ENVIRONMENTAL, LAND USE / LAND COVER BASELINE SURVEYS

In

LAKE VICTORIA BASIN, LAKE BARINGO CATCHMENT AND MERU-MWEA REGION

J. M. Maitima, P.C. Kariuki, S.M. Mugatha and I. N. Mutie (2008).

ENVIRONMENTAL, LAND USE / LAND COVER BASELINE SURVEYS

In

LAKE VICTORIA BASIN, LAKE BARINGO CATCHMENT AND MERU-MWEA REGION

Report to Pan African Tsetse and Trypanosomiasis Eradication Campaign (PATTEC) Kenya

Kenya Ministry of Livestock and **African Development Bank**

Submitted by

International Livestock Research Institute (ILRI)
P.O. Box 30709 Nairobi 00100, Kenya

2008

Citation:

J. M. Maitima, P.C. Kariuki, S.M. Mugatha and I. N. Mutie (2008). Environmental, land Use and Land Cover Baseline Surveys in Lake Victoria basin, Lake Baringo Catchment and Meru-Mwea Area. International Livestock Research Institute (ILRI) P.O. Box 30709 – 00100, Nairobi, Kenya.

For further information please contact Joseph M. Maitima

Email: j.maitima@cgiar.org
Tel: +254 20 422 3000
Fax: +254 20 422 3001

Disclaimer : This publication is an output from a project funded by African Development Bank (ADB) through the Ministry of Livestock of Government of Kenya and the Pan African Tsetse and Typanosomiasis Eradication Campaign (PATTEC) Kenya. However, the views expressed here are not necessarily those of ADB.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Preamble

This report is the final document developed on the project to establish a baseline data on the environmental and land Use / land cover status in three PATTEC phase 1 sites in Kenya.

Activities of the survey were guided by terms of reference (TOR) agreed between the PATTEC PCMU and ILRI as follows:

The project is expected to:

- Review reports of previous related work.
- To adapt to an agreed data capture format and management and conduct field surveys in an ideal time to obtain reliable data.
- Acquire available maps and reports on previous work done on the subject
- Determine the ecological zones, land cover types/ habitat patterns in the project area
- Carry out vegetation surveys
- Survey animal abundance distribution and densities
- Establish types, distribution and abundance of animal and plant species of economic importance using methods acceptable to PCMU.
- Determine soil physical and chemical characteristics (including water) in different land use and natural habitats in the project areas.
- Develop checklists of different biodiversity components in the project areas utilizing information available in literature and field surveys under this consultancy.
- Generate detailed maps of vegetation distribution, land use patterns and natural resources in the project areas.
- Prepare and submit an acceptable report to the project coordinator (PCMU) containing a synthesis of information acquired in all the above stated activities. The structure and contents of the report will be agreed with PCMU.

Summaries of results of this study are presented in various sections of this report and more detailed data is presented in an easy to use digital format attached to this report as an interactive CD. The CD contains this report in digital format fully with hyper links to data for various sections.

General Introduction

The work reported here was undertaken in three principal sites. These sites are 1) the western Kenya's Lake Victoria Basin/ Winam Gulf; 2) central Rift valley's Lake Baringo basin, and 3) the eastern Kenya's Meru Mwea Region. These three sites are the PATTEC project areas during the phase 1 of ADB funded project. Western Kenya is densely populated due to the presence of fertile lands and the long-term occupation of the area by people. The area has been under cultivation for many generations. Subsistence agriculture is the main human activity that supports livelihoods in the region. Farmers produce cereals, cassava and pulses both for home consumption and for the local market to provide cash. Sugar cane, tobacco and pepper are by some farmers grown primarily as cash crops. Most of the area is relatively dry and is characterized as cotton growing area in the agro-ecological zones classification (Jaetzold and Schmidt. 1983). Rainfall is bimodal with short rains falling between March and May and the long rains falling between October and December. Crops grown are cassava, maize, sorghum, sweet potatoes and a number of other annual subsistence crops that are grown on a small scale.

Lake Baringo basin is located in the Central Rift Valley that is similarly hot and dry for most of the year like some part of western Kenya but is less densely populated compared to western Kenya. The area has been under cultivation for many generations but livestock keeping is more prominent in the Rift Valley. Most of the land around Lake Baringo is used for grazing. Rainfall is bimodal.

In both the western and Rift Valley Study areas livestock keeping is a major contributor to the local economy. Livestock kept are mainly indigenous breeds and cross-breeds. Several farmers especially close to town have started raring exotic cattle in an effort to improve productivity and get better returns from their small plots of land.

