilchamus who depend a great deal on these biological materials.

2.3.0: THE ILCHAMUS

2.3.1: Historical Background

The Ilchamus occupy part of Marigat Division of Baringo District together with the Tugens. The Ilchamus are a non-Kalenjin group who occupy the area immediately south of Lake Baringo and are composed of about 13 clans. It has been suggested that they sprang from a Samburu section called *Ildoigoi* in the mid-eighteenth century. Yet another theory proposes that they are one of the *Iloikop* group, a remnant of which migrated to and settled in the area, and their relatives are the Laikipia Maasai (Fedders and Salvadori, 1976).

2.3.2: Demographic and Settlement Patterns

According to the 1979 Population Census, there were 4,195 females and 1,487 males (total 5,682) Ilchamus. Table 2.1 gives population figures for the three locations of the study area for the year 1979 and 1989. The table (2.1) reveals quite a remarkable change as from the year 1979 to 1989 with the population increasing from 5682 to 15,389 over the respective years. This figures represent a total population increase of about 9707 persons within the 10 years period. Settlement intensity has also shown a notable change over the years. This increment in population has resulted in increased pressure on the biological resources. Table 2.2 presents information on changes in settlements on selected sites in the study area.

Table. 2.1: Population of the study area

Location	1979 Population	1989 population
Ng'ambo	2,902	4,019
Salabani	1,793	5,394
Marigat	987	5,976
Total	5,682	15,389

Source: Republic of Kenya, 1979 and 1989

Table 2.2: Changes in settlements of selected sites in the study area

SITE	No. OF SETTLEMENTS (1950)	No. OF SETTLEMENTS (1981)
Marigat	36	668
Kampi Samaki	2	463
Ng'ambo	20	136
Salabani	13	132

Source: Republic of Kenya, 1962, 1979 and 1989 Population Censuses, and Little (1981)

2.3.3: Economic Activities

The majority of the Ilchamus live on overgrazed central villages where every family has about half a hectare of land on which houses and the livestock **"Boma"** are constructed (Were, 1986). Thus, they are settled pastoralists who own land in common. However, some of them (especially the educated rich) are beginning to fence off individual plots particularly those close to Lake Baringo in order to ensure dry and wet private grazing grounds (Were, 1986). Such polarized settlement arrangements have had negative impact on the vegetation in the area.

The Ilchamus had developed an irrigation system using water from the Perkerra River as early as 1916 to produce millet, sorghum and gourds. However, the area was devastated by floods of 1918 (Fedders and Salvadori, 1976) which made the river to change its course and the people dispersed so that they now rely more on stock herding, as well as on some fishing activities. In 1936 the Ministry of Works (Hydraulic Branch) carried out a survey on the site and made proposals for an irrigation scheme. In 1954 the construction of the scheme started and the main canal was completed by 1956 using detainee labour (Fedders and Salvadori, 1976). By early 1959 up to 596 ha had been developed and planted with onions. While the scheme has a total gazetted area of 2340 ha, the irrigable land now is about 600 ha due to gradual reduction in the flow of River Perkerra. A notable number of the Ilchamus have 1.0 to 1.5 ha each at the scheme where the crops grown are mainly horticultural like onions and chillies. Due to the problems of marketing these crops, other crops like water melon, pawpaw, etc., are being tried.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1.0: INTRODUCTION

This chapter reviews the materials and methods used in the study. Remote Sensing and GIS were applied to assess the vegetation dynamics while quantitative vegetation analysis facilitated an in-depth analysis of the situation. Socio-economic data were generated through a questionnaire (Appendix 1) which was administered to a randomly-selected sample of households.

3.2.0: SAMPLING AND DATA COLLECTION

3.2.1: Preliminary Field Survey

A reconnaissance survey was carried out between November and December 1994. The exercise afforded baseline information on Land use/cover. During this period, collection and compilation of the first plant checklist was undertaken. Vegetation sampling sites were discerned concurrently. Ten copies of the questionnaire were used to pre-test it.

3.2.2: Land Use/Cover Classification and Mapping

This was afforded by the use of multitemporal imageries that were referenced with a topographic map of the area (a composite of sheets 90/4 Saimo, and 91/3 Lake Baringo, edition 3 - Republic of Kenya, 1983; and sheets 104/2 Marigat and 105/1 Ngelesha, edition 7 - Republic of Kenya, 1973).

Enhanced 1:50,000 dry season imageries were used. and a false colour composite SPOT imagery (scene 136-349) of 17/3/1987. and LANDSAT MSS (scene 181/60) of 31/1/1973. which was purchased from the Regional Centre for Services in Surveying Mapping and Remote Sensing. Each of this was overlaid with a transparent Myler[2] paper. and visually interpreted on a light table to delineate the scenes into various homogenous units/stands. based on the element analysis of tone. texture and patterns (Colwell. 1983). The units were transferred into the baseline map that was at the same scale and of the same paper quality.

The unit boundaries were verified and the necessary adjustments made. Consequently, vegetation types were delineated and further classified on the basis of their physiognomic structural characteristics and species composition. Areas that did not show significant changes in both imageries acted as reference points. which ensured accuracy within acceptable limits. Accuracy was further enhanced through adoption of a few (six) Land use/cover classes (Lillesand and Keiffer. 1987). as it will be shown in the later sections.

3.2.3: Vegetation Data Collection Techniques

For ground floristic survey. five sampling sites were chosen; Salabani and Ng'ambo (forests), Chemeron and Nyalibuch (shrublands) and Endao (woodland). These were the major vegetation types in the study area. In these sampling sites, characteristics of the woody plants such as the diameter and height were measured.

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[2] A stable paper that ensured accuracy in readiness for GIS analysis

3.2.3.1: **Point Centred Quarter (PCQ) Method**

Point Centred Quarter (PCQ), a plotless sampling technique, was adopted (Mueller-Dombois and Ellenberg, 1974; Cottam and Curtis, 1956). It is simple in application and has been recommended for East African vegetation (Agnew, *et al.*, 1983). At least two transects, each with a minimum of fifteen sampling points were executed at every sampling site. Accuracy was assumed to increase with the number of sampling points, hence, a minimum of 20 sampling points per stand were undertaken (Cottam and Curtis, 1956). The length of the transects ranged from 375 to 525 m, while the mid-distances from individual sample points was invariably 25 m.

At each sampling point, four mid-distances (one at each quarter) to the nearest individual plant were determined by the use of a measuring tape 30 m long (Plate 3.1). The diameters of the respective plants were measured at base position due to the nature of most species which were multi-stemmed at breast height (1.5 m above the ground). The heights of the plants were estimated with an Haga Gauge.

3.2.3.2: **Identification of Woody plants**

Field identification of the woody plants encountered was facilitated by the use of floral publications (Dale and Greenway, 1961; and Heine and Heine, 1988). Local names were given by the field assistant. Specimens which could not be identified in the field were collected, labelled and coded in readiness for further identification at the Forestry Department, Marigat Office. The final plant checklist was consequentially compiled (Appendix 2). Topographic, land use characteristics and other environmental features were systematically entered into a recording sheet (Appendix 3).

3.2.3.3: Cover Determination

A modified Relev e method as described by Grunblatt, *et al.*, (1989) was used. An area that was subjectively believed to represent a given community was chosen. Visual estimation of the canopy cover was done from an elevated point, such as the top of Tugen Hills (Plates 3.2 and 3.3). Figures 5a and 5b are sketches that are drawn from plate 3.2 and 3.3 respectively, in order to afford additional illustration. Cover classes were assigned for each community as follows: closed > 80%; dense (50-80%); open (21-50%), sparse (2-20%) and bare, < 2% (Grunblatt, *et al*., 1989).

3.2.4: Determination of the Soil Characteristics

This was limited to soil colour, texture and structure on the assumption that these to a good extent reflect major soil changes which influence the plant response. The soil colour was determined using the Munsell Colour Chart (Munsell Color Co., 1974), while the soil structure was identified and evaluated following FAO guidelines, (1977). Soil texture was determined using Buoyuocus Hydrometer Method as described by Milford (1976). This method is simple and most rapid for mechanical analysis of soil.

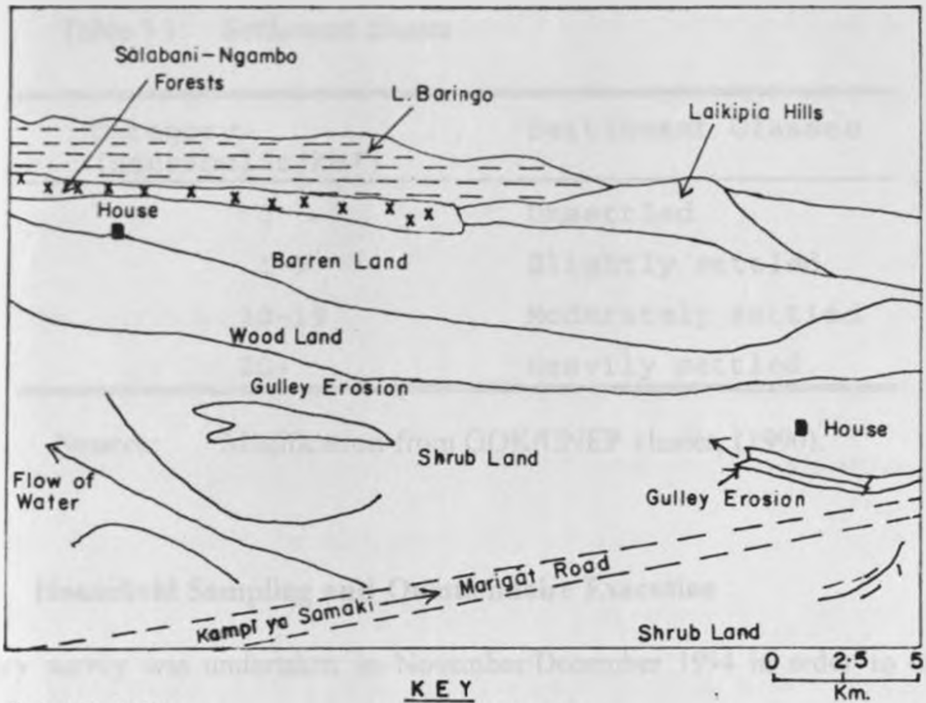
3.2.5: Determination of the Settlement Classes

Representative samples (five from each location) were taken, and the number of households counted per km². The classes used are a modification from those used in the GoK/UNEP (1990) report (see Table 3.1). By the use of the base map and extensive field surveys settlement class boundaries were delineated.

Plate 3.1: **Ng'ambo-Salabani forest; vegetation analysis using PCQ Method. *Acacia seyal* dominates the wood species (Author).**

Plate 3.2: The study area from the Tugen Hills towards Ng'ambo. Notice the barren land in the background (Author).

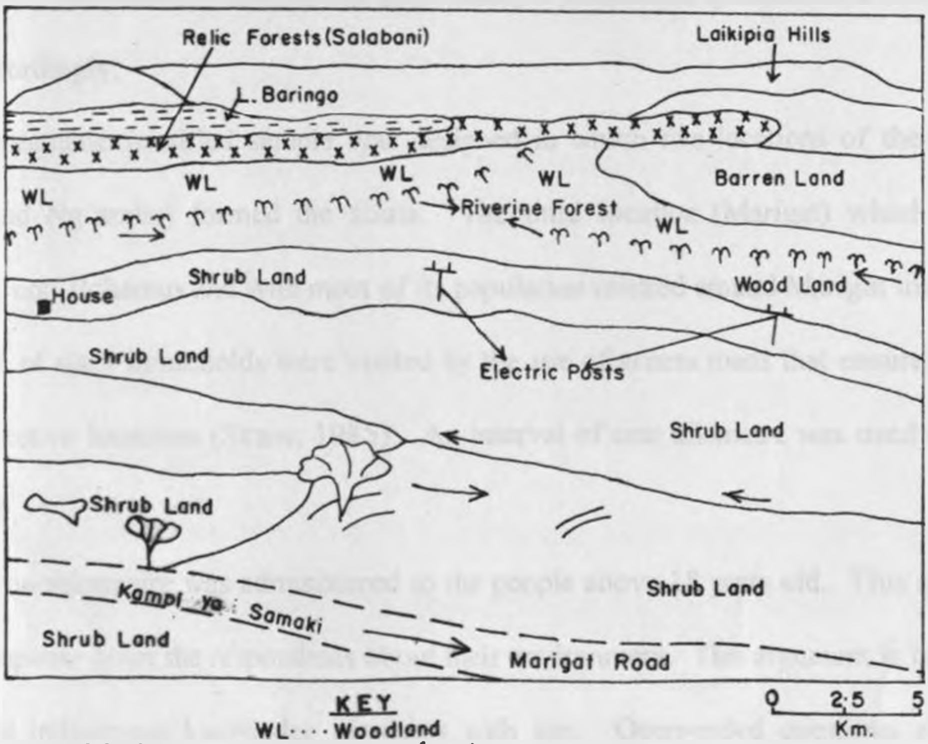
Plate 3.3: The study area: an overview from the Tugen Hills towards Lake Baringo (Author).



Source: Author

KEY
⟶ Flow of water

Fig. 5 a: Plate 3·2 in sketch



Source: Author

KEY
WL···· Woodland
⟶ Flow of water

Fig. 5b: Plate 3·3 in sketch

Table 3.1: Settlement classes

Category (Households/km²)	Settlement Classes
0	Unsettled
1-9	Slightly settled
10-19	Moderately settled
20+	Heavily settled.

Source: Modification from GOK/UNEP classes, (1990).

3.2.6: Household Sampling and Questionnaire Execution

A preliminary survey was undertaken in November/December 1994 in order to obtain prior knowledge on the population and its distribution, accessibility, as well as to assess the cost and time needed for the exercise. During this pilot survey a provisional questionnaire was tested and adjusted accordingly.

A systematic stratified sample was designed in which two locations of the study area (Salabani and Ng'ambo) formed the strata. The third location (Marigat) which is largely occupied by non-Ilchamus and with most of its population centred around Marigat town was left out. A total of sixty households were visited by the use of access roads that ensured least bias for the respective locations (Skane, 1985). An interval of one kilometre was used to pick the respondents.

The questionnaire was administered to the people above 18 years old. This age ensured informed response from the respondents about their environment. This argument is based on the premise that indigenous knowledge increases with age. Open-ended questions allowed the respondents to articulate their ideas freely, while the structured questions served to elicit specific information. In order to ensure accuracy all attempts were made to guard against procedural errors. say. failure to ask all the questions. inadequate probing. and inaccurate recording. among others (Moser and Kalton. 1971).

3.2.7: Direct Observation

Observation was made concurrently with all other activities executed during the field exercise. This form of data collection afforded observations of salient physical characteristics such as topography and water courses. In addition. human activities for instance, signs of charcoal burning. agricultural activities and felling of trees were also noted. The information obtained assisted in counter-checking verbal information. Ground photographs were also taken at selected sites to offer additional details.

3.3.0: DATA ANALYSIS

Where appropriate. both descriptive and inferential statistics have been utilized to organize and present information in various forms.

3.3.1.0: Vegetation Analysis

3.3.1.1: Species Diversity

The Shannon-Weiner Index was used to compute species diversity (Mueller-Dombois and Ellenberg. 1974 and Kershaw, 1974). As Odum (1979) notes, the Shannon Index is one of the best for making comparison because it is reasonably independent of sample size (which means that in practice fewer samples are required to obtain a reliable index for the purpose of comparison). The index is expressed as follows:

$$H_i = -\sum\{(n_i / N)\log_e(n_i / N)\}$$

where

H	=	Shannon-Weiner Index.
n_i	=	Number of individuals of the i^{th} species in the sample.
N	=	Total number of individuals.
n_i/N	=	Proportion of the i^{th} species represented in the sample.

3.3.1.2: Species Density

This is expressed according to Mueller-Dumbois and Ellenberg (1974) as:

$$Density(N / ha) = \frac{1}{d^2} x10,000$$

N/ha = Number of plants per hectare.

d^2 = The mean area, calculated by squaring the mean distance (d).

$$d = \frac{D}{Total\ No.\ of\ Measurements^*}$$

D = Total of distances (on a given unit).

* = Number of sample points times 4

$$\text{Relative Density for Species A} = \frac{\text{No. of Measurements for A}}{\text{No. of All Measurements}}$$

$$\textit{Absolute density for species A} = \textit{Total density} \times \textit{relative density}$$

3.3.1.3: Species Dominance

Dominant plant species are those which, by means of their number, coverage, or size, have considerable influence or control on the conditions of existence of associated species (Kershaw, 1974).

$$\textit{Relative dominance} = \frac{\textit{Total basal area of a species}}{\textit{Total basal area of all species}}$$

Where;

$$\textit{Basal Area} = \pi r^2$$

and r = half of the base diameter

π = pi (i.e. 3.14)

3.3.1.4: Relative Importance Value (RIV)

According to Curtis (1959), relative importance value is normally calculated as:

$$RIV = \textit{Relative Density} + \textit{Relative Frequency} + \textit{Relative Dominance}$$

However, for PCQ method, this index was calculated as:

$RIV = Relative\ density + Relative\ dominance$

This is because relative density and relative frequency are the same with PCQ (Agnew, *et al.* 1983; Mueller-Dumbois and Ellenberg, 1974)

3.3.1.5: Frequency

Frequency relates to the number of times a species occurs in a given number of repeatedly small plots or sample points. It is expressed as a fraction of the total sample points, usually in percent (Mueller-Dombois and Ellenberg, 1974).

$$Relative\ Frequency = \frac{Frequency\ of\ a\ Species}{\sum frequency\ of\ all\ Species} x100$$

3.3.2: Analysis of Socio-economic Data

The responses from the questionnaires were coded and later analyzed using the Scientific Package for Social Sciences (SPSS). This offered the capability to cross-tabulate various attributes and also generate other descriptive statistics (Hull, *et al.*, 1975).

3.3.3.0: Geographic Information System (GIS)

ARC/INFO was used as the GIS software. Unlike IDRISI GIS software, ARC/INFO has a superior capability in handling an enormous data base with efficiency. The data to be automated was organized thematically as a series of layers (coverages in ARC/INFO language). Thematic layers for the same year represented vertical coverages.

Digitizing was carried out using the ARC/INFO edit graphic coverage module (ESRI, 1990). The module was also used in correcting the digitizing errors (Interactive Graphic Editor, 1989). Then, GIS map production and analysis was carried out systematically through various steps, as outlined below.