In the Meru Mwea region of eastern Kenya however, we find different characteristics as the areas are at much higher elevations compared to Lake Victoria and lake Baringo basins. Climate in the Meru-Mwea is modified by the presence of Mt. Kenya that is the biggest rain tower in Kenya. Much of the region faces the windward side of Mt. Kenya, but the areas of interest in this project are those characterized as rangelands where tsetse and trypanosomiasis are found. These areas are still seriously affected by animal trypanosomosis but sleeping sickness is only common in western Kenya. PATTEC-Kenya project is implementing activities to suppress tsetse populations and eventually eradicate using different types of technologies.

Proper implementation of PATTEC activities will require evaluation of impacts to assess progress in a number of areas. Determination of impacts will always require baseline information acquired before the interventions. Baseline data is required on all parameters on which the assessment is to be made. These include biophysical conditions and ecological states like soil fertility, biodiversity composition and abundances, and socioeconomic characteristics like household income, commodities produced, education, and nutrition among others. It is from the baseline information that changes can be determined during future assessments. It is recommended that baseline data should be collected before commencement of the interventions. The baseline data should be based on a set of acceptable indicators for each system or component of assessment. To guide the development of baseline data it is therefore necessary to first develop a set of indicators to be used in assessing changes. As much as possible the methods used to generate the baseline data should be similar to those intended to be use in assessment exercises so that the results can be comparable in determining the impacts.

Monitoring of project impacts needs to feed directly into strengthening the ability of communities to take action to sustain their natural resources. Without this connection, monitoring has no impact on the rural poor. A series of techniques have been developed to involve communities in monitoring and to empower them to better manage their natural resources. The overall objective is to increase the sustainability of natural resources and agricultural systems, through environmental monitoring and management. The twin objectives of increasing productivity to improve human welfare and to sustain those gains over the long term are at the core of the objectives of the agricultural sector development in the vision 2030. The purpose of this environmental baseline survey is to increase the level of information and awareness of environmental change and increase the capacity to respond proactively to these changes among stakeholders (EMMC Report 2002). To attain this goal, an information system able to store and manage the information describing the changes in tsetse flies and trypanosomosis challenges, control measures and landscape will be necessary. Local communities will have a critical role as the source of information, and the main users / recipients of the information. They should therefore be deeply involved in its design. The information flow should match their needs alongside the objectives of the program. This latter point is crucial to ensure the sustainability of the information system after the end program.

Objective

The main objective of this work is to conduct a baseline inventory on land cover in the three project sites; vegetation surveys, biodiversity surveys; and the general status and management of natural resources.

More specifically:

- Establish types, distribution and abundance of plant species in the study areas and develop a database of species of economic importance using standard scientific methods
- Determine soil physical and chemical characteristics in different land use and natural habitats in the project areas.
- Develop checklists of different biodiversity components in the project areas utilizing information available in literature and field surveys under this consultancy.
- Generate detailed maps of vegetation distribution, land use patterns and natural resources in the project areas.

SECTION 1

METHODLOGY AND APPROACH

1.1 Methodological Approaches

There are many methods available and commonly used in conducting ecological surveys for various organisms in different ecological settings. For any survey the purpose for which the survey is being conducted helps to determine the type methodological approaches to be used. The purpose for the study conducted here is to document environmental and land cover states before tsetse and trypanosomiasis eradication interventions to provide a baseline for assessing the impacts of these interventions at an appropriate future time during the implementation of PATTEC project.

The purpose therefore is NOT to produce botanical or zoological species checklists of various organisms in the study areas as would be expected in a standard taxonomical or biodiversity survey, rather the purpose was to give a general description of the environmental and land cover situations in the area showing the presence and a measure of the represententation of such organisms in a an area. The terms of reference olso required us to develop lists of indicators for different ecological states that can be used to assess the conditions of the environment in the study areas. The other consideration used in guiding the selection of methodologies used in this study is the likelihood of being used in future monitoring and assessment studies. These include assessment of major or critical plant and animal biodiversity components in the area and giving a measure of their representation. The following sections describe sampling methodologies used to sample various components that include land use and land cover, vegetation, soils, and animal biodiversity. For this study animal biodiversity was to be done on a few selected groups that are historically known to be important in tsetse and trypanosomiasis interventions. These primarily include insects and birds. Since most of the areas where the study was done is in areas already under human occupation, it was agreed that the appropriate method to be used is to conduct a rapid appraisal to the occupants of the land to provide the types of anaimals they find in the area and the historical changes in the presence of such animals.

1.1.1 Environmental impacts due to tsetse control

In selecting baseline survey and impact assessment methods it is necessary to reflect on the the nature of impacts that are known to occur due to tsetse control interventions especially at this point in time when several such studies have been done before. It is evident from the review that a wide range of control methods have been used in various geographical locations, and were carried out under different environmental conditions. These activities may have had direct and indirect impacts, operating at considerably different spatial and temporal scales. Numerous impact

assessment reports show that past control operations were done without adequate environmental considerations leading to ecological disruptions manifested in loss of wildlife and habitat fragmentation. Table 1.1 and the list below are summaries of some of the reported impacts:

- Cases of altered population structure i.e., a smaller proportion of seedlings and a larger proportion of vegetative adults when compared to large extensive populations (Reid and Swallow, 1998).

- Inaccessibility of rangeland areas due to land tenure reforms and policy changes (new rules on land use following tsetse control) leading to cessation of nomadic movements and changes in grazing systems (boundaries) and/or limited access, e.g. the Orma pastoralists were prohibited from using Galana ranch, and the fencing off of national parks excluding people and livestock completely, e.g. in Ruma national park, following increasing competition for grazing areas with livestock (Muriuki et al 2005).

- Wildlife numbers are reported to negatively correlate with cattle biomass due to increased interspecific competition, food shortage due to drought, hunting, excessive legal and illegal off takes.

- Conversion of rangeland to crop land which limits access of wildlife and or livestock to the area e.g. in Ghibe valley Ethiopia, large government-run farms were ploughed exclusively for cash crops like citrus, onions, maize, spices etc (Wilson 2003).

- There are few and isolated cases of successful control especially where pesticides which form relatively persistent deposits on the leaves and branches, e.g. dieldrin, DDT and endosulfan are used. Few trials with ultra-low volume low-dose rate applications of endosulfan and later deltamethryn (knock-down method) appear to succeed in Botswana. Most operations carried out were directed to open savannahs (e.g. the Sudan savannah in West Africa and the Miombo woodland in East and South-east Africa which are marginal and likely to suffer land degradation, if use is not controlled and planned.

Table1.1 Summary of Tsetse Control and Eradication Techniques and their Direct Impacts on Environment

T&T control and eradication technique	*Associated direct impacts on environment*	*Available options to mitigate or minimize the impacts*
Odour baited traps	Non target insects caught in the traps	None
	Vegetation clearance along service paths / transects	Paths should be narrow
Insecticide impregnated targets	Effects on non-target organisms	None
	Use of treated fabrics by uninformed people	Create public awareness
Treated nets for zero grazing	Killing of non-target organisms	None. but may be beneficial on other disease vectors
	Effect of chemical on children	Keep children off the net especially when chemical is fresh
Crush pens and live baits or moving targets	Spill of insecticides around the crush pen	Fencing off areas used for crush pens
	Spread of insecticides to objects in contact with cattle	Keeping treated cattle out of vegetable and fruit gardens and areas with other consumables
	Contamination of milk with chemicals	Proper sanitary conditions during milking
Ground spraying	Application of insecticides on vegetable crops and non-target organisms	Apply on tsetse habitats and during appropriate times and seasons
	Accumulation of chemicals on water reservoirs	Should not spray on small stagnant water bodies.
	Effects on people handling spray pumps	Public education on proper use of insecticides
Pour ons	Effects on no-target organisms	None
Sequential Aerosol technique (SAT)	Effects on non target organisms	None
	Effects of chemicals on stagnant water reservoirs	None
Sterile Insect Technique (SIT)	Effects of gamma radiated materials on environment?	Public awareness
Trypanocidal drugs	Disposal of drug containers	Public awareness of proper disposal methods

Sampling designs

1.1.2 Land Use Land Cover Analysis:

Satellite imagery has been found to be a good source of information on landuse landcover classification. Such products have been widely used not only to give the current status of cover but to also give the dynamics over time. Satellite image interpretations therefore provides a good source of information for this study since it provides for future monitoring of expected changes due to the current tsetse eradication program.

In the study, satellite imagery was used to establish the percentage cover of the various land cover types in each of the three study sites. In carrying out this the Africover vegetation Landcover Classification System (LCCS) scheme was used as the guide to delineate distribution patterns based on a collection of available landsat imagery for the period 2000-2004. In carrying out the classification colour composites of the various bands of the imagery were used to distinguish between the various landcover types based on their differences in intensity of reflectance of the used band combination and also the visual patterns on the imagery (see FAO Africover report 2004 for detailed methodology).