3.3.3.1: Creation of a Master tic file

Co-ordinates were entered by means of a digitizer in straight table units (inches[3]). To facilitate a digitizer transformation it was necessary to enter at least 4 tics with their identities which acted as control or reference points that allowed registration of coverage features to a common coordinate system.

With this, a Boundary file (BND File) that defined coordinate limits and the map extent was created. Root mean square (RMS) error was maintained below 0.003 inches (0.008 cm) to ensure accuracy (ESRI, 1990).

3.3.3.2: Cover Creation

Arc edit module of ARC/INFO was used. Using crosshairs of the digitizing pad, arcs were retraced systematically. By the end of the process, draft maps on a myler paper were transformed in digital format in readiness for further manipulation.

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[3] During transformation process this measurements are converted into SI units (metres)

3.3.3.3: Construction of Topology

Spatial relationships were defined using the mathematical procedures of the ARC/INFO programme (ESRI, 1990). By the use of **CLEAN** command it was possible to construct topology of the coverages. Clean command was used to intersect arcs where they cross by inserting a node, and in correcting undershoots as well as overshoots within a specified tolerance. On the other hand **BUILD** command was used at some stages to reconstruct topology whenever slight changes (editing) were made. At this stage the coverages were ready for projection.

3.3.3.4: Transformation

The digitized coverage had x and y coordinates still in digitizer measurement of inches which were later converted to real world coordinate system and projection in which the original map was created. A Tic table was developed manually. This contained a list of all the tic numbers and the known locational reference for each tic, read from the original map. Universal Transverse Mercator (UTM) coordinate system was used. For projection, the real world locations were conventionally referenced in degrees, minutes and seconds.

3.3.3.5: Analysis

Overlaying of the coverages resulted into composites that demonstrated various relationships. Simple statistics to calculate areas and percentages were also possible to work out.

3.3.3.6: Making look-up tables (LUT) and the key

A LUT which presents **CODES** and their respective **SYMBOLS** in a tabular form was made. A key was used to give a particular symbol its corresponding text.

3.3.3.7: Arc Macro Language (AML) File

AML was used to customize a series of ARC/INFO commands. This was facilitated by AML processor that interprets these commands (Interactive Graphic Editor, 1989). After manipulation AML File was converted into **PLOT FILE** in readiness for plotting.

3.3.4.0: Statistical Data Analysis

3.3.4.1: Rank Correlation

This statistic is based on ranks/order of observations and does not depend on a specific distribution of x and y. The formula for Spearman's rank correlation (r_s) is expressed according to Conover (1971) and Gupta and Kopoor (1983) as:

$$r_s = 1 - \frac{6 \sum d^2}{n(n^2 - 1)}$$

where,

r_s	=	the Spearman's rank correlation
d	=	different in ranks of a pair of scores
n	=	number of pairs of scores.

In case of two or more items occupying the same rank, a common rank was given to these This common rank was the average of the ranks which these items would have assumed if they were slightly different from each other, and the next item will get the rank next to the ranks already assumed (Gupta and Kopoor, 1983). As a result a correlation factor was added to the rank correlation formula. The factor is;

$$\frac{m(m^2 - 1)}{12}$$

Where; m = The number of times an item is repeated.

This was added to the Σd^2 (Gupta and Kopoor, 1983; Walker, 1953; Gregory 1978). Given that the data on the importance value of the woody species was in the form of ranks rather than in absolute values, this method was found to be one of the most appropriate statistical technique in handling of the data.

3.3.4.2: Chi-Square (x^2)

This is a simple but a powerful tool that works by testing a distribution actually observed in the field against some other distribution determined by a null hypothesis.

The formula may be expressed as:

$$x^2 = \Sigma^k \Sigma (0 - E)^2 / E$$

where:

r and k = rows and columns respectively.

$\Sigma^{*}\Sigma$ = sum over all rows and columns (sum of all the cells in the table).

E = Expected frequencies

O = Observed frequencies

To determine the expected frequency for any cell in the contingency table (i.e the frequency expected under the null hypothesis), the sum of the row in which the cell occurs was multiplied by the sum of the columns in which it occurs and divide by the total of the observed frequencies (McCullagh. 1974). On the other hand. the degrees of freedom were determined as follows:

$$\mathbf{Df = (r - 1)(k - 1)}$$

Where.

r = No. of rows

k = No. of columns

For the Chi-square test to be valid, the following conditions were taken into consideration;

1: The test only applies to frequencies, not to absolute values.

2: When degrees of freedom are more than 1, the Chi-square does not work if the expected frequencies in more than 20% of the cells is less than 5.

3: The total observed frequencies must equal at least 20.

4: The observations must be independent (i.e one observation must not influence another).

If the calculated value is greater than the critical value, the null (H_0) hypothesis is rejected and vice versa (Hammond and McCullagh, 1978; Gregory, 1978). This statistical method was highly appropriate in handling of the spatial information and this facilitated an explanation on the distribution of the woody species that were found in the arable areas.

3.4.0: LIMITATIONS

The research had several limitations. The main ones were:

Funds were limited, presenting a lot of practical difficulties. The purchase of digital imageries was consequently limited to two sets (LANDSAT, 1973 and SPOT, 1987). More sets would have afforded a better comparative aspect on the environmental dynamics. The study was also restricted to an area of about 100 km² due to logistical difficulties precipitated by inadequate funds. Due to unreliable public transport in the study area, private movement arrangements were made, making the exercise even more costly. Time was also a real constraint at every stage of the exercise.

Most respondents could not articulate their ideas effectively in either English or Kiswahili. An interpreter was therefore necessary at every stage. Assigning some technical words like biodiversity an equivalent meaning in the local language context was a real challenge, not to mention the cost of hiring an interpreter. Suspicion was also a common difficulty encountered during the interviews.

CHAPTER FOUR

LAND USE/COVER CHARACTERISTICS AND DYNAMICS

4.1.0: INTRODUCTION

In a bid to determine how the people have influenced the biological resources, attempts have been made to explicitly evaluate the dynamics of vegetation in the study area. Description and discussion of the vegetation communities is offered, based on salient features obtained from the quantitative floristic analysis.

4.2.0: LAND USE/COVER MAPPING AND ANALYSIS

4.2.1: The 1973 land use/cover in the study area

The mapping and subsequent further analysis followed the procedures outlined in chapter three. As Table 4.1 shows, 8 land-use/cover types were delineated and later quantified by the use of GIS (ARC/INFO) capabilities (ESRI,1990). The 1973 LANDSAT imagery was used as the data source.

The analysis indicates that most of the area in 1973 comprised of woodlands which covered about 8,360 ha, or approximately 41% of the study area (Fig. 6). Forest covered about 10% of the area (2,024 ha.), while riverine forests and shrublands covered 7.5% and 4.8% of the study area respectively (Table 4.1). The lake sector of the study area had an area coverage of about 5,385 ha (26.2% of the study area). The observed distribution is discussed in later sections.

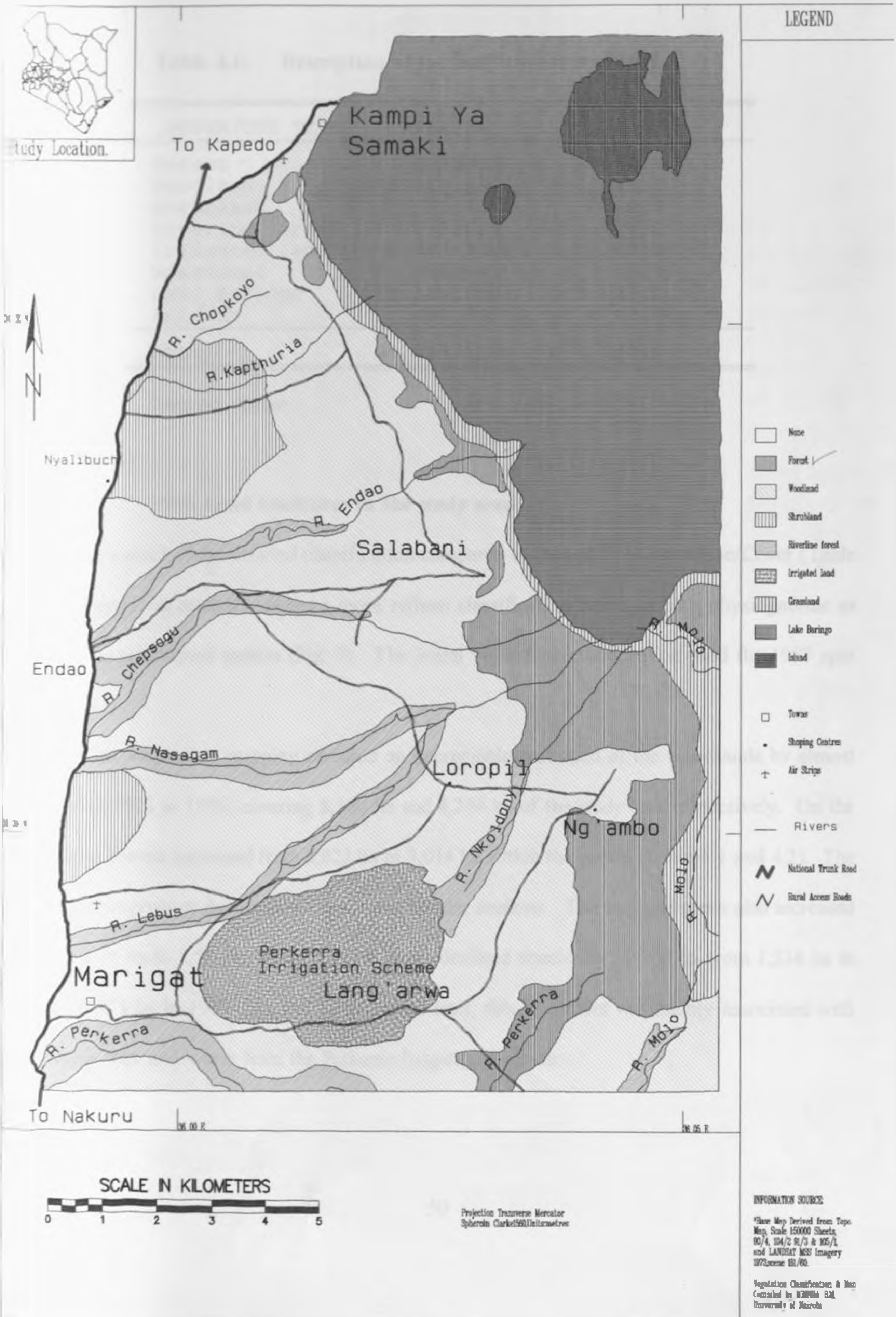


Fig 6: THE STUDY AREA (NJEMPS FLATS;BARINGO): VEGETATION MAP 1973

Table 4.1: Description of the land use/cover in 1973

COVER/USE TYPE	AREA(ha)	% AREA
Forest	2,023.919	9.9
Woodland	8,360.257	40.7
Shrubland	991.469	4.8
Riverine forest	1,535.620	7.5
Irrigated land	1,097.713	5.3
Grassland	720.641	3.5
Lake Baringo	5,384.590	26.2
Islands	430.895	2.1
Total	20,545.102	100.0

Source: Author

4.2.2: 1995 Land Use/Cover in the study area

This was a much more detailed classification compared to that of 1973 Land Use/Cover (Table 4.2). Vegetation analysis offered a more refined classification based on both physiognomic as well as compositional aspects (Fig. 7). The initial vegetation classification used the 1987 spot imagery.

The vegetation mapping revealed an appreciable reduction of the woodlands by almost half from 1973 to 1995, covering 8,360 ha and 4,254 ha of the study area respectively. On the converse, forests increased from 2,023 ha to 3,014 ha within the period (Table 4.1 and 4.2). The observed vegetation dynamics are discussed in later sections. The irrigated areas also increased from 1,098 ha to 1,512 ha while riverine forest declined drastically by 963 ha from 1,536 ha in 1973 to 573 ha in 1995. As will be discussed later, this increment was mainly associated with *Prosopis* spp. and water from the Perkerra Irrigation Scheme.

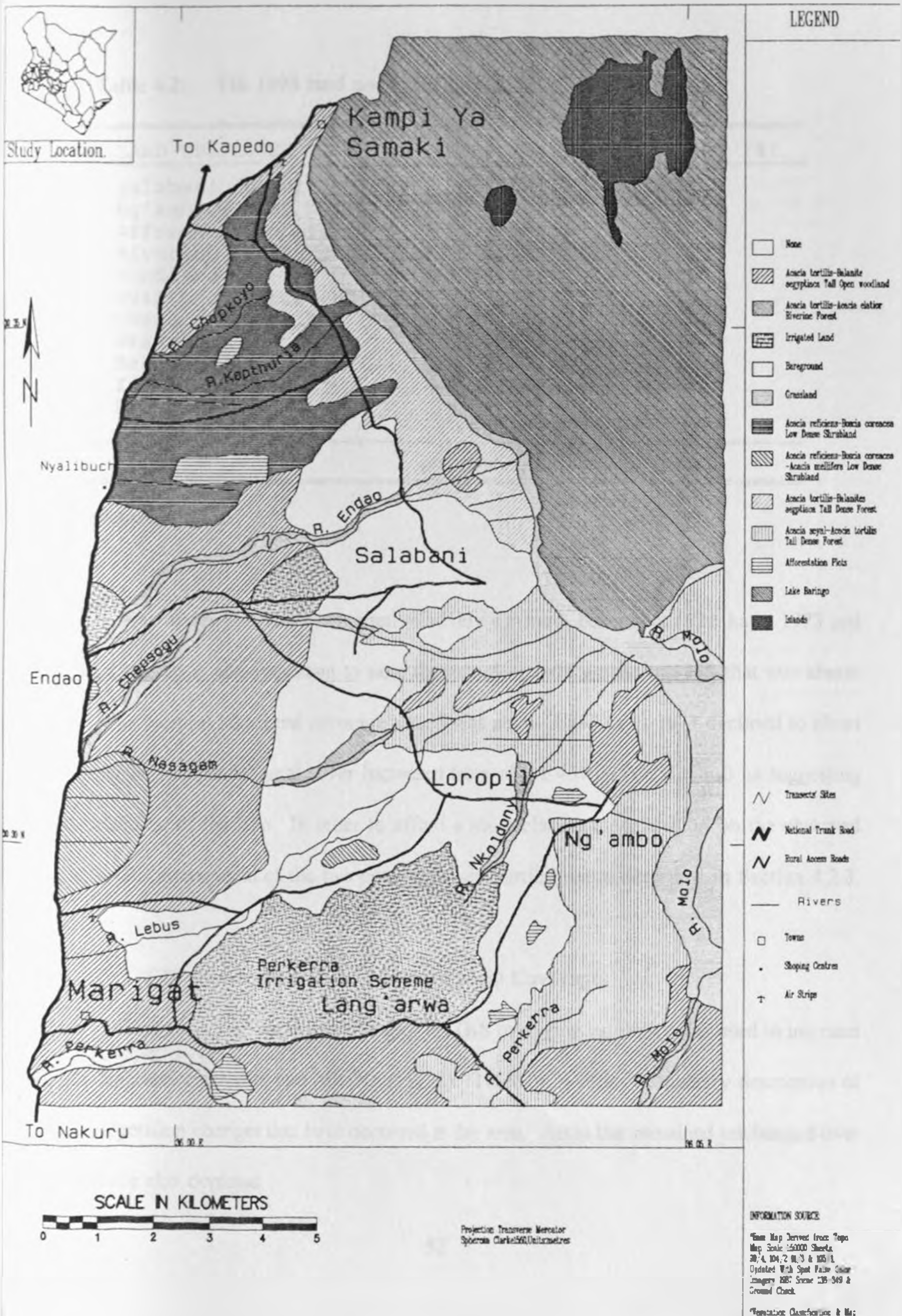


Fig.7: THE STUDY AREA (NJEMPS FLATS;BARINGO): 1995 VEGETATION MAP

Table 4.2: The 1995 land use/cover in the study area.

LAND USE/COVER TYPE	AREA (ha)	AREA (%)
Salabani forest	615.780	3.0
Ng'ambo forest	2,222.785	10.8
Afforestation plots	174.984	0.9
Riverine forest	573.211	2.8
Woodland	4,254.141	20.7
Nyalibuch shrubland	1,357.678	6.6
Chemeron shrubland	346.476	1.7
Grassland	885.724	4.3
Bare ground	3,079.321	15.0
Irrigated land	1,512.851	7.0
Lake Baringo	5,055.720	24.6
Islands	460.082	0.6
TOTAL	20,538.750	100.0

Source: Author

The area under grasslands remained relatively constant, being about 721 ha in 1973 and 886 ha in 1995. It is also important to note the extensive bare ground in 1995 that was absent in 1973. The sectoral lake areal coverage which was about 5,385 ha in 1973 declined to about 5056 ha, while the islands' areal cover increased from about 431 ha to about 460 ha suggesting possible receding of the lake. In order to afford a more elaborate explanation on the observed changes, a GIS intersection of the two coverages was carried out as described in Section 4.2.3.

4.2.3: GIS Intersection of the Multitemporal Coverages

In order to discern the land use/cover changes, the GIS overlying capability was used to intersect the 1973 land use/cover with that of 1995 (Fig. 8). Table (4.3) offers a summary description of the main vegetation changes that have occurred in the area. Areas that remained unchanged over the period are also depicted.