The obtained broad classes comprised of cultivations, forest, bush, grasslands, swamps or wetlands and bare lands which were in turn input into a Geographical Information System (GIS) for analysis. In the analysis, the size of each class was estimated by use of geometry calculation algorithm (see ESRI ArcGIS 2006 for details).

The resulting landcover classes together with reported tsetse areas data, were used as the basis for sampling design where transects were generated to cover all the major landcover classes in each site weighted by presence or absence of tsetse. Transects were of different lengths dependent on diversity of the landcover classes and presence of critical or unique habitats. Transects were also such as to include controls where tsetse is not present to allow for future impacts monitoring. Random sampling points were automatically generated from the GIS tool along transects but constrained to fall within all the major landcover classes within such transects. The resulting points were then used in the next stage of field sampling.

Vegetation Surveys

Based on the distribution of these land cover types, transects were laid in each site to guide sampling of plants where transects were such as to cut across all the major landcover types within the site. Along each site 10 sampling points were selected randomly where the random points were constrained to fall within all the major landcover types. On each sampling point plant species were

identified and enumerated according to the three life forms: Trees, shrubs and herbs/ grass. Other than plants, insects were also identified.

Sampling was done using circular quadrants (figure 1.1) as specified in the Terms of Reference (TOR).
The following quadrant sizes were used in all the sites

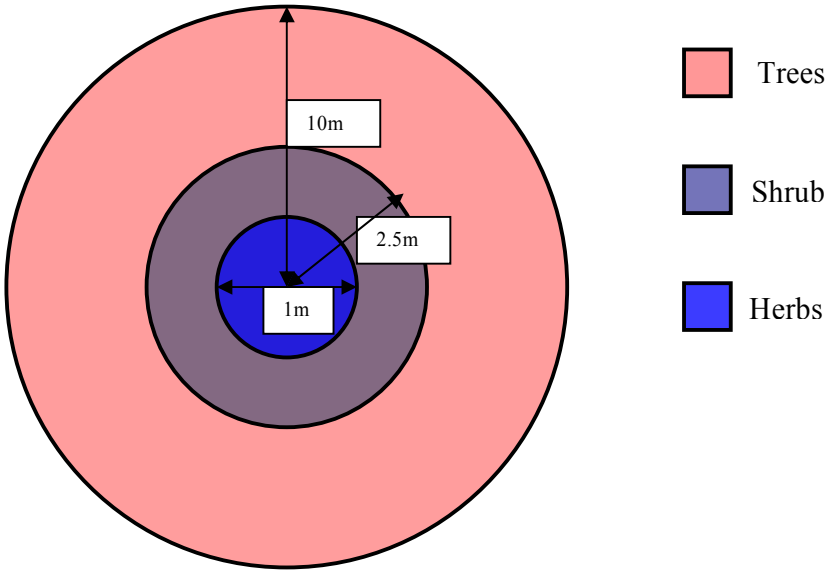

Figure 1.1: The vegetation sampling plan

Samples were taken for the vegetation, insects and soil, at the random points. It had been proposed that 10 points be sampled per land use and 2 quadrants per point. However, at some points, due to the homogeneity, uniformity and similarity of the vegetation structure and plant species, the team decided to take less than the predetermined 10 points but always more than 50% of the predetermined 10 points.

Vegetation sampling was guided by the land uses along or adjacent to transect. Although the TOR required sampling of transects of at least 4km, transect lengths were determined according to distances separating particular land use types. Sampling was focused on land use by locating 10 random sample points in each type. Therefore, a transect cutting across five land use types had 10(sample points) x 5(land uses) x 2(replicates) quadrats sampled for tree, shrub and herbs. Once in the land use, a Point Centered Quadrant (PCQ) (J. G. Mutangah & A. D. Q. Agnew, 1996) figure 1.1 above was used in sampling the vegetation. A PCQ of diameter 20 meters was used to collect tree

samples, 5m for shrubs and 1m for herbaceous cover. The GPS coordinates for each quadrant was recorded. The vegetation attributes focused on included, the number per species identified, the height and the percentage canopy cover estimates. Table 1.2 illustrates the approximate area sampled for each lifeform in any land use. Identification by names was done by both local as well as scientific names. What was not identified in the field was collected and pressed for further identification in the laboratory.