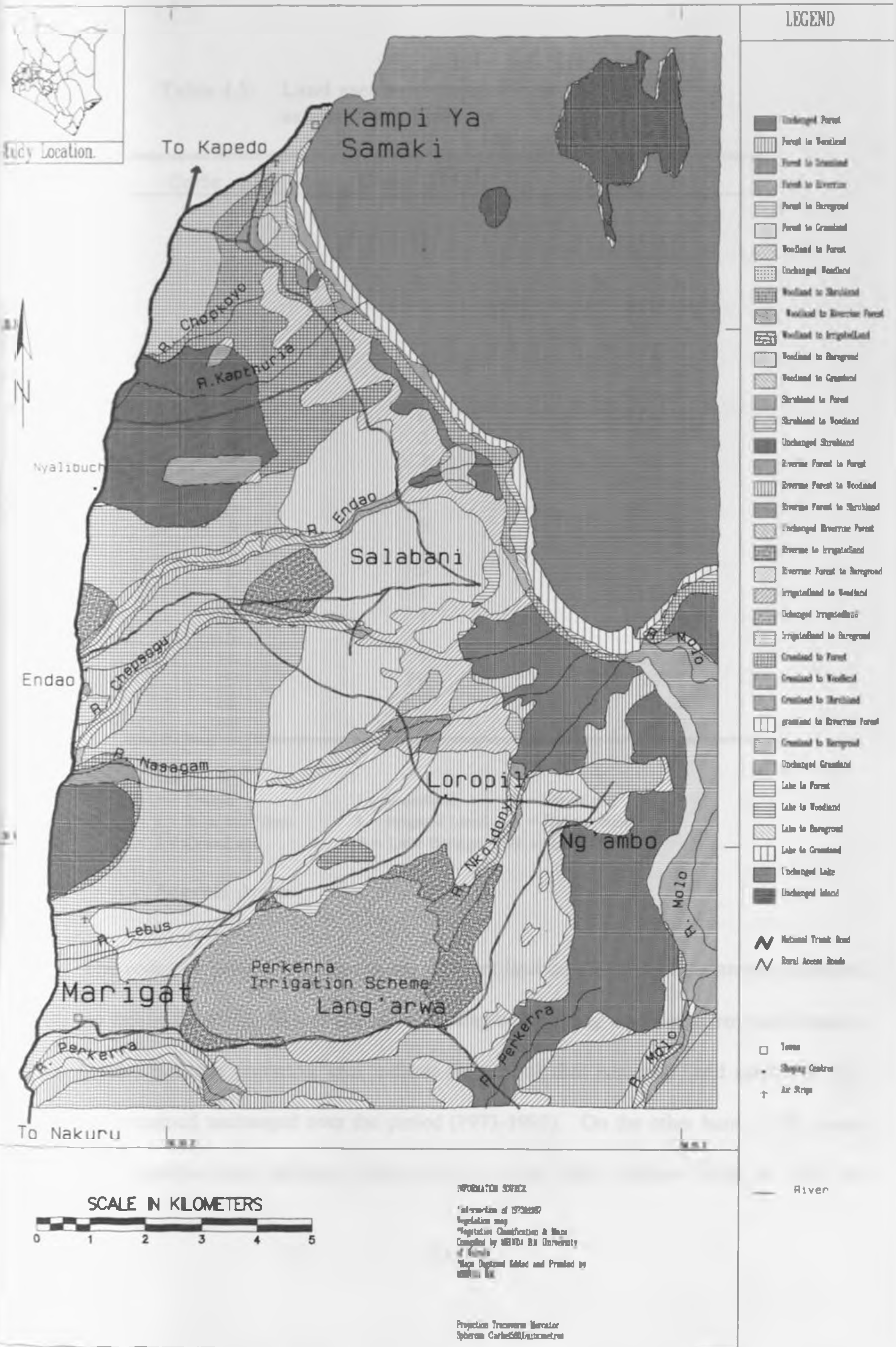


Fig. 8: THE STUDY AREA: (NJEMPS FLATS; BARINGO): 1973/95 LANDUSE/COVER COMPOSITE

Table 4.3: Land use/cover changes from 1973 to 1995 as sorted combinations

Code (73)	Code (95)	Area (ha)
1	1	1,572.4
1	2	260.7
1	3	29.3
1	6	27.4
1	7	122.5
2	1	1,031.6
2	2	3,378.2
2	3	724.4
2	5	424.8
2	6	2,604.4
4	2	512.2
4	3	41.3
4	4	474.4
4	5	100.0
4	6	408.8
5	2	91.8
5	5	987.0
7	1	186.9
7	7	503.3
15	1	46.4
15	7	243.8
15	15	5,056.5
15	99	25.3
99	99	433.0

Key

1 = Forests 2 = Woodland 3 = Shrubland
4 = Riverine Forest 5 = Irrigated Land 6 = Bare ground
7 = GrassLand 15 = Lake Baringo 99 = Islands

Source: Author

The codes in Table 4.3 represents the different land cover types in the area as indicated in the key below the table. In case the corresponding codes along a particular row are found to be invariable, then the respective area indicate the size of that particular land use/cover type which has remained unchanged over the period (1973-1995). On the other hand, if the codes differ, the respective area indicates what size of a given land use/cover type in 1973 has converted into the corresponding land use/cover type in 1995 (Table 4.3). Moreover, the areas that have changed or remained unchanged over the period are depicted in Figures, 9 and 10 Respectively.

The tabular data indicate minimal negative changes of the forested areas with only a total of about 440 ha of this converting into other cover types such as woodland (260 ha), shrubland (29 ha), grassland (122 ha) and bare ground (29 ha). On the average there was an observable increase in forest hectarage by about 991 ha, with about 1,031 ha, 187 ha and 46 ha, originally under woodland, grassland and the lake respectively, converting into the forests.

From the quantitative floristic analysis it may be safely concluded that *Prosopis* spp. had contributed remarkably to the observed increment in forests hectarage. Although it was meant to rehabilitate the degraded areas, the species had spread rapidly in and out of the plots to an extent of even dominating some areas, particularly along the shores of Lake Baringo. With the exception of its fruits which are highly palatable, the species is only desirable to livestock under conditions of extreme drought. This appeared to have given it a competitive advantage over the other palatable species.

Elsewhere, Glendening (1952) notes the rapid spread of *Prosopis* spp. in many parts of Southwest United States of America, affecting well over seventy million hectares of rangelands due to its well-developed root systems that ensure efficient utilization of the available water and nutrients. However, the species was found to be spreading at an alarming rate, thus threatening to become a weed that may in the long run exterminate the indigenous species thereby reducing biological diversity.

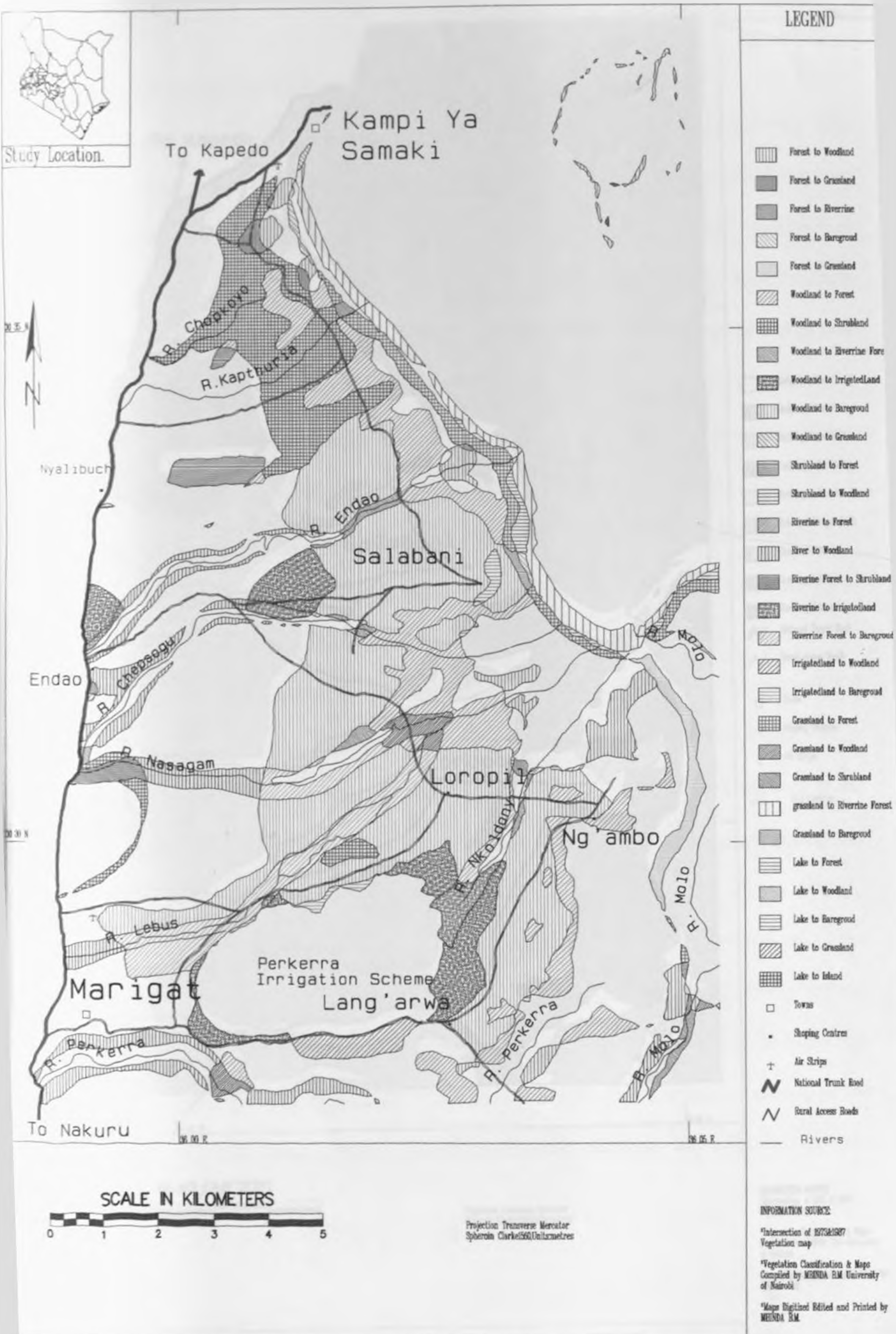


Fig. 9: THE STUDY AREA (NJEMPS FLATS;BARINGO): CHANGED LANDUSE/COVER 1973 -1995

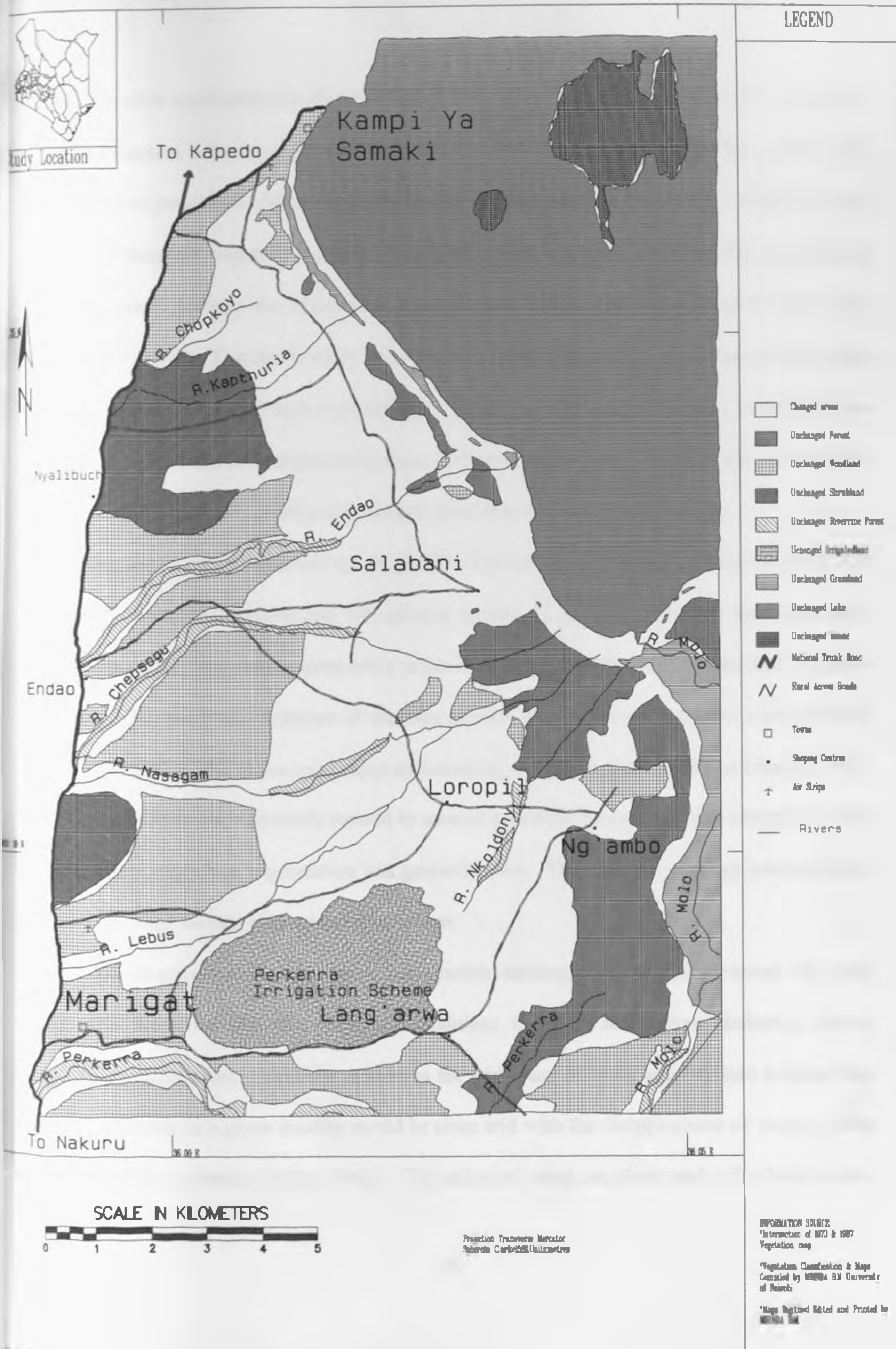


Fig. 10: THE STUDY AREA (NJEMPS FLATS;BARINGO): UNCHANGED LANDUSE/COVER 1973 -1995

The other explanation for the increased forest cover is the effect on ground water by the Perkerra Irrigation Scheme which was established in 1916 (Fedders and Salvadori. 1976). The irrigation water supposedly flows as both surface and subsurface. thus becoming available to these forests. Furthermore. vegetation in some localities has both expanded in area as well as improved in canopy cover. perhaps due to percolation of water from the irrigation scheme to these areas (GoK/UNEP. 1990). During the rains. the chemical fertilizers used in the scheme probably find their way to these forests through overland flow. Finally. as discussed in Chapter 5. the Ilchamus were found to have well-developed indigenous systems that have contributed to the conservation of these useful (culturally. medicinally and in other assorted uses) forest relics.

The reduction of woodland by about 49% of the original hectarage (Tables 4.1 and 4.2) was mainly through conversion into bare ground, by about 2,604 ha. A notable hectarage came under forest (1.032 ha), while some other areas were lost to shrubland (724 ha) and irrigation (424 ha). The observed expansion of the bare ground and shrublands with the corresponding reduction of the woodland coverage suggests worsening environmental conditions (Smiet. 1992). These communities were generally located in areas of relatively limited moisture compared to the forests. hence vegetation regeneration was generally slow. The situation was aggravated further by the increasing human and animal populations.

Human activities like agriculture, construction, fencing, collection of firewood, etc., have supposedly worsened the micro-climatic conditions in these areas, thus hindering normal vegetation regeneration. Similarly, studies in the arid areas of India and Pakistan indicate that the micro-climate in a given locality would be more arid with the disappearance of woody plants through human activities (White. 1961). The action of wind on plants and soils thus become more marked, temperature variations on and below the soil surface become greater and water infiltration rates into the soil decrease, making regeneration of the displaced vegetation difficult.

The expansion of the bare ground appeared to be mainly as a result of increased settlements (Figs. 11 and 12). The study revealed drastic vegetation destruction at the vicinity of the settlements, further rendering the soils susceptible to wind and water erosion. The soil structure had degenerated due to lack of organic matter. Consequently, soil porosity and its permeability as well as water storage capacity had declined leading to reduced biological activity (Jordan, 1986). This has in turn accelerated the desertification process.

On the other hand, there was a discernible reduction in the area of Lake Baringo. Quantitative GIS analysis indicated that the lake had receded by about 300 m from 1973 to 1995, an equivalent mean receding rate of about 14 m per year. This was mainly due to reduced water supply with increased vegetation destruction in the catchment areas that had rendered many rivers in the area seasonal. Vegetation destruction around the lake mainly through overgrazing and shifting cultivation had resulted into large quantities of sediments, ending up in the lake, thus, reducing its capacity.

This observation was supported by the characteristic light-blue colour of the lake from satellite imageries, *vis-a-vis* other water bodies within the Rift Valley, which indicates heavy suspended sediment load (Colwell, 1983). Similar findings have been made by Wahome (1984) who notes the heavy sediment load from the surrounding area and the Perkerra Irrigation Scheme.

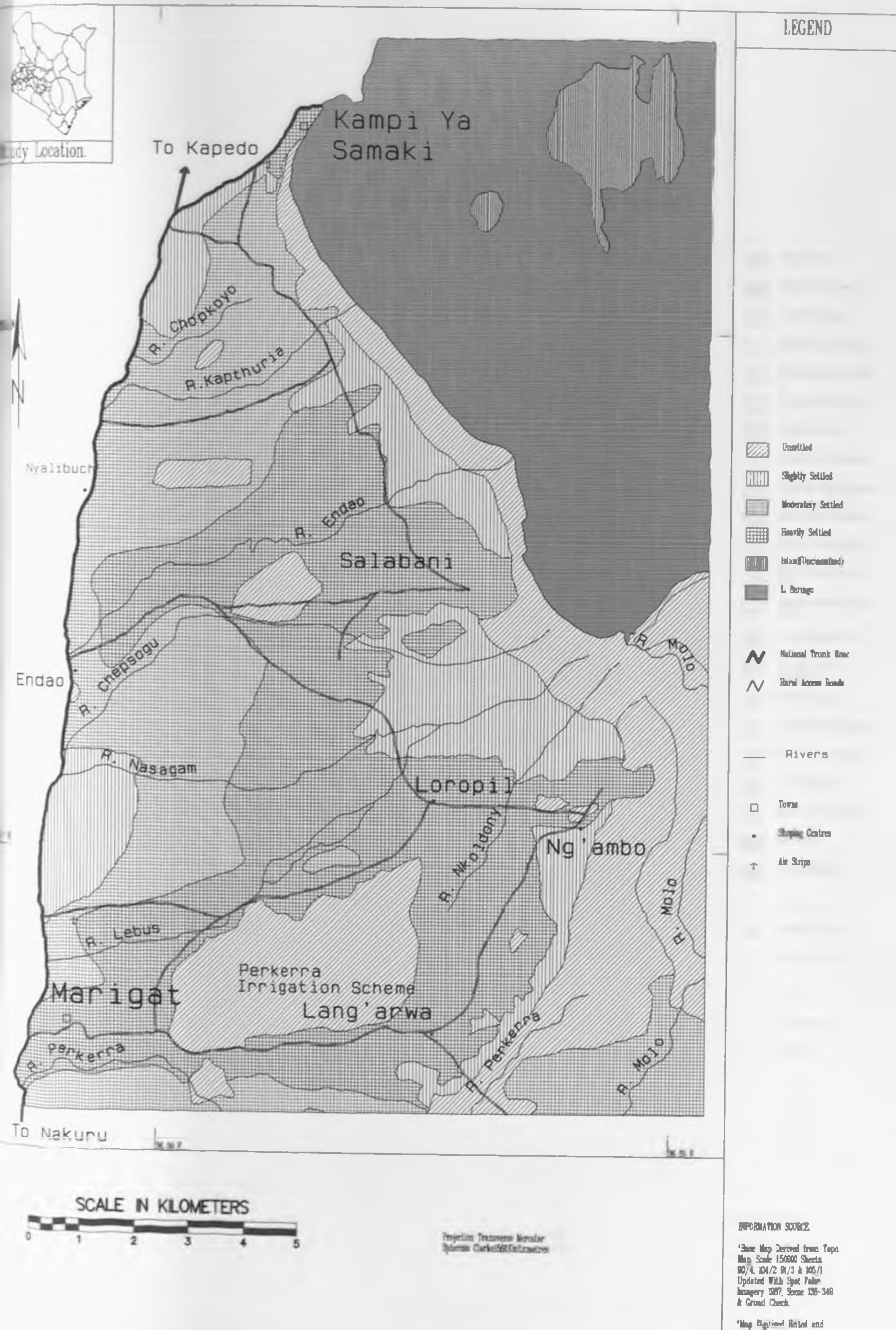


Fig. 11: THE STUDY AREA (NJEMPS FLATS;BARINGO) SETTLEMENT CLASSES 1995

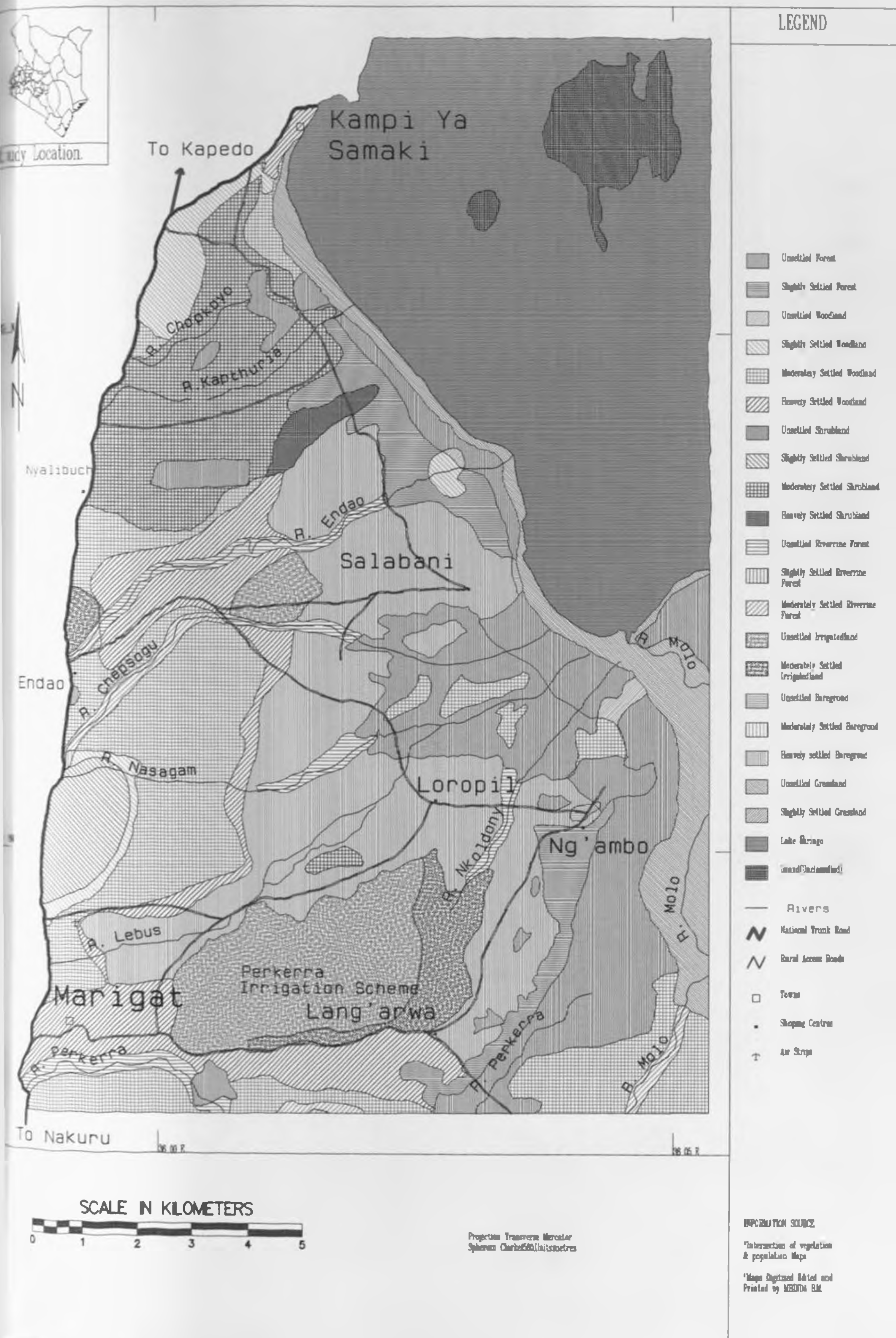


Fig. 12: THE STUDY AREA (NJEMPS FLATS; BARINGO): 1995 LANDUSE/COVER AND SETTLEMENT CLASSES

4.3.0: VEGETATION TYPES AND CHARACTERISTICS

4.3.1: *Acacia tortilis - Balanites aegyptica* Tall Dense Forest (Salabani).

This plant community covered the area to the western shoreline of Lake Baringo (Fig. 7) and had an areal coverage of about 615 ha (approximately 3% of the study area). Characteristic plant species in the community constituted *Acacia tortilis*. *Prosopis* spp., *Balanites aegyptica*. *Acacia nilotica*. (L.) Del, *Cordia sinensis*. Lam.. *Grewia mollis*. Juss., *Acacia mellifera*, *Ziziphus mauritiana*. Lam.. *Acacia reficiens* and *Fiscus sycomorus* (Table 4.4).

The average tree height was 13 m with some trees attaining up to 22 m and a base diameter up to 38 cm. The ground cover was generally dense and was dominated by *Solanum incanum*. *Tetrapogon tenellus*. *Pluchea ovalis*, Pers. and *Lantana camara*. The well-established ground cover was due to the relatively open canopy of this vegetation community. In addition, the area was unsettled, allowing effective vegetation establishment.

The community was predominantly made up of *Acacia tortilis* with a relative frequency of 65%, hence a relative density of about 65% (Table 4.4). It also exhibited the largest percentage dominance (76.9%) as well as the relative importance value (70.8%). *Prosopis spp.* and *Balanites aegyptica* were fairly abundant, with a frequency of 33 and 16 respectively (Table 4.4).

Table 4.4: Floristic characteristics within *Acacia tortilis - Balanites aegyptica* forest

Species	Relative Frequency (%)	Relative Density (%)	Relative Dominance (%)	RIV (%)
Acacia tortilis	64.5	64.5	76.89	70.8
Prosopis spp.	16.5	16.5	7.57	12.1
Balanites aegyptica	8.0	8.0	9.11	8.6
Acacia nilotica	3.0	3.0	1.71	2.4
Cordia sinensis	2.5	2.5	0.73	1.6
Grewia mollis	2.0	2.0	1.07	1.6
Acacia mellifera	1.0	1.0	2.23	1.6
Ziziphus mauritiana	1.0	1.0	0.25	0.7
Acacia reficiens	0.5	0.5	0.31	0.4
Ficus sycomorus	0.5	0.5	0.31	0.4
Total	100.0	100.0	100.00	100.0

Source: Author

The results further indicate that the majority of the species never occurred as important elements within the community, with only two species (*Acacia tortilis* and *Prosopis* spp.), attaining a RIV above the mean percentage (10%) of the species. This implies a situation whereby there are a few common species with a large number of individuals associated with other rare species consisting of only a few individuals (Odum, 1979). Such a community may be regarded as ecologically unstable, thus making it prone to any form of external disturbance.

Further floristic analysis revealed an average basal area of 18.6 m^2/ha whilst the Shannon-Weiner diversity index was 1.065. The diversity index was relatively high compared to that exhibited by the forest sample site around Ng'ambo (Fig. 7). This vegetation type had developed on soils that were relatively better-drained than the area around Ng'ambo which normally experienced more frequent seasonal floods, perhaps due to the raised water table after the rains.

thereby impeding drainage. Besides, the soils were relatively better structured, with granular and spongy structure.

Ground observations revealed extensive agricultural activities in the forest. Due to lack of agricultural intensification shifting cultivation was the prevalent practice in the area. This system had resulted in the elimination of the mature species, hence the observed low basal area. In addition, the notable cases of tree felling mostly for construction and fencing consumed a large number of trees. Although charcoal burning was found to be unpopular among the Ilchamus, there were isolated cases noted along the sampling transects. In addition, peeling off tree barks mainly for medicinal and construction purposes was also common (Plate 4.1) and this has had inevitable direct negative impact on the vegetation.

4.3.2: *Acacia seyal - Acacia tortilis* Tall Dense Forest (Salabani - Ng'ambo)

This community was a dense forest and covered an area of about 2.222 ha (about 11% of the study area) mainly to the South of Lake Baringo (Fig. 7). The species that characterized the community included *Acacia seyal*, *Acacia tortilis*, *Prosopis* spp., *Crateva adansonii*, Dc., *Securinega virosa*, (Wild.) Baill. and *Acacia elatior* (Table 4.5). The trees had an average height of about 15 m, with maximum base trunk diameter of about 86 cm.

Cynodon dactylon and *Diplachne fusca*, Beauv. were the dominant grasses, forming almost 100% cover on relatively open areas. Towards River Molo the grass often reached a height of 5-7 m (Plate 4.2). *Acalypha fruticosa*, Forsk formed a dense understorey in some areas. *Cassia obtusifolia*, *Lantana camara* and *Hygrophila auriculata*, Schumach. were also common.

Plate 4.1:

Salabani area: peeled off barks mainly for medicine and construction (Author).

Plate 4.2:

Diplanhe fusica grass near Molo River, entangled with trees (Author).

Table 4.5: Floristic characteristics within the *Acacia seyal* - *Acacia tortilis* forest.

Species	Relative Frequency (%)	Relative Density (%)	Relative Dominance (%)	RIV (%)
Acacia seyal	66.0	66.0	64.17	65.1
Acacia tortilis	29.0	29.0	34.23	32.0
Prosopis spp.	2.0	2.0	0.39	12.0
Crateva adansonii	0.7	0.7	0.18	0.4
Securinega virosa	0.7	0.7	0.15	0.4
Acacia eletior	0.7	0.7	0.89	0.8
Total	100.0	100.0	100.00	100.0

Source: Author.

Close examination of the quantitative floristic analysis indicate that *Acacia seyal* was floristically the most important component in this community, with RIV of up to 65% and a relative frequency of about 66% (Table 4.5). The second conspicuous species was *Acacia tortilis* with 29% of relative frequency/density, 34% of the total basal area, and a RIV of about 32%. The rest of the woody species were floristically unimportant with values less than the mean RIV (17%). This indicates a situation whereby most of the species are in imminent danger of local extinction incase of any adverse environmental conditions or intensified human activities.

Collectively, the average basal area was 41.09 m^2/ha with species diversity index of about 0.819. The observed low species diversity registered may be attributed to the fact that the vegetation type had developed on soils that were poorly-drained. They were also deep, greyish-brown to olive, with friable silty-clay loam. These soils were found to be extremely unstable and readily collapsed when wet forming massive structures that had probably prevented the establishment of ecologically-sensitive species. It is important to realize that soil type is a major factor causing compositional differences in vegetation types even when they exhibit the same physiognomy (Herlocker and barker, 1988).

This type of vegetation could also have occurred due to intense human activity, particularly in the area between Salabani and Nga'mbo whereby agricultural-based encroachment was a common practice (Plate 4.3). Similarly, in Salabani area forest tree-felling was rampant, mainly for construction and fencing (Plate 4.4). The habitual peeling of tree barks was also evident.

4.3.3: Afforestation Plots

The afforestation programme was started in 1982 by the GoK and FAO (Fedders and Salvadori, 1976). The main species planted were *Prosopis chilensis* and *Prosopis juliflora.* It is important to note that this are exotic species that were introduced in the area from India in 1982. uOther species like *Cassia siamea*, *Cassia spectablis* and *Croton megalocarpus* have largely failed to become established, and often individuals of trees could be observed. Planted indigenous species particularly *Acacia mellifera* and *Cordia sinensis* were evident in some plots as well.

Prosopis spp. appeared to be highly adapted to the local conditions, and had spread widely all over the study area. The fruits of *Prosopis* spp. are highly palatable to livestock (especially goats): a fact that largely explains their rapid dispersal (through animals' droppings). For example, Plate 4.5 shows the species patterned around what used to be a livestock **"Boma"** in an isolated area mainly dominated by shrubs in the Chemeron area (Fig. 7). The seeds of this species germinate better after pre-digestion of the testa and thus its relationship with animals may perhaps be regarded as co-evolutionary (World Bank,1992). Furthermore, children consume the fruits, contributing substantially to the dispersal process (Plate 4.6).

4.3.4: *Acacia tortilis - Acacia elatior* Riverine Forest

This vegetation type was observed along water courses and it covered about 2.8% of the study area. The main tree species were *Acacia tortilis* and *Acacia elatior*, with an understorey dominated by *Acacia mellifera*, and *Acacia fruticosa*. *Ficus sycomorus*, L. and *Crateva adansonii* were also a common occurrence, while the common grass was *Cynodon spp.* Quantitative floristic analysis could not be reasonably carried out, because most of the riverine forests have largely disappeared and were only represented by extremely thin strips few metres on either side of the water courses (Plate 4.7).

Since in a riverine environment there is normally high moisture content the unexpected diminishing vegetation cover seemed to have been caused by human activities rather than environmental factors. In fact, the settlement map of the area indicates heavy settlements along the water courses (Fig. 11). Therefore most of the vegetation had been cleared for agriculture and settlement.

4.3.5: *Acacia tortilis - Balanites aegyptica* Tall Open Woodland (Endao)

The representative sample site is an area immediately to the East of Endao shopping centre (Fig. 7). This community covered an area of about 4,254 ha which was approximately 2.8% of the study area. Floristic analysis showed that the vegetation type was characterized by *Acacia tortilis*, *Balanites aegyptica*, *Acacia mellifera*, *Maerua crassifolia*, Forssk., *Acacia reficiens*, *Cordia* *sinensis*, *Acacia elatior*, *Boscia coriacea*, Pax and *Salvadora persica* (Table 4.6). Trees had a mean height of about 11 m, with some emergent individuals reaching up to 16 metres in height and trunk base diameters of up to 123 cm were observed.

Table 4.6: Floristic characteristics of *Acacia tortilis* - *Balanites aegyptica* woodland

Species	Relative Frequency (%)	Relative Density (%)	Percentage Basal Area (Dominance)	RIV (%)
Acacia tortilis	40.8	40.8	45.24	45.0
Balanites aegyptica	17.5	17.5	15.27	16.4
Boscia coriacea	12.5	12.5	4.61	8.7
Maerua crassifolia	8.3	8.3	7.53	7.9
Solvadora persica	10.0	10.0	6.52	8.4
Acacia mellifera	5.0	5.0	8.00	3.2
Acacia elatior	3.3	3.3	12.24	8.8
Cordia sinensis	1.7	1.7	0.63	1.3
Acacia reficiens	0.8	0.8	0.05	0.5
Total	100.0	100.0	100.00	100.0

Source: Author

Acacia tortilis superseded the other species, registering about 41% of the total frequency and 45% of RIV (Table 4.6). It was also the most dominant species, with the highest percentage basal area (45). *Acacia mellifera*, *Cordia sinensis* and *Acacia reficiens* were the only species with an RIV of less than 7% (the mean RIV). The woodland further exhibited a correspondingly high species diversity index value of about 1.740. This community appeared to be relatively the most stable floristically, with most of the species exhibiting comparable RIV percentages (Table 4.6).

The observed floristic balance within this community was perhaps due to the relatively open structure, hence less extra-species competitive pressure. Comparatively, the soils were fairly better-drained than those in the forests, thereby facilitating a better environment for most species to establish. Given that this was an area of high settlement densities, it appeared that the local people had to a great extent managed to exert a fairly uniform exploitative pressure on virtually all the available species, thereby offering an opportunity for a wider range of species. Paine (1966), as quoted in Odum (1979), concludes that species diversity is directly related to the efficiency with which "predators" prevent monopolisation of the major environmental requisites by one species.

Moreover, the woodland was characterised by individuals of relatively large basal areas, thus recording the highest cumulative value of about 44.08 m^2/ha. The species were more spaced *vis-a-vis* those that constituted the forests, hence, there was less resource competition. Regeneration potential was very low, with most of the species encountered being well above 3 metres tall, hence there was little or no undergrowth, (Plate 4.8). Due to inadequate ground cover, a lot of rainwater was being lost as overland flow, partly undermining the regeneration process. The soil had also degenerated, tending to form a massive structure after rains. Felling of trees was limited, suggesting a high level of awareness about the importance of these biological resources. The practice of pollarding and/or lopping the trees for forage had highly helped in the conservation of trees in the area.

4.3.6: *Acacia reficiens - Boscia coriacea* low dense shrubland (Nyalibuch)

This shrubland was found to cover an area of about 1,357 ha. (approximately 6.6% of the study area). The woody species that characterized this community included: *Acacia tortilis*, *Acacia mellifera*, *Maerua crassifolia*, *Acacia reficiens*, *Boscia coriacea*, *Salvadora persica*, *Acacia nubica*, *Diospyros scabra*, (Chiov.) Cuf. and *Grewia tembensis*, Fres. (Table 4.7).

Plate 4.3: Freshly cleared forest (Ng'ambo-Salabani) for cultivation. *Acacia seyal* dominates the canopy cover (Author).