Table 1.2 Approximate area in square m sampled for each lifeform in each land use

Lifeform	Area (m^2)
Trees	6280
Shrub	392.5
Herb	62.8

There were 3, 1 and 4 transects done in Lake Victoria Basin, Baringo Basin and Meru - Mwea region respectively (figure 1.2). The lengths of transects were as follows:

1. Suba - Homa Bay **41** Km
2. Busia – Siaya – Bondo **68** Km
3. Rachuonyo – Nyando **72** Km
4. Baringo – **74** Km (figure 1.3)
5. Kitui **48** Km
6. Mbeere - **40** Km
7. Mwingi **90** Km
8. Meru North **40** Km

Figure 1.2: Landsat composite image showing transect locations

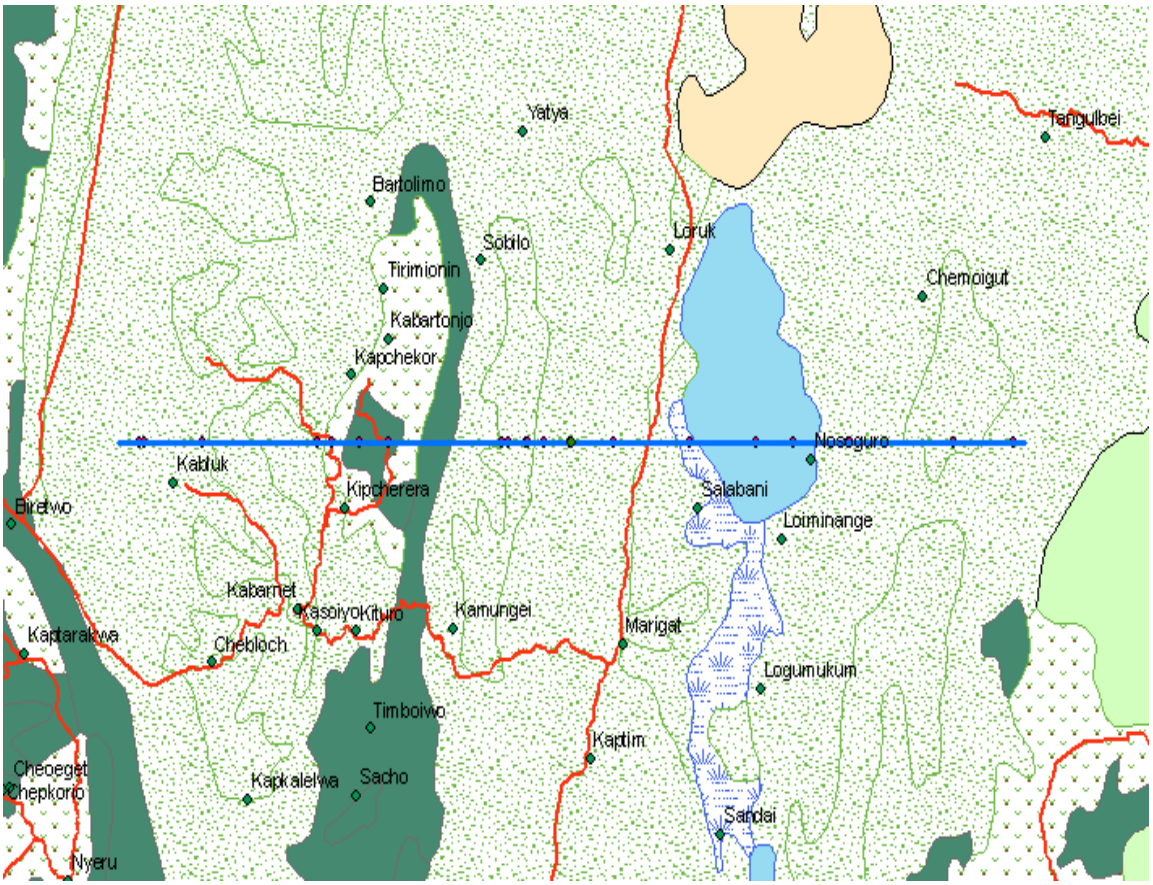

Figure 1.3 Lake Baringo Transect with random sampling points

Other Biodiversity Surveys

As pointed out in the general methodologies section, one of the biodiversity components that was considered critical in this study is the insects due to the fact that all methods of tsetse control will affect other non-tsetse members of Arthropods. Insects were studied in every sampling unit in each transect, making them have a similar samplying effort with vegetation. Birds were also considered to be important indicators of ecological change. However, in areas where human activities have modified the environment to a great extent, changes can be considered to have already occurred and any survey will only capture indicators of modified ecosystems. Our surveys on birds therefore focused heavily on the areas that impacts of tsetse control / eradication and the subsequent changes in land use will alter the composition and abundance of birds. On the other hand studies on birds require specialized skills and approaches that are very different from all the others and therefore could be very expensive to conduct in all the transects. Unlike plants and insects that are

point based and localize in distribution, birds have very large distribution ranges that should be best accounted for by ecological types rather than point observations as in the case of transects.