Plate 4.4: "Manyatta" construction: This consumes quite a substantial amount of biological resources (Author).

Plate 4.5: *Prosopis* spp. patterned around abandoned livestock "Boma"- Chemeron area (Author).

Plate 4.6: The vicinity of Marigat town: *Prosopis* spp. has become a major source of fruits in the area (Author)

Plate 4.7: Riverine forest forming a thin strip along River Nkoldony. *Acacia tortilis* dominates the vegetation (Author).

Plate 4.8: Woodland near Endao: Notice the extensive bare ground. *Balanites aegyptica* is conspicuous in the foreground (Author).

Table 4.7: Floristic characteristics within Nyalibuch shrubland

Species	Relative Frequency (%)	Relative Density (%)	Basal Area (%)	RIV (%)
Acacia reficiens	60.4	60.4	59.05	61.5
Boscia coriacea	12.9	12.9	10.60	11.2
Acacia mellifera	10.6	10.6	14.98	12.2
Maerua crassifolia	7.8	7.8	2.76	5.1
Acacia tortilis	2.3	2.3	5.96	4.0
Salvadora persica	2.3	2.3	4.60	3.3
Acacia nubica	2.3	2.3	1.64	1.9
Diospyros scabra	0.7	0.7	0.35	0.5
Grewia tembensis	0.7	0.7	0.11	0.4
Total	100.0	100.0	100.00	100.0

Source: Author

On the average, the shrubs were 4 metres tall with some isolated emergent trees going up to 10 m. The highest basal diameter recorded within the vegetation type was 22 cm, while the understorey mainly constituted, *Cissus cactiformis* and *Solanum incanum*. *Cynodon dactylon* and *Panicum coloratum* occurred preferably at the shrubs' base where there was shelter from grazers and other assorted disturbances. Additionally, *Aristida mutabilis*, Trin. & Rupr. and *Tetrapogon tenellius* occur.

From the table (4.7), it is evident that the vegetation type was dominated by *Acacia reficiens*, exhibiting about 60 and 62 of percentage relative frequency and RIV correspondingly. It had also the highest percentage basal area (about 59%). *Boscia coriacea*, *Acacia mellifera*, *Maerua crassifolia* occurred as fairly important elements, with RIV values above 5 percent. The cumulative basal area for this vegetation type was about 13.17 m^2/ha., owing to the generally small sizes of the shrubs. The species diversity was at 0.953, which is far below the corresponding value recorded within the Chemeron shrubland, of about 1.429 (Table. 4.10).

The soils here were more bouldery and stony. These appeared to have largely deterred easy establishment of vegetation, probably through roots' restriction. Generally this vegetation type had developed on a moderately drained, deep reddish to dark brown sticky sand clay with fairly granular structure when dry. Apart from the soils, this area seemed to be comparably drier than the rest of the study area, with only a few small streams passing through it (Fig. 7). Furthermore, settlement density in this area was higher *vis-a-vis* that of Chemeron shrubland, suggesting a more intense human influence on the vegetation than on the latter (Fig. 12).

4.3.7: *Acacia reficiens - Boscia coriacea - Acacia mellifera* Low Dense Shrubland (Chemeron)

This vegetation type covered the area between River Lebus and River Nasagam, immediately from the tarmac road that connects Kampi ya Samaki to Marigat town (Fig. 7). It had an areal coverage of approximately 346 ha, which was about 2% of the study area. The characteristic woody species included *Acacia tortilis, Acacia mellifera, Acacia reficiens, Boscia coriacea, Acacia nubica, Maerua crassifolia* and *Grewia tembensis* (Table 4.8). On the average, the shrubs were 3 metres tall with a few scattered emergent trees growing up to 9 metres high. The highest shrub basal diameter recorded was 29 cm. *Acalypha fruticosa* was the dominant undergrowth, while a few other species like *Cynodon dactylon* and *Heliotropium somalense*, Jaub & Spach were found as well. Incidents of shrub cutting were also apparent.

Table 4.8: Floristic characteristics within Chemeron shrubland

Species	Relative Frequency (%)	Relative Density (%)	Relative Dominance (%)	RIV (%)
Acacia reficiens	45.9	45.9	34.19	39.9
Acacia mellifera	23.3	23.3	25.87	24.5
Boscia coriacea	17.2	17.2	18.67	17.9
Acacia tortilis	7.8	7.8	10.98	9.4
Acacia nubica	2.6	2.6	2.47	2.5
Maerua crassifolia	2.6	2.6	7.82	5.2
Grewia tembensis	0.9	0.9	0.19	0.5
Total	100.0	100.0	100.00	100.0

Source: Author

Quantitative floristic analysis of this community indicate a marked difference between the percentage frequencies, with *Acacia reficiens* having about 46% of the total relative frequency while *Grewia tembensis* occurred only once, thus, having 0.9% of the frequency (Table 4.8). However, the species were relatively comparable in their RIV, which explains why there was comparatively fairly high species diversity (1.429). On the other hand the mean basal area for the woody species was found to be 17.45 m²/ha. Chemeron was an area of slight settlement, hence human influence on these biological resources was understandably minimal (Fig. 12). In addition the community had developed on soils that were well drained and less bouldery as compared to those of Nyalibuch shrubland. The soils were fairly structured, exhibiting a sub-angular blocky arrangement when dry, but showed tendency to form massive structure under wetness. As Fitzpatrick (1986) observes, structure is one of the least permanent properties of soils, for it can be altered very rapidly by any type of disturbance. Hence these soils seem to have played a critical role in allowing a more diversified species establishment.

4.3.8: Grasslands

Grasslands had an areal coverage of about 885 ha which was approximately 4% of the study area. The grassland community bordering the shoreline of Lake Baringo constituted mainly of a closed *Cynodon dactylon, Cyperus rotundus, Cyperus papyrus*, with scattered *Indigofera arracta*, A. Rich. shrubs comprising less than 20% of the canopy cover. Along Molo River the common grasses included *Cynodon dactylon, Diplachne fusca* and *Cynodon plectostachyum*, Pilger.

These vegetation communities had developed on soils that were poorly drained, greyish to light olive, soapy silty clay. Mottling at some localities was evident, implying some form of a reduction process (Fiztpatrick, 1986), which may be attributed to the frequent seasonal floods. This kind of phenomenon had probably restricted the establishment of most woody species, hence, resulting to grassland. The grassland was found to form an extremely important pasture for both domestic livestock (Plate 4.9), as well as for the wild animals, particularly zebras and wild pigs.

4.3.9: Bare ground/Barren land

It had an areal extent of about 3,079 ha, or approximately 15% of the study area, covering mainly the heavily settled region (Figs. 11 and 12). Characteristically, only ephemeral herbaceous species grew just after the rains, with the most prevalent herbaceous form being *Cissus cactiformis*, Gilg. which was normally elevated on abruptly sided pedestals (Plate 4.10), that are formed through piling up of sand by means of wind and/or sheet erosion. Wind erosion was particularly highly effective due to excellent fetch afforded by the long stretch of the open area. Therefore giant dust storms were consequently common afternoon phenomena. Very scattered woody species, predominantly *Acacia tortilis*, *Acacia nubica*, *Acacia reficiens* and *Solvadora persica* occurred in the area.

The area was characterized by soils that were imperfectly drained, moderately deep reddish to dark brown, sticky clay (Jaetzold and Schmidt, 1982). Soil structure was normally granular when dry but was found to collapse easily under light rains, forming massive structure. Soil devoid of vegetation for any length of time is liable to lose its structure as the microflora and fauna becomes poor (FitzPatrick, 1986). Water seepage was therefore limited, culminating into heavy overland flow that had caused serious soil transport, largely in form of sheet erosion. Consequently, the bare ground exhibited high reflectance tones on the spot imagery, which are characteristics of exposed subsoil and/or sandy soils sediments (Wahome, 1984). Consequently, the rate of vegetation regeneration was observed to be minimal due to the impoverished soils that were short of organic matter, and the poor soil structure.

4.4.0: Cumulative characteristics of the woody species

Cumulatively, the woody species were also analyzed in an attempt to demonstrate their relative status in terms of frequencies and densities (Table. 4.9). *Acacia tortilis* emerged as the most dominant species, with 33% of the total frequency and a mean density of 309/ha. This was an interesting finding given the fact that *Acacia tortilis* was found to be the most heavily used tree species by the local people. This observation may be attributed to the fact that *Acacia tortilis* grow vigorously, coppice readily and withstand heavy browsing (Khoshoo and Subrahmanyan, 1984). It also appeared to be well adapted to human activities: quickly establishing in freshly cleared fields, its dispersal being highly aided by livestock as well. Additionally, Ilchamus were found to conserve the important trees.

Table 4.9: Collective floristic characteristics within the study area

Species	Relative Frequency (%)	Relative Density (%)	Absolute Density
Acacia tortilis	32.7	32.7	308.81
Acacia mellifera	6.9	6.9	65.16
Maerua crassifolia	3.4	3.4	32.11
Acacia reficiens	19.1	19.1	180.38
Boscia corriacea	7.3	7.3	68.94
Salvadora persica	1.8	1.8	17.00
Acacia nubica	0.8	0.8	7.56
Acacia eletior	0.7	0.7	6.61
Securinega virosa	0.1	0.1	0.94
Acacia seyal	13.3	13.3	126.01
Prosopis spp.	5.1	5.1	47.22
Crateva adansonii	0.1	0.1	0.94
Balanites aegyptica	5.2	5.2	49.11
Cordia senensis	1.0	1.0	9.44
Grewia tembensis	0.3	0.3	2.83
Acacia nilotica	0.8	0.8	7.56
Ziziphus mauritiana	0.3	0.3	2.83
Ficus sycomorus	0.1	0.1	0.94
Grewia mollis	0.6	0.6	5.67
Sesbania kiniensis	0.1	0.1	0.94
Diospyros scabra	0.1	0.1	0.94
Total	100.0	100.0	941.93

Source: Author

Plate 4.9: Livestock grazing along the shoreline of Lake Baringo. Notice the Kokwa Island in the background (Author).

Plate 4.10: Bare ground/barren land near Loropil: *Cissus cactiformis* elevated on abruptly sided pedestals (Author).

The second important species was *Acacia reficiens*, having 19% of the total frequency and a mean density of about 180/ha. (Table.4.9). The other species of relative importance were; *Acacia seyal, Boscia corriacea, Balanites aegyptica* and *Prosopis* spp. with 13, 7, 7, 5 and 5 percent of the total frequency respectively.

Finally the rest (14 [67%] species) occurred as less important elements in the area with frequencies well below the average percentage (5%). Such species may be considered as locally threatened and as such, conservation should be geared towards promoting them. Otherwise, in such an ecosystem, the very few species can become extinct with external disturbance. However, such findings are in no way unique and tally with Gilbert's (1980) observation that many species of tropical forests exist at very low densities, leaving them extremely vulnerable to sudden elimination.

In summary, this chapter has highlighted the major vegetation dynamics in the area over the years. The species diversity index varied significantly across the communities (Table 4.10). It is important to realize that however much physical factors may be important in determining vegetation characteristics, human activities have the most tremendous influence on these.

Table 4.10: The Shannon-Weiner species diversity index of the vegetation communities

Salabani Forest	Ng'ambo Forest	Endao Woodland	Nyalibuch Shrubland	Chemeron Shrubland
1.065	0.819	1.740	0.953	1.429

Source: Author

CHAPTER FIVE

INDIGENOUS KNOWLEDGE AND PRACTICES IN WOODY PLANTS' BIODIVERSITY CONSERVATION

5.1: INTRODUCTION

This section presents a critical focus on how the Ilchamus relate with plants in the face of their socio-economic setting as well as their indigenous modes of life. Special attention has been directed towards determining whether or not these intricate rural systems have been instrumental in the conservation of these biological resources.

5.2: SOCIO-ECONOMIC CHARACTERISTICS OF THE ILCHAMUS

Analysis of the questionnaire (Appendix 1) indicated that out of the 60 respondents, 62% were male. Culturally, men are expected to offer more informed ideas and this made women to shy off whenever their husbands were within the homestead. 95% of the respondents had lived in the area for over 50 years, hence they can be considered to have had reliable information about their environment (Table 5.1).

The study revealed fairly low literacy levels, with almost half the respondents (48%) having no formal education, while 32% had only attained elementary education (Table 5.2). The rest (20%) had either attained secondary or post-secondary education. The practice of early marriage was preferable, denying most of the women education beyond primary school. Most women, therefore, remained in an economically subordinate position, making their contribution to the overall community development appear insignificant.

Table 5.1: Settlement duration in the study area

Duration (yrs)	No.of respondents	Percentage
< 50	3	5
> 50	57	95
Total	60	100

Source: Author

Table 5.2: Literacy level in the study area

Education level	No. of respondents	Percentage
None	29	47.7
Primary	19	31.7
Secondary and beyond	12	20.0
Total	60	100.0

Source: Author

The majority of the Ilchamus (82%) were low-income subsistence farmers who depend solely on small-scale subsistence agriculture. Only 18% supplemented their incomes from agriculture with earnings from other lucrative occupations. Such an economic position largely negates possibilities of sustainable use of the biological resources due to the limited economic options, hence, posing a real challenge that needs all disciplines to face and apply their talents in order to ameliorate the situation.

5.3.0: SOME IMPORTANT ASPECTS OF DIRECT IMPLICATION ON WOODY PLANTS' BIODIVERSITY

5.3.1: Settlement distribution

The intersection of the 1995 vegetation map (Fig.7) and the settlement map (Fig.11) of the study area indicate quite a notable relationship between settlement and vegetation distribution (Fig.12). Table 5.3 shows the area coverage by a given settlement class and the respective land use/cover type. The codes indicate the combinations of land use/cover types with their corresponding settlement classes, while the area show the hectarage of a particular land use/cover type that was under the respective settlement class (Table 5.3).

The forested area was either unsettled or slightly settled while most of the bare ground was heavily settled (Table 5.3). Most of the woodland was either moderately or heavily settled. with only 9% of its area falling under both unsettled and slightly settled classes. On the other hand. a substantial area under the shrubland (1,276 ha.) was found to be moderately settled (Table 5.3). Virtually all the area under grassland was unsettled (Over 99% of its area). This predominantly pastoralist group attaches much importance to these pasture areas.

It is important to notice the highly polarized settlement distribution in the area (Fig.11). The field survey revealed a strong tendency by the people to settle near the major pasture lands (either near Molo River or the lake banks) as well as at the vicinity of the main towns (Marigat and Kampi Ya Samaki). People also showed preference for the area around the Perkerra Irrigation Scheme. possibly to benefit from the irrigation water.

Table 5.3: The coverage by a given settlement class and the respective land use/cover type

VEGETATION	SETCLASS	CODE	AREA (ha)
1	1	11	1307.12
1	2	12	1513.33
2	1	21	42.54
2	2	22	357.16
2	3	23	2,708.26
2	4	24	1,339.29
3	1	31	3.01
3	2	32	317.71
3	3	33	1,276.00
3	4	34	107.44
4	1	41	13.98
4	2	42	5.28
4	3	43	167.15
4	4	44	386.80
5	1	51	1,121.33
5	3	53	391.53
6	1	61	16.98
6	3	63	0.34
6	4	64	3,062.00
7	1	71	885.71
7	2	72	0.01
7	4	74	0.01
15	15	15*	5,055.72
99	99	99*	460.08
Total	-	-	20,538.74

Key: VEGETATION:
1 = Forest; 2 = Woodland; 3 = Shrubland;
4 = Riverine; 5 = Grassland; 6 = Bare ground;
7 = Irrigated land.
SETTLEMENT:
1 = Unsettled; 2 = Slight; 3 = Moderate; 4 = heavy
OTHERS:
15 = Lake; 99; = Island; * = Unclassified

Source: Author

This behaviour is consistent with observations elsewhere. For instance, in Marsabit District there is sedentarization in certain localities, say, around water points, shops, schools and famine relief posts (GoK/UNEP, 1990). Such concentration had caused localized desertification along these strips The World Bank (1992) notes that population growth increases the demand for goods and services and this implies increased environmental damage due to additional direct pressure on natural resources The poor settlement distribution may be attributed largely to the undefined individual land rights, creating a scenario whereby people tended to concentrate in the areas endowed with relatively better resources.

5.3.2: Agricultural practices

Although basically pastoralists, the Ilchamus engage in considerable agricultural activities. Mainly, maize (*Zea mays*), beans (*Phaseolus vulgaris*), sorghum (*Sorghum vulgare*), and millet (*Panicum miliaceum*), were the preferred crops. The arable plots were fairly small but sizeable for tractor operation. Ox power is culturally unacceptable to this group because they consider this as unjustified torture to the animals. On the average, the cultivable land area was 0.5 to 1.5 ha per household.

The maintenance of soil fertility was minimal with majority of the farmers (72%) entirely dependent on intercropping and on-farm trees (Table 5.4). The rest (28%) were found to either apply manure and/or practice other methods of fertility regulation. Most farmers circumvent the eventual soil impoverishment by practising some kind of shifting cultivation. By virtue of the land being communally owned, farmers seemed to compete in making the best out of the relic forested areas. However, this production system appeared to have had some negative impact on the forests In the face of increasing population accompanied by shortened fallow periods, long-term shifting cultivation can have a significant impact on species composition in forests (Gomez-Pompa and Kaus, 1993). The net result of such activities is loss of forest species (Anderson, 1990). Disturbance (natural or man induced) alters forests as habitat for both animal and plant species. This tends to simplify the ecosystem and results into loss of biological diversity.

The extreme poverty that appeared to be endemic in the area, compounded by lack of incentive to invest on land without security are some factors that discouraged the farmers from cultivating on a sustainable basis. Moreover, credit facilities were largely inaccessible due to lack of title deeds. According to the World Bank (1992), poor communities often have a strong ethic of stewardship in managing their customary lands. But the fragile environment, limited resources and often poorly defined property rights prevent them from investing as much as they should in environmental protection. These multidimensional limitations have made the prospects of intensified agriculture largely futile, with a corresponding great loss of plants and their habitats. This habitat loss has been noted by Olkesyn and Reich (1994) as being accountable for regional decline of most woody species.

Table 5.4: Maintenance of soil fertility by the farmers

Methods	No. of respondents	%
Intercropping & Agroforestry.	43	71.7
Manure. Intercropping & Agroforestry	14	23.3
Soil Conservation. Intercropping & Agroforestry	3	5.0
Total	60	100.0

Source: Author

It is however interesting to note the contribution made by these farmers towards biological diversification through indigenous agroforestry practices. Farmers demonstrated a distinctive knowledge on agroforestry through careful discrimination of the species preserved in the arable lands. For instance, it was common knowledge that such species as a requirement should possess deep rooting systems in order to guard against competition for nutrient and/or moisture with the crops. The trees were widely believed to avail underground water and nutrients to the crops; an assertion that cannot be easily dismissed.

This indigenous production system is by no means unique. McKell (1980) observes that trees and shrubs have been used traditionally as part of rotational cropping in many regions of dry zones. He further notes that apart from restoring soil fertility and protecting it against wind erosion, the trees and shrubs provide fuelwood, fencing material and fodder.

Statistical analysis (Chi-square) of the available woody species on the arable land to determine any possible discrimination against some species by the farmers was highly significant ($p < 0.01$). The calculated x^2 was 23.52, with a corresponding critical value of 13.28 and 4 degrees of freedom. Only those species that occurred in more than 10 arable lands were considered to avoid a large number of cells with expected values of less than five (Gregory, 1978; and Hammond and McCullagh, 1978). Table 5.5 gives the data for the on-farm woody species. The two broad groups (1-2 and > 2) were conveniently considered to give a picture on the quantitative aspect of the species within the samples (farms).

Table 5.5: **The preferred on-farm woody perennials in the study area**

Names of the Species	No. of the farms the Species occur				Total
	1-2		> 2		
	Observed	Expected	Observed	Expected	
Acacia tortilis	10	19.4	33	23.6	43
Balanites aegyptiaca	13	10.8	11	13.2	24
Salvadora persica	16	9.0	4	11.0	20
Maerua crassifolia	10	7.2	6	8.8	16
Prosopis spp.	2	4.5	8	5.5	10
Total	51	50.9	62	62.1	113

Source: Author

It is therefore statistically logical to argue that the farmers carefully choose indigenous woody species that are preserved on the arable lands, practising some kind of indigenous agroforestry. 62% of the respondents underscored the importance of these species on the basis of annual fodder supply (Plate 5.1), fuelwood, soil and water conservation, windbreak and fencing poles. Other assorted values of these species outlined were: medicinal, shade to people and also serve as watchtowers when guarding the crops against wild animals.

From Table. 5.5, it is evident that *Acacia tortilis* was the most preferred agroforestry species by the farmers, probably due to its distinctive usefulness (Table. 5.12). Elsewhere, this species has proven to be the most useful in the arid and semi-arid regions in the State of Rajasthan, India (Khoshoo and Subrahmanyam, 1984). In fact it is a boon to the people of the desert who suffer from shortage of fuel, fodder and timber.

Plate 5.1: **Endao: On-farm wood perennials are normally lopped to provide fodder, fencing materials, etc. (Author).**

Tree tenure was also an outstanding feature among the Ilchamus. Although the land was communally owned, trees within a given radius from a household belonged exclusively to the respective owners. The head of the household authorized any form of exploitation by outsiders. This was particularly the case around Endao where the area is distant from the relic forests. Moreover, it was not permissible to clearfell trees, so that the common practice was to lop them. During fruiting season, to cut even a branch of some trees like *Acacia tortilis* that are important sources of fodder was not allowed. Therefore this indigenous production system is environmentally sound, apart from its central role in meeting the family needs. Consequently, plant biodiversity is consciously maintained.

5.3.3: Pastoralism

It was an indigenous practice to diversify domesticate livestock among the Ilchamus. Active selection and distinctive ability to accurately discriminate between these animals on the basis of traits was evident. Survey data (Appendix 1) indicates that only 8% of the respondents owned goats alone, while 92% had at least more than one variety of livestock (Table. 5.6). 68% of the respondents reared goats, cattle and sheep and only a few farmers (7%) reared donkeys.

In addition, the animals were selected on the basis of their colour, size and general performance in terms of productivity and/or adaptability. On these bases, exotic cattle were unattractive as investment in the area. This is by no means a unique criteria but tally rather well with Chambers (1987) findings that for the poor rural people, exotic cattle are either unattractive or impossible to invest in because they are vulnerable to tick-borne diseases amongst other environmental challenges.

Table 5.6: **The variety of domestic livestock in the study area.**

Livestock Variety	Farmers	
	No.	(%)
G + C + S + D	4	7
S + C + G	41	68
S + C	4	7
G + C	6	10
G	5	8
Total	60	100

Key: G = Goat, C = Cattle, D = Donkey, S = Sheep.

Source: Author

The well-developed indigenous knowledge exhibited by the Ilchamus appeared to have been necessitated by the existing socio-economic as well as the fragile environmental setting. Consequently, people have been able to consciously conserved the livestock diversity. Besides, the different varieties exploit different ecological niches in the area. Keeping more than two different types of animals leads to more efficient use of rangelands, as each animal has different but slightly overlapping diets with the others (Spencer, 1965). This has greatly helped in spreading exploitative pressure on the plant species in such a precariously balanced environment. Livestock were numerically few, with an average of about six cattle per household. Goats were the most abundant, with about 4.7% of the respondents having more than ten. The field survey revealed an average of about 6 goats per household.

According to Little (1981), the Ilchamus practised an organized system whereby there were grazing controls (**"Olokeri"**). These indigenous systems were governed by a council of elders (**"Lamaal"**) and enforced by the youth, the **"Il-murrans"** (18 to 26 years of age). Animals of non-Ilchamus were strictly kept off the pastures as well as internally restricting grazing patterns to ensure annual regeneration and dry season grazing. These internal controls were realized through observing closed season for particular areas at some point in time. Normally during rains, the areas bordering the Lake were usually closed and reserved for dry season grazing. Any person violating the stipulated rules was fined by the elders (Little, 1981). These rotational strategies of pastoralists can be more efficient and complex than what would possibly be achieved through conventional ranching (Western, 1982).

5.3.4: Dependency on the woody plants

Owing to their cultural and economic setting, the Ilchamus depend heavily on plants to meet their daily needs. This is in accordance with Cherry's (1984) observation that poor people utilize a wide range of plant species and will put them to much more complete and varied use than the affluent. Accordingly, there was a remarkably large reservoir of knowledge about plants. Children as young as eight years were found to be quite familiar with most of the plants and could even give their names and uses with great accuracy. According to some informants, this knowledge is usually passed over when family members are relaxed in the night; normally around an open fire. The youth's knowledge on plants was orally tested in a form of a game whereby they were asked to give names and uses of these resources. This kind of recitation exercise kept the youth informed and acted as an incentive, with each one of them aspiring to emerge a winner at every brainstorming session. In addition, the young were also taught names and uses of these biological resources by their elders during their daily activities, for instance, when looking after cattle, fetching firewood, clearing crop fields, amongst others. With this general awareness, most of the plants were treated with a lot of respect. Table 5.7 shows that 95% of the respondents made use of the locally-available materials for the construction of their huts {"**manyattas**"; (Plate 4.4) }. The life-span of these "**manyattas**" was found to be three to four years on average (field research). However, termites were very rampant in the area (Plate 5.2), and often reduced the life-span of the "manyattas" to less than two years. Many plants, were therefore lost during the process of reconstruction.

Table 5.7: Sources of building materials in the study area

Source	No. of respondents	Percentage
locally available	57	95
Bought	3	5
Total	60	100

Source: Author

Firewood collection has also profound implications on the plants, since it happened to be the main source of energy for virtually all the residents (Table, 5.8). Although alternative energy supplies (e.g solar, wind and fossil fuels) are possible (Kamweti, 1981), the logistics involved in procurement of these other energy sources are so prohibitive, thus, making wood the only practical energy source (Openshaw, 1981).

The daily firewood expenditure was approximately 8 kg[1] per household which is lower than the district's average household consumption of about 13 kg/day (Odada and Otieno. 1990). Elsewhere. Anderson and Grove (1987) found the average wood consumption per household to be at 9.6 kg/day in the area around Bura Irrigation Scheme.

Table 5.8: Sources of domestic energy in the study area

Source	No. of Respondents	Percentage
Firewood	58	96.7
Others (Charcoal. Crop residual, Cowdug. etc.)	2	3.3
Total	60	100.0

Source: Author

The average firewood consumption in the study area is higher during rainy seasons when a lot of firewood is used for warming and chasing away mosquitoes. Fire was also lit for cattle (at the ***"Boma"***) to keep off mosquitoes that were believed to make the animals very unhealthy (Field research). The relative less expenditure (8 kg/day/household) was perhaps due to the people's realization of the scarcity of these biological resources. In addition, food was a rare commodity in this arid area and as such, there was often little wood consumption through cooking.

[1] The weight was obtained by the use of a spring balance.

Plate 5.2: Termite mounds are a common feature all over the study area. The environs of the Perkerra Scheme (Author).

The most preferred species for firewood were *Acacia tortilis*, *Balanites aegyptiaca*, and *Acacia reficiens*. *Prosopis* spp. was becoming an increasingly important source as well. It has been reported that in arid zones of India most of the fuel comes from *Prosopis* spp. and *Acacia* spp. (Khoshoo and Subrahmanyam, 1984). Furthermore, *Prosopis* spp. is good for fuelwood and makes excellent charcoal, with a calorific value equal to that of coal (Berry *et al*. 1992). When asked to make a comparative statement on the availability of firewood compared to the past (10 to 20 years back), the general consensus of an overwhelming majority (75%) was that there had been an observable decrease (Table 5.9). 10% however, did not notice any changes, while 7% were not sure whether there was any change or not.

Table 5.9: Firewood availability in relation to the past

Opinions	Respondents	
	No.	%
No change	6	10.0
Scarce	45	75.0
Cannot tell	9	6.7
Total	60	100.0

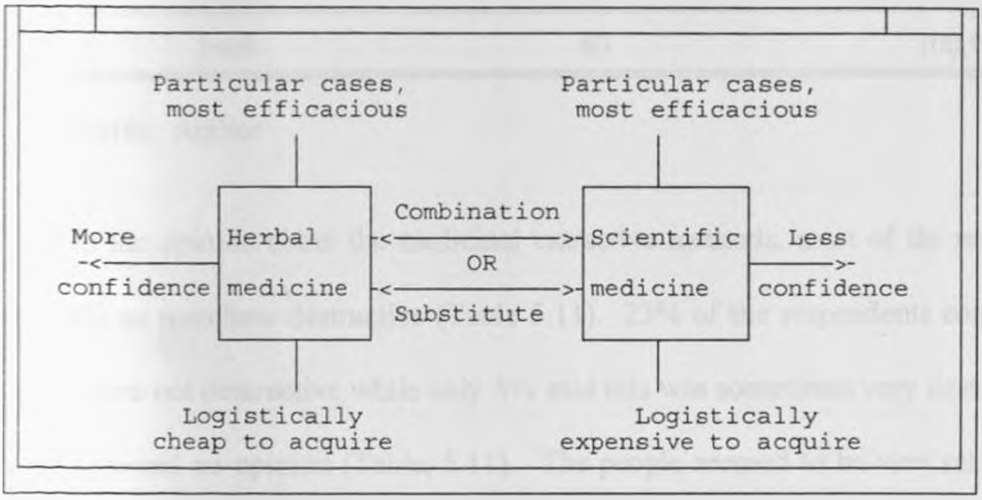
Source: Author

Charcoal burning was unpopular among the Ilchamus. Traditionally these people considered charcoal burning as socially demeaning. With increasing economic difficulties such a notion seemed to have lost popularity hence, a few cases of charcoal burning were evident (Plate 5.3). Nevertheless, field observation indicated that among the Ilchamus, the practice was less rampant *vis-a-vis* their counterparts. the neighbouring Tugens who appeared to have greatly capitalised on this. Charcoal burning for most Ilchamus was done out of desperation particularly during drought to generate money for purchasing food. Furthermore, it was traditionally unacceptable to cut live trees for charcoal burning. This is in agreement with findings elsewhere. For example, among the Pokot and Turkana, only dry dead wood is collected for fuel because trees have important roles in their culture (Barrow, 1988). However, with the weakening indigenous structures, together with economic difficulties, such norms seemed to have been widely undermined.

Plants are medicinally important among the Ilchamus and most of the respondents preferred herbal rather than scientific medicine. This was principally so because herbal medicine is logistically cheaper than modern medicine. The majority (82%) indicated the use of herbal medicine for their first source of health care with a notable number, particularly the aged going to hospital as the last resort (Table 5.10). About 7% preferred hospital while 12% sought other alternatives (eg. traditional healing). Figure 13 affords an illustrative summary on this issue.

Although most of the respondents appreciated the effectiveness of scientifically-prepared medicine, it was common knowledge that neither of the source could suffice alone, citing some ailments that are most effectively handled through the use of herbal medicine. "*Naparsen*" is an intestinal ailment which is better treated by the use of *Salvadora persica* (*Sokotei*). Herbal and scientific medicine were therefore used either in combination or as substitutes (Fig. 13). Nevertheless, the respondents appeared to have more confidence in their locally prepared medicine.

Plate 5.3: Lake Baringo: Charcoal bags awaiting transport to Kokwa Island (Author).



Source: Author

Fig. 13: The Ilchamus perception on medical sources of care.

Table 5.10: The first source of health care for Ilchamus

Source	Respondents	
	No.	%
Herbal	49	81.7
Hospital	4	6.6
Others	7	11.7
total	60	100.0

Source: Author

On the opinion about the medicinal extractive methods, most of the respondents (45%) termed this as somehow destructive (Table 5.11). 23% of the respondents contended that such methods were not destructive while only 5% said this was sometimes very destructive. The rest (27%) expressed no opinion (Table, 5.11). The people seemed to be very reluctant to provide any reliable information on this subject, perhaps fearing that this might jeopardise future access to these resources.

Table 5.11: Opinion on the medicinal extractive methods.

Opinion	Respondents	
	No.	%
Very destructive	3	5
Somehow destructive	27	45
Not destructive	14	23
Can't tell	16	27
Total	60	100

Source: Author

According to the FAO (1990), harvesting techniques can at times be damaging to the plants, citing an example of the Fulani of Northern Senegal, who often use fire to stimulate *gum arabic* trees to release their gum and make it easier to harvest, a practice that may turn out to be very destructive to the whole plant in the long run. In the study area cases of unsustainable use of these plants were widely evident. Trees were often stripped of their barks, exposing them to infections among other things (Plates 5.4). Normal functioning of such plants is impeded rendering them unhealthy, eventually drying off. A few cases of uprooting trees completely for their roots were also cited. Trees provided other assorted materials such as veterinary medicine, bed poles, forage, fencing, food, walking sticks, tooth brushes and stools, to mention but a few.

5.3.5: Importance of woody species as perceived by the Ilchamus

As mentioned earlier, the Ilchamus depend heavily on woody species. This overwhelming dependency prompted the attempt to explore and subsequently quantify the uses of the biological resources in an effort to determine the possible human impact on these. Table 5.12 depicts the main uses of the woody plants with their corresponding scores as ranked[2] by the respondents. Out of the maximum possible score of 30, *Acacia tortilis* scored the highest (22), while *Securinega virosa* registered the least (3).

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[2] 0,1,2,3, for; not applicable, rarely, moderately and heavily used respectively.

Plate 5.4: Peeled off barks, mainly for medicine and construction in the forested area between Ng'ambo and Salabani. *Acacia tortilis* dominates the canopy while *Acalypha fruticosa* forms a thick undergrowth (Author).

Table 5.12: Importance rating of woody species by the Ilchamus

Spp.	FD	FG	FE-N	FU-L	CTR	HM-ED	CUL-T	FUM	VM-ED	OTH-ERS	T.SC-ORE
A.e	0	1	1	3	2	3	0	0	0	2	12
A.m	0	2	2	3	1	2	0	3	0	3	16
A.r	0	2	3	3	3	0	0	0	0	2	13
A.nu	1	0	2	2	1	3	3	3	0	2	17
A.t	3	3	3	3	3	1	3	0	0	3	22
A.s	2	1	2	3	3	2	0	0	0	2	13
A.ni	0	3	0	3	0	3	0	0	0	2	11
M.c	0	2	1	1	2	0	2	2	0	0	10
D.s	0	2	0	3	3	2	0	0	0	3	13
G.t	3	3	1	0	3	2	0	0	3	3	18
Z.m	0	2	0	0	2	0	0	0	0	2	6
F.s	2	2	1	0	0	2	3	0	0	2	12
S.v	0	1	0	0	1	0	0	0	0	1	3
B.a	0	3	2	3	2	3	0	0	0	3	16
C.a	2	1	0	1	0	0	2	0	0	3	9
C.s	2	3	1	1	3	0	3	0	3	3	19
B.c	2	3	1	1	2	3	0	0	0	2	14
G.m	1	3	0	1	3	0	0	0	0	3	11
S.p	3	2	3	2	2	3	0	0	3	3	21
P.s	2	2	3	2	3	0	0	0	0	3	15
S.k	0	3	0	1	3	0	0	0	0	3	10
Cummulative total.	23	42	26	36	42	29	16	18	9	49	280

Key:
C.s = Cordia sinesis; A.nu = Acacia nubica;
A.t = Acacia tortilis; A.s = Acacia seyal; A.m = Acacia mellifera;
A.ni = Acacia nilotica; M.c = Maerua crassifolia; D.s = Diospyros scabra;
G.t. = Grewia tembensis; Z.m = Ziziphus mauritiana; F.s = Ficus sycomorous;
S v = Securinega virosa; B.a = Balanites aegyptiaca; G.m = Grewia mollis;
C.a = Crateva adansonii; B.c = Boscia corriacea; S.p = Solvadora persica;
A.r = Acacia reficiens; p.s = prosopis species S.k = Sesbania kiniensi;
A.e = Acacia elatior; VMED = veterinary medicine FEN = fencing;
HMED = human medicine; CTR = construction; CULT = cultural;
FD = food; FG = forage; FUM = fumigation; FUL = fuel;

Source: Author

The tabular analysis further indicate that forage, fuel and construction consume the greatest amount of the woody plants; with a cumulative total[3] of 42, 36 and 42 respectively. Human medicine, fencing, food and cultural functions were also found to be important uses of the woody plants, registering 29, 26, 23 and 16 cumulative totals respectively. On the other hand, the woody species appeared to be relatively less important as sources of veterinary medicine and fumigation material with a cumulative total of 9 and 18 respectively while other assorted uses of plants registered a cumulative total of 49. Fig. 14 depicts the relative importance (percent) of the woody species with regard to the different uses.

The analysis further indicates a significant contribution of the seven *Acacia* spp. in meeting the local needs. As a source of fuel, the *Acacia* spp. scored 20 out of a cumulative total of 36 registered by the overall species. This group also exhibited distinctive values as a source of fencing material and human medicine with 13 out of 26 and 14 out of 29 cumulative totals respectively.

Analysis of woody plants' uses against their respective densities (Table 5.13)[4] indicated a significant ($P < 0.05$), positive relationship with Spearman's rank correlation coefficient (r_s) of about 0.55. Appendix 4 gives values of (r_s) that are significant at the 0.05 and 0.01 levels, when the number of pairs is 30 or less (Gupta and Kopoor, 1983). The null hypothesis was consequently rejected and the alternative adopted, thus, there was a significant relationship between plant uses and their densities. This suggests commendable conservation efforts employed by the Ilchamus to these vital resources. The highest species diversity registered within the

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[3] The total score registered for a particular usage by all the species

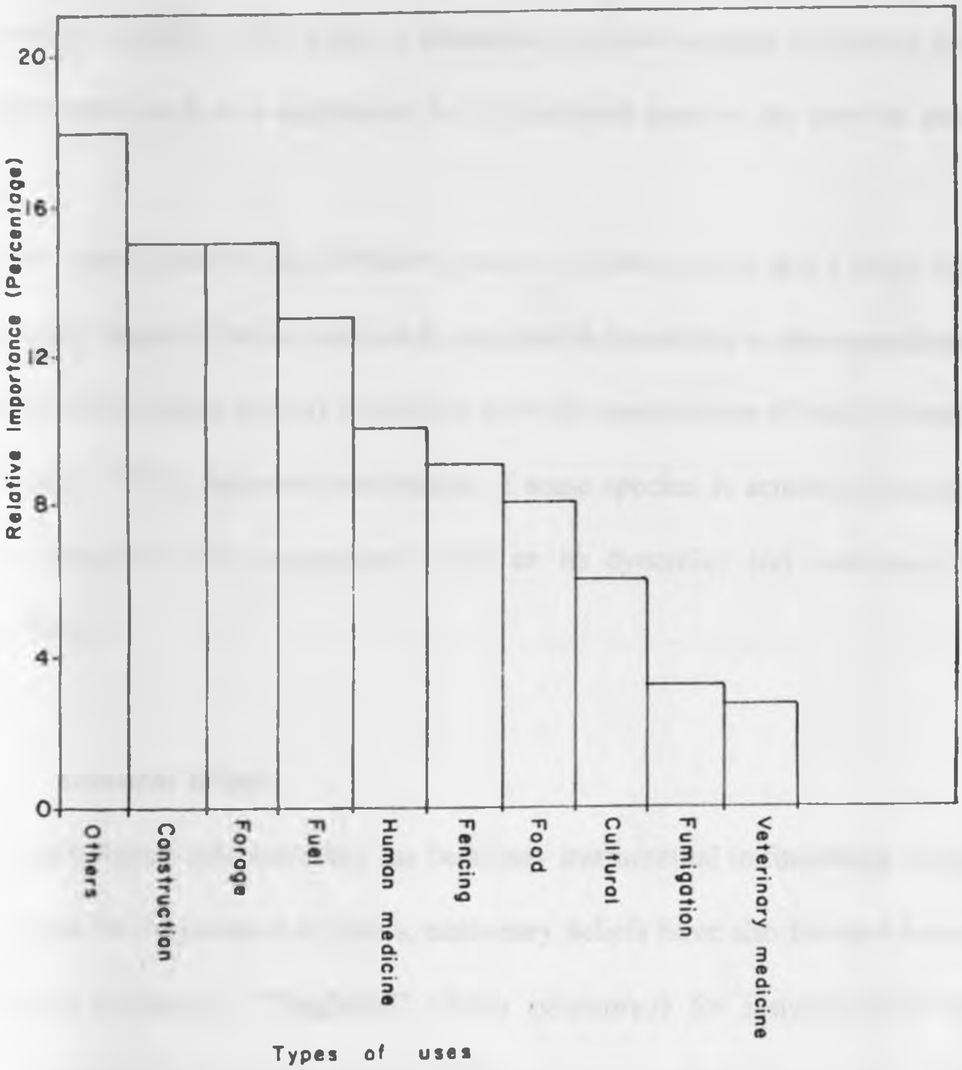
[4] Drawn from the last columns of Table 4.9 and 5.12.

woodland (Table 4.10). although one of the heavily settled area. seem to support this argument. Informal education. beliefs and customary rules appear to have effectively restrained people from unsustainable exploitation of the biological resources.

Table 5.13: The absolute densities and importance score of species in the study area

Species	Absolute Density	Importance Score
Acacia tortilis	308.81	22
Acacia mellifera	65.16	16
Maerua crassifolia	32.11	10
Acacia reficiens	180.38	13
Boscia corriacea	68.94	14
Salvadora persica	17.00	21
Acacia nubica	7.56	17
Acacia eletior	6.61	12
Securinega virosa	0.94	13
Acacia seyal	126.01	13
Prosopis species	47.22	15
Crateva adansonii	0.94	9
Balanites aegyptiaca	49.11	16
Cordia sinensis	9.44	19
Grewia tembensis	2.83	18
Acacia nilotica	7.56	11
Ziziphus mauritiana	2.83	6
Ficus sycomorus	0.94	12
Grewia mollis	5.67	11
Sesbania kiniensis	0.94	10
Diospyros scabra	0.94	13
Total	941.93	280

Source: Author



Source : Author

Fig. 14 : Relative Importance of Woody Species in relation to their uses

It is however important to realize that the Ilchamus made use of almost all plants. hence the disappearance or scarcity of a particular species prompted the people to turn to other sources that were readily available. This adaptive behaviour may have created a scenario whereby most of the species were used as a supplement to the preferred species that may be diminishing in supply.

In fact. some species like *Salvadora persica. Acacia nubica* and *Cordia sinensis* were vanishing rapidly inspite of being undeniably very useful (according to the respondents). Species like "**sipei**" (*Aeschynomene indica*) commonly used for construction of locally-made crafts had decreased widely. This selective exploitation of some species is actually removal of part of biological community with concomitant effect on its dynamics and ecosystem functioning (Robinson. 1993).

5.3.6: Cultural beliefs

Apart from the informal education that has been very instrumental in furnishing people with the knowledge about the importance of plants. customary beliefs have also fostered conservation of these biological resources. "**Ilng'aboli**" (*Ficus sycomorus*) for instance. had widely been conserved. According to the respondents (78%). the species was believed to be sacred (Table 5.14). However. 22% of the respondents appeared to be unaware about the sacred significance of this species. These were particularly the respondents between the age of 20 and 28 years. probably due to their changing life styles with the advent of modern education.

In the recent past (up to 1960's) people used to make sacrificial gestures under this species. for instance pouring some milk around it. Even to date people refer to this species with some reverence (personal observation). Moreover, the "Ilng'aboli" tree is up to date reserved for very special occasions like, "**unoto**", an initiation ceremony to become an elder, or "**Ilkichiroto**", that is, a ceremony performed in case one happens to commit a grievous crime, in the belief that cleansing is facilitated.

Table 5.14: Awareness of the sacred importance of *Ficus sycomorus*

Response	Respondents	
	No.	%
Very important	47	78.3
Not aware	13	21.7
Total	60	100.0

Source: Author

Another excellent example is the "**Ilmeidimukoon**" *Maerua oblongifolia,* Forssk that had also greatly benefitted from such beliefs, owing to its importance to the local witchdoctors. With its decreasing supply, some kind of beliefs got attached to it, possibly to restrain people from exploiting the species (according to one old man). Consequently it was believed that if one happened to burn it, a curse would befall the family. It was further believed that if a cow was caned with a stick from this species, it could die. Furthermore, the local name of the species, ("**Ilmeidimukoon**") which means "it can't help itself", connotes its susceptibility to destruction, thus people treated it tenderly.

These among other beliefs scared the people from touching such trees even when dry. Similar observations have been made elsewhere that certain important trees (e.g. *Acacia tortilis,* *Cordia sinensis* and *Ziziphus mauritiana*) are protected by custom (Barrow, 1986). However it was unfortunate to find that such customary norms were increasingly becoming eroded in the face of the fast-changing cultural and economic setting. For instance, of late people had begun to exploit "**Ilng'aboli**" without respect, for purposes like firewood and even for beehive construction. In fact, "**Ilmeidimukoon**" was locally endangered (personal observation).

5.4: *PROSOPIS* SPECIES AS ENVIRONMENTALLY PERCEIVED BY THE ILCHAMUS

Although 96% of the respondents underscored the importance of *Prosopis* spp., the general consensus from the two locations (Salabani and Ng'ambo) was that the alien species should be monitored closely (Appendix 1). 49 (82%) of the respondents were of the opinion to have some control checks for the species, while only 11 (18%) advocated for its increase (Table 5.15).

Field interview (Appendix 1) revealed that the species was not highly palatable to livestock, yet it was alleged to be replacing the indigenous species like, *Cynodon* grass and other woody plants which were an important source of fodder for the animals, not to mention a wide spectrum of other invaluable contributions of these species to their daily needs. This observation by the local residents is consistent with Gledening's (1952) view that once *Prosopis* spp. has been established, it increases rapidly at the expense of grass, due to its ability to develop root systems capable of using all, or most of the available soil moisture so that the grass cover thins out and is eventually eliminated. This may be potentially risky, especially with regard to Miller's (1990) observation that in situations where an alien species happens to have no natural competitor in its new habitat it may dominate, outcompeting and outproducing many native species, eventually causing extinction or displacement of these. Appreciating the importance of the *Prosopis* in successfully rehabilitating most of once bare grounds, the general feeling of the people was that the species was spreading alarmingly, an observation the author totally agrees with.

Table 5.15: Opinions from the two Locations about *Prosopis* spp.

Location	To be Increased	To be controlled	Total
Ng'ambo	6	24	30
Salabani	5	25	30
Total	11	49	60

Source: Author

5.5: SUMMARY AND CONCLUSION

From the foregoing discussion, it is apparent that the Ilchamus have to some extent managed to initiate sustainable development. The indigenous agroforestry production system has played a facilitating role in the conservation of numerous woody species that would otherwise have been cleared. Hence, it was not surprising to find moderately to heavily settled areas under the woodland cover (Table 5.3). It is however important to note that due to lack of individual land tenure rights, settlements have traditionally tended to be concentrated in particular areas causing much destruction to the biological resources (Fig. 12). The people had in particular concentrated in areas bordering major pasture lands or near the main towns.

Shifting cultivation was prevalent in the area, but due to increased population, such practices had become unsustainable. This activity was causing much destruction to the forest relics that were extremely important to the daily needs of the people, not to mention their significant role to the maintenance of the lake ecosystem. Actually, as McKell (1980) notes, dwindling vegetation cover will adversely affect all facets of rural life, in which trees and shrubs generally serve not only as fuel, but also as shade and shelter for man, animals and crops. Tragically, this practice had therefore worked to the detriment of both the habitat and species diversity of the respective ecosystems through their simplification. As Miller (1990) notes, in modifying ecosystems for our use, we simplify these through replacing thousands of interrelated plants and animal species in these ecosystems. The need for land adjudication and measures to raise the people's living standards is thus imminent as a prerequisite to intensive agriculture.

The Ilchamus were found to have pastoral models that are environmentally sound. Through consciously selecting livestock variety to suit their environment, the people had managed to maintain a commendable ecological balance in such a fragile ecosystem. Organized grazing, amongst other pasture management systems, had further enabled them to exploit their environment in a sustained manner. This ecosystem management strategy had in turn played a central role in conserving plant species diversity.

From the field information, there was strong evidence to indicate that owing to their cultural and economic setting the Ilchamus depended heavily on plants. For instance, plants were widely used for construction, fuelwood, medicine and various customary festivities. Given the strong attachment to these biological resources, the Ilchamus had developed various indigenous models that had fostered conservation of the plants. Through active informal education systems as well as cultural beliefs and norms, the people had managed to co-exist with these resources harmoniously for a long time. However, due to the weak economic base and the increasing population, effective conservation of the biological resources was increasingly becoming elusive.

This was perhaps due to the fact that in times of resource shortages basic needs understandably override any knowledge and consideration of conservation practices (Brokensha and Riley, 1980). Lack of secure private land tenure as well as the changing climatic conditions had further complicated the whole issue, making the problem almost insurmountable.

There was a felt need by the informants to monitor *Prosopis* spp. closely as it was seen as a potential danger to the long-term ecological balance in the area. This species is undeniably very important in rehabilitating the area that has lately been degraded at an alarming rate. Nevertheless, the alien species appeared to be replacing other indigenous species that are otherwise vital for the normal functioning of the ecosystem, not to mention the indispensability of these species for the survival of the Ilchamus.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1: INTRODUCTION

In essence, this chapter presents a summary of the salient findings and conclusions of the study. The main focus is on the critical overview of the indigenous knowledge and practices of the Ilchamus, in the light of the woody plants' biodiversity conservation. It was encouraging to find the Ilchamus being keenly aware of the close socio-economic and cultural ties they have with the biological resources. The value of these resources to the people was manifested in their indigenous systems that aim to conserve them. However, it was disheartening to note the influence of the weak economic position of the vast majority, which more often had compelled the people to make ecologically unsafe decisions. Besides, communal ownership of the land had prohibited individual drive towards sustainable practices.

6.2: SOCIO-ECONOMIC CHARACTERISTICS AND SETTLEMENT PATTERNS

Findings from the study indicated that most of the Ilchamus had lived in area for over 50 years, thus this is an area of early settlement. Consequently, the temporal vegetation dynamics supposedly manifested human manipulation. GIS intersection between the vegetation map of the study area and the settlement distribution indicated close correlation between the two, with heavily settled areas found to be largely bare, mainly due to vegetation clearance for settlement and/or agriculture, as well as through other assorted uses of these resources. There was also a remarkable settlement concentration in areas of interest, for instance, around the major shopping centres like Ng'ambo and Salabani (Fig. 12). This highly polarised settlement distribution may perhaps be due to communal land ownership in the area. Such spatial arrangement had widely affected biological resources, causing local desertification, thereby reducing biological diversity in such areas through species loss and habitat destruction.

The literacy level in the area was fairly low, with a large percentage (48%) having no formal education (Appendix 1). This probably explains why most of the respondents (82%) had no salaried occupation. Dependency on biological resources was therefore understandably high due to limited economic options.

6.3: AGRICULTURAL PRACTICES

The findings established a strong sense of conservation by the Ilchamus through indigenous agroforestry. This production system was carefully managed through distinctive selection of woody perennials that minimally compete with crops for available resources. Furthermore, the species were intentionally preserved to provide mulch, organic matter, fodder, to bind soils and to improve their water-retention capacity. In addition, the trees provided fuelwood, building and fencing poles, amongst a wide range of other uses.

Chi-square test indicated a significant difference ($P < 0.01$) between the woody species found in the arable lands, thus there was careful discrimination based on their usefulness. The most widely preferred tree species was *Acacia tortilis*, but *Balanites aegyptiaca* and *Salvadora persica* were also popular. This practice had contributed substantially towards the conservation of these biological resources.

Maintenance of soil fertility was however found to be minimal with most farmers practising some form of shifting cultivation whenever soils became impoverished. Lack of individual land tenure, coupled with the ever-increasing economic difficulties appeared to be the major deterrents to sustainable cultivation. Owing to the resulting highly impoverished soils, recolonization of such areas after abandonment becomes extremely difficult, thus encouraging the expansion of the bare ground. Herds diversification, a common practice among the Ilchamus had helped to spread exploitative pressure amongst the plant species. This argument is based on the fact that different species occupy different niches so that the ecosystem is evenly exploited, resulting in a more biologically-diversified ecosystem.

6.4: DEPENDENCE ON WOODY PLANTS

The Ilchamus depended heavily on woody plants to meet their daily challenges. Plants were used for building **"manyattas"** that have a very short life span, (three to four years), while fuelwood was the major source of energy. Plants were also used extensively for medicinal purposes. Biological resources were also used for making of furniture, for milk treatment and for cultural festivities, amongst other uses.

Given this overdependence, the Ilchamus had realized the indispensable nature of these biological resources, consequently developing models to conserve them. Although communally owned, people were found to have assumed a semi-private ownership of trees within a given radius from their homesteads. This was particularly the case in the areas far removed from sites of resource concentration. One took care of these trees in the wild and exploited them responsibly. This fact seems to explain largely why the sample site around Endao (Woodland) exhibited the highest species diversity although it was fairly densely settled.

Traditionally, it was unacceptable to burn charcoal from live trees. In addition, burning of charcoal in the area was regarded as the occupation of the poor. However, with increasing economic difficulties, this attitude was dying off progressively with several people increasingly engaging in this economic venture. There was very active informal education about the importance of plants to the people. The young, in a form of recitation exercise, learnt about names and uses of plants. Thus, the general awareness of the importance of these biological resources was commendably high. Children as young as about eight years were found to have detailed and accurate information on the most useful plants. With this kind of awareness it is unlikely that the people would engage in destructive practices.

The relationship between plant uses and their respective densities was found to be statistically significant ($p < 0.05$) with Spearman's rank correlation coefficient of 0.55. This is strong evidence of considerable efforts employed by the Ilchamus to conserve plants that are useful in their daily lives. Nevertheless, owing to the worsening climatic conditions, increasing population and economic constraints amongst other things, conservation of these resources had not been very effective, hence the rather moderate correlation coefficient (0.55).

6.5: CULTURAL BELIEFS

Some plants were governed by taboos that restricted their utility, for instance, *Ficus sycomorus* was believed to be sacred and as such it was treated with respect. *Maerua oblongifolia* has also been widely conserved through beliefs that restrain people from exploiting the plant. It appeared that such beliefs were attached to the species that were very useful to the well-being of the people. yet. ecologically less competitive. *Ficus sycomorus* was believed to regulate stream water supply. while *Maerua oblongifolia* was a very useful plant among witchdoctors. yet both of these species were scarce. In fact the latter species was found to be locally endangered. In this way. such plants that may otherwise have been overexploited were effectively conserved. It was though unfortunate to find that such beliefs are rapidly weakening with the fast-changing lifestyle. leading to reckless exploitation of some of these important, yet threatened or endangered species.

6.6: GIS ANALYSIS OF THE MULTITEMPORAL IMAGERIES

GIS analysis of the multi-temporal imageries indicated an increase in forest areal coverage. Given that the population of the Ilchamus was increasing and climatic condition gradually worsening. this suggests significant conservation efforts by the people. resulting in sustainable use of these biological resources. It is important to realize that these forests harbour considerable number of plants and herbs that are very useful to these people. making these resources conservation targets. Although there were cases of agricultural encroachment in these forests. the establishment of permanent settlement was restricted beyond some points. This was mainly to protect the dry-season pasture lands as well as other useful biological resources. particularly the herbs that have largely disappeared in the other areas.

Given this kind of indigenous management. *Prosopis* species that was recently introduced (in 1982) had established itself extensively. even extending beyond the former forest boundaries. Quantitative vegetation analysis indicated an increasing importance of the species as a functioning component of these forests relics. This species is however a prolific seeder. and may become a weed in future. It is potentially risky to introduce alien species in such fragile ecosystems. taking into consideration the possibility of off-setting the existing precarious ecological balance. thus resulting in the extinction or displacement of the indigenous species. This would not only be ecologically devastating. but could possibly reduce the availability of these resources to the people. The irrigation water (Perkerra Scheme). through subsurface flow had an eventual indirect impact on these forests. Furthermore. the heavily utilized-chemical fertilizers may as well have become available to these areas through surface run-off during heavy rains. contributing to the expansion of forests.

Strikingly. other vegetation types like riverine forests had declined to only a thin strip of trees along the riverbanks. while much of the woodland had degenerated to bare ground. This rapid change cannot be explained adequately by the gradual climatic changes recorded within the period in question. Analyses of settlements in relation to vegetation indicates heaviest settlement under bare grounds. while forests recorded the lowest settlement density (Fig. 12). This. compounded with other assorted human activities accounts for the observed diminishing area coverages.

However. at the ecosystem level it may be concluded that the Ilchamus had to a great extent managed to maintain these ecosystems relatively stable. This argument is based on the findings drawn from the quantitative vegetation analysis whereby there was very little variation on plant species diversity amongst the vegetation types in the area. Woodlands exhibited surprisingly a higher species diversity than the forests. despite its corresponding high settlement densities than the latter. This observation may be attributed to the great importance attached to almost all the plant species available in the area. a fact that appeared to have compelled people into maintaining a wide variety of species that in turn provided them with a wider range of options in meeting their daily needs. Furthermore, the removal of some adult trees had probably reduced the rate of competitive displacement in the community, potentially increasing the number of co-existing species (Huston, 1979). Therefore it may be concluded that in the relatively unmanaged forests some species had suppressed others (through ecological dominance), lowering the overall woody plant biodiversity. The soil may be an important factor influencing species composition within the communities, and as such further comprehensive research on this aspect is recommended.

It may therefore be summarily concluded that the weak economic status and cultural setting of the Ilchamus have created a scenario of overdependence on biological resources. It is also clear that the increasing population and economic hardships have compelled the people to indulge in biologically destructive activities. However, it is important to realize that poverty is the single most overriding constraint to sustainable use of these biological resources, hence for any meaningful intervention the uplifting of the economic state of the people is imperative. The weakening indigenous conservation structures have also been important contributing factors to the abuse of these biological resources, thereby posing environmental concern. Conversely, commendable conscious attempts towards biological conservation have been noted, and therefore this study concludes that there is much to be borrowed from the material culture of the Ilchamus for more practicable, acceptable and sustainable conservation strategies.

6.7.0: RECOMMENDATIONS

6.7.1: To policy makers

1. Some important aspects of indigenous knowledge and practices should be integrated into the formal sector of education to ensure the viability of conservation strategies. In the view of the findings. the Ilchamus have better knowledge about their environment, constraints and priorities and should therefore be consulted in order to facilitate more direct involvement in development initiatives and projects.

2. There is pressing need to institute economically-profitable activities in the area in order to uplift the living standards of the people. thus creating an empowering environment that will facilitate sustainable development. Otherwise, poverty has posed several practical problems rendering sustainable use of biological resources largely impracticable.

3. It is important to set up an aggressive campaign on education. Otherwise it would be unrealistic to expect technological as well as economic progress without education. Moreover. the sustainable utilization of biological resources depends on the economic status of the population concerned.

4. Land adjudication is undeniably a priority area that needs to be addressed urgently. Lack of secure individual land tenure is one of the prime factors leading to unsustainable land use practices by inhibiting individual drive to invest in a situation where much is at stake.

6.7.2: To conservationists

1. It is important that at least a given radius from Lake Baringo should be conserved of which its width could be determined by detailed ecological study. This national resource is threatened through sedimentation, with the increasing destruction of the shoreline vegetation that acts as sediment trap. In addition, catchments of the main rivers serving this lake (e.g Rivers Molo and Perkerra) should be protected to ensure the maintenance of this important resource.

2. For any meaningful conservation endeavours (efforts and issues) by the existing institutions and structures (National Environment Secretariat, the country's Museums, etc.), there is need to involve communities at all levels. This would help to ensure receptability of such strategies as well as to serve the intended purposes.

3. Indigenous conservation systems should be given the necessary emphasis. This could be done by the use of mass media, ensuring effective communication, and the dissemination of information down to grassroot levels. It can also be done effectively through published articles. Although commendable attempts towards this goal have been made, this has not yet found adequate expression in policy promulgation.

6.7.3: For further research

1. For practical reasons of the local situation context, it is important that ecologically, culturally and economically relevant plant species be actively propagated with a view to achieving a more balanced solution to sustainability in such a fragile environmental setting. This would ensure diverse options for the survival of the rural communities who depend very much on these biological resources.

2. The possible ecological impact of *Prosopis* species needs to be addressed urgently. The species is spreading widely all over the area, and could easily become a "weed" in the long-term. More indigenous species should be included in the afforestation programmes, otherwise in such fragile ecosystems a slight imbalance may be ecologically costly and irreversible.

3. Similar research focusing on IK and practices can be applied successfully in other areas of Kenya, Africa and elsewhere in order to facilitate comparative aspects on this topical subject.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

STRICTLY CONFIDENTIAL

DATE ....
RESPONDENT NO ....
LOCATION ....

PRELIMINARY SECTION:

1: Sex ....
2: When did you settle here? ....
3: Where did you come from? ....
4: Do you have a title deed for the parcel of land you have? ....
5: What is the highest level of education you have attained? ....
(a) Primary level (b) Secondary level (c) Post secondary
6: How many members are there in your household? ....
7: Do you own a plot at the Perkerra Irrigation Scheme (a)Yes (b)No
8: What is the major source of your building materials? ....
9: If locally acquired materials, why are they preferable?
(a) less expensive to acquire (b) A matter of choice
10: After how many years do you rebuild your "manyatta"?.......(yrs)

SECTION 1: AGROFORESTRY:

1: How big is your arable land (rainfed)? ....(ha)
2: How do you maintain soil fertility (rainfed agriculture)?
(a) Intercropping (b) Manure (c) Chemical fertilizer
(d) Other(s) (specify) ....
3: If you do have some woody perennial(s) on the arable land, what could be the major reasons for this?
(a) Sun-shade to crops (b) Wind break (c) Mulching (d) Wood fuel
(e)Medicinal value (f) Forage (g) N/A (h) Other(s) specify ....

4: Please give the name(s). number and use(s) of the species?

Local Name	Scientific / English Name	No.	Uses	Parts used
1				
.				
.				
n				

SECTION 2: LIVESTOCK.

IF NO LIVESTOCK. GO TO SECTION 3.

1: If you have livestock, please indicate their variety and numbers you own?

Variety	Number
Goats	
Cattle	
Sheep	
Donkeys	
Other(s) specify	

IF THE FARMER HAS MORE THAN ONE TYPE OF LIVESTOCK. ASK.

2: Why do you keep such a variety? . . . .
3: What mainly determines the number of livestock you keep? . . . .
4: If you practice some kind of livestock selection, what criteria do you use?
(a) Colour (b) Resistance to drought
(c) Resistance to diseases (d) Size (e) Other(s) specify . . . .
5: If you don't have exotic cattle. what are the reasons for this?
(a) Less resistant to diseases and drought (b) Expensive to purchase
(c) No enough forage (d)Other(s) specify . . . .

SECTION 3: VEGETATION

HAVING SO FAR TALKED ABOUT YOUR LIFE AND AGRICULTURAL EXPERIENCE. I WOULD LIKE AT THIS POINT TO BRIEFLY DISCUSS ABOUT FORESTRY.

If there has been some noticeable change in vegetation over the years. what could be the major underlying factors? (a) Agriculture (b) Livestock (c) Wood fuel (d) Climatic changes (e) Construction (f) Herbal medicine (g) Other(s) specify ....
What are the major sources of your domestic energy?
(a) Wood fuel (b) Cow dung (c) Electricity (d) Solar
(e) Other(s) specify ....

ASK THE RESPONDENT TO SHOW YOU A REPRESENTATIVE BUNDLE OF FUELWOOD THAT IS FETCHED PER TRIP. USING THE WEIGHING SCALE, RECORD ITS WEIGHT ....(Kg).

Approximately how long does a bundle of firewood last?..(days)
If the household is selective of the species it uses for fuelwood. name four of the most preferred woody species:(i)....... (ii)....... (iii)....... (iv) ....
Compare the availability of firewood today with some 10-15 years back?
(a) The same (b) Plenty
(c) Getting scarce (d) Can't tell
If you do burn charcoal. which is the most preferable season for this activity? (a) During drought (b) Rainy season (c) N/A.
Why is the above season the most preferable? ....
What do you do first when you fall sick?
(a) Hospital (b) Herbal medicine
Why is the above option the one you normally prefer? ....
Please give the following information on the medicinal woody plants in this area:

Local Name	Botanical Name	Part used	Treatment	Status of species
1				
.				
.				
n				

Do you find some of your extractive methods to be destructive to the species? (a) Very much (b) Somehow (c) Not at all (e) Can't tell
What efforts are you making to conserve the threatened and/or endangered woody plant species? (a) Domesticating them

(b) Controlling their use (c) Other(s). specify . . . .

13. Please give any other woody species of importance in this area:

Local Name	Botanical Name	Uses	Part used	Species status
1				
.				
.				
n				

14: Please rank (0,1,2,3) the woody species respectively;

Species	FD	FG	FEN	FUL	CTR	HMED	CULT	FUM	VMED	OTHER
1										
.										
.										
n										

Key:
FD = food; FG = Forage; FEN = Fence; FUL = Fuel;
CTR = Construction HMED = Human medicine; CULT = Cultural; FUM = Fumigation;
VMED = Veterinary medicine 0 = Unused; 1 = Rarely used;
2 = Moderately used; 3 = Heavily used

15: Do you know of any sacred grove(s) and/or tree(s) preserved in this area? (a) Yes (b) No

IN CASE OF SACRED TREE(S) GET THE NAME(S)

16: IF YES, what are their symbolic significance? . . . .
17: How do you conserve these patches and/or tree(s)? . . . .
18: Which are the most preferred tree species for the construction of crafts? . . . .
19: What is the current status of the above (18) species in this area?
(a) Abundant (b) Rare (c) Disappeared
20: What is your opinion about the widespread agricultural encroachment of the relic forests?
(a) Very destructive (b) Somehow destructive
(c) Not destructive (d) Can't tell

(b) Controlling their use (c) Other(s). specify ....

13. Please give any other woody species of importance in this area:

Local Name	Botanical Name	Uses	Part used	Species status
1				
.				
.				
n				

14: Please rank (0.1.2.3) the woody species respectively;

Species	FD	FG	FEN	FUL	CTR	HMED	CULT	FUM	VMED	OTHER
1										
.										
.										
n										

Key:
FD = food; FG = Forage; FEN = Fence; FUL = Fuel;
CTR = Construction HMED = Human medicine; CULT = Cultural; FUM = Fumigation;
VMED = Veterinary medicine 0 = Unused; 1 = Rarely used;
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15: Do you know of any sacred grove(s) and/or tree(s) preserved in this area? (a) Yes (b) No

IN CASE OF SACRED TREE(S) GET THE NAME(S)

16: IF YES, what are their symbolic significance? ....

17: How do you conserve these patches and/or tree(s)? ....

18: Which are the most preferred tree species for the construction of crafts? ....

19: What is the current status of the above (18) species in this area?
(a) Abundant (b) Rare (c) Disappeared

20: What is your opinion about the widespread agricultural encroachment of the relic forests?
(a) Very destructive (b) Somehow destructive
(c) Not destructive (d) Can't tell

21: If cultivation activities are destructive, what could be done to remedy the situation?
(a) Restrict encroachment (b) Preserve the forests (c) Hard to tell.

22: What is your comment about the alien species (*Prosopis*) introduced through the afforestation programme?
(a) Very important (b) Somehow important
(c) Not important (d) Can't tell

23: What do you suggest should be done about the species?
(a) Increase it (b) Should be controlled (c) Do away with it

24: Normally how do you conserve the relic forests? . . . .

SECTION 6: MISCELLANEOUS QUESTIONS

1: Do you have access to credit facilities? Yes/No.

2: If No, Why? (a) Not available (b) Lack of awareness
(c) Other(s) specify . . . .

3: If there are widespread cases of unsustainable practices in this area (e.g. inadequate soil conservation, felling of trees, etc.), what would you say is the most important reason underlying them? (a) Low literacy
(b) Low income (c) Insecure individual land tenure (d) Other(s) specify . . . .

END
THANK YOU.

APPENDIX 2: CHECKLIST OF PLANTS' SPECIES.

Local Name (Ilchamus)	Scientific/Botanical Name	Life form	Origin
Ilatacha	*Maerua crassifolia*	t	I
Ilchurei	*Acacia reficiens*	s	I
Ildalami	*Prosopis species*	t	E
Ildepe	*Acacia nubica*	s	I
Ilkiloriti	*Acacia nilotica*	t	I
Ilkogomi	*Grewia tembensis*	s	I
Ilkujitalentapa	*Tetrapogon tenellus*	g	I
Illowwei	*Balanites aegyptiaca*	t	I
Illoyang'aleni	*Sesbania keniensis*	s	I
Ilmangirigiriani	*Lantana camara*	s	I
Ilmapapai	*Ziziphus mauritiana*	s	I
Ilmeidimukoon	*Maerua oblongifolia*	t	I
Ilng'aboli	*Ficus sycomorus*	t	I
Ilngotoi	*Diospyros scabra*	t	I
Ilnkapasura	*Diplachne fusca*	g	I
Iloipup	*Aristida mutabilis*	g	I
Ilperesi	*Cynodon plectostachyum*	g	I
Iltepes	*Acacia tortilis*	t	I
Iltikilte	*Hygrophila auriculata*	f	I
Iltulelei	*Solanum incanum*	s	I
Itii	*Acacia mellifera*	t	I
Koloswe (Tugen)	*Terminalia brownii*	t	I
Lamarguanyi	*Cadaba farinosa*	s	I
Lekima	*Pluchea ovalis*	f	I
Lekuru	*Acalypha fruticosa*	s	I
Leng'osoiron	*Securinega virosa*	s	I
Long'eri	*Cynodon dactylon*	g	I
Long'ortomia	*Indigofera arrecta*	t	I
Lorupakini	*Achyranthes aspera*	f	I
Luaai/Lwai	*Acacia seyal*	t	I
Nakunka	*Tragus berteronianus*	g	I
Nchanoti	*Crateva adansonii*	t	I
Nteiyo	*Heliotropium somalense*	g	I
Rara	*Cassia obtusifolia*	f	I
Salapani	*Cordia sinensis*	t	I
Serichoi	*Boscia coriacea*	t	I
Sesiai	*Acacia elatior*	t	I
Seyyai	*Cyperus spp.*	s	I
Sipei	*Aeschynomene elaphroxylon*	t	I
Siteti	*Grewia mollis*	t	I
Sokotei	*Salvadora persica*	t	I
Sukurutiti	*Cissus cactiformis*	f	I
Tabilikwe (Tugen)	*Dodhyonea angustifolia*	t	I

Life form: g = grass s = shrub t = tree f = forb
Origin: I = Indigenous E = Exotic
Source: Author

APPENDIX 3: THE RECORDING SHEET

1. DATE ______________________
   SITE NAME ______________________
   WEATHER ______________________

2. **PHYSICAL CHARACTERISTICS**

   TOPOGRAPHY (Hilliness, Valleys etc.) ______________________
   SOIL TEXTURAL CHARACTERISTIC ______________________

3. **VEGETATION**

   TYPE ______________________
   TRANSECT No ______________________
   SAMPLE POINT ______________________
   DISTURBANCE ______________________
   GROUND COVER ______________________

   SPECIES
   SCIENTIFIC NAME ______________________
   LOCAL NAME ______________________
   CIRCUMFERENCE ______________________
   HEIGHT ______________________

4. **ANIMALS**

   WILDLIFE ______________________
   DOMESTICATES ______________________

APPENDIX 4: CRITICAL VALUES FOR SPEARMAN'S r_s*

N (number of pairs)	Level of significance (α)				
	.20	.10	.05	.02	.01
4	-	1.00	-	-	-
5	.80	.90	-	1.00	-
6	.66	.83	.89	.94	1.00
7	.57	.71	.79	.89	.93
8	.52	.64	.74	.83	.88
9	.48	.60	.68	.78	.83
10	.45	.56	.65	.73	.79
11	.41	.52	.61	.71	.77
12	.39	.50	.59	.68	.75
13	.37	.47	.56	.65	.71
14	.36	.46	.54	.63	.69
15	.34	.44	.52	.60	.66
16	.33	.42	.51	.58	.64
17	.32	.41	.49	.57	.62
18	.31	.40	.48	.55	.61
19	.30	.39	.46	.54	.60
20	.29	.38	.45	.53	.58
21	.29	.37	.44	.51	.56
22	.28	.36	.43	.50	.55
23	.27	.35	.42	.49	.54
24	.27	.34	.41	.48	.53
25	.26	.34	.40	.47	.52
26	.26	.33	.39	.46	.51
27	.25	.32	.38	.45	.50
28	.25	.32	.38	.44	.49
29	.24	.31	.37	.44	.48
30	.24	.31	.36	.43	.47

* To be significant, the r_s obtained from the data must be equal to or larger than the values shown in the table.

Source: Gregory, 1963