Large mammals are more like the birds. In areas where human modifications of land use has already taken place all the large mammals have either been driven away or have been locally exterminated. Any sampling therefore should focus on reconstructions of the changes that have occurred on temporal perspectives. We have achieved this by developing and administering a questionnaire to capture the changes.

Questionnaire Administration

A questionnaire was administered in all the sampling sites to get both qualitative and quantitative values of a number of variables: These include non arthropod biodiversity, land tenure, land use history, natural resources management and utilization among others. A sample of questionnaire is presented in this report as appendix1. Questionnaires were administered along the sampling transects and stratified on the land cover and land use types per transect. Data obtained from the questionnaire were analyzed using Microsoft excel and access programs to show the status of temporal changes in various environmental components based on the perceptions of the respondents. Information obtained is presented in section six of this report and facilitate future monitoring and assessments. This data is presented in the CD accompanying the report.

Survey Soil Erosion Indicators

Conventional method in determination of soil erosion consists of a checklist of various indicators among which are rills, gullies, sedimentation in streams among others. The indicators were observed per quadrant and recorded in the data collecting sheets where a checklist of the various indicators among others included; presence of rills, gullies, sedimentation in streams, pedestals and rivers, accumulation of soils around clumps of vegetation or upslope of trees, fences or other barriers, exposed roots or parent material etc. This was then categorised in four classes namely;

EO: No visible evidence of erosion or very slight sheet wash,
EL: Slight-moderate sheet wash,
E2: Moderate – severe Sheet washes,
E3: Very severe Sheet wash.

Soil Sampling for fertility analysis

Standard soil sampling procedures were used in the soil sampling where each landcover class was represented by two sampling points in a transect. At each point, soil was collected in a quadrant

and pooled for analysis by drawing a three sided triangle of 1.5 meters (Figure 1.4) with soil samples being taken from the three corners. This was repeated in the second quadrant of a sampling point. There after, the soil from the two quadrants was mixed to form one soil sample from that particular point. A total of 40 soil samples were collected for each of the two regions of study.

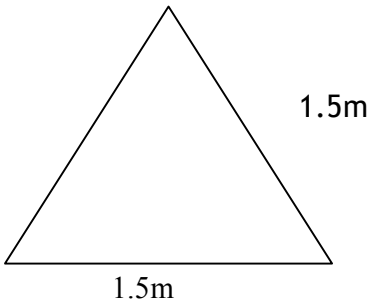

Figure 1.4. Soil sampling plan

The total of 80 soil samples was taken for chemical analysis at KARI soil laboratory to determine soil fertility. Table 1.3 is an example of the listing of samples collected in one of the sites:

Table 1.3: An example of soil sampling locations in each Land Use

LONGITUDE	LATITUDE	CODE	LAND USE	VEGETATION TYPE	LOCATION
34.73154	-0.36580	RN4	Agriculture	Maize Ocimum suave	Rambira
36.24790	0.59690	B1	Bushland	Mimosa	Arabal
34.88185	-0.29831	RN5	Agriculture	Heinsenia diervilleodes,Ocimum suave	Nyalunya
35.66755	0.59625	B2	Bushland	Lantana camara	Kabutei
34.95461	-0.24502	RN6	Agriculture	Maize	Gem Rae
36.02169	0.59474	B3	Agriculture	Amaranthus,Zea mays	Bartum
35.03423	-0.20280	RN7	Shrubs	Cloris gayana,Eragrostis exasperate	Awasi
35.82122	0.50355	B4	Agriculture	Beans,maize,Bidens	Morop-Tirikwir village
35.08838	-0.17378	RN8	Agriculture	Cassava,maize	Awasi
35.74424	0.58967	B5	Woodland	Aloe vera,Euphobia	Katiorin
34.16590	-0.54047	SH1	Agriculture	Maize,	Kaksingri east
35.75474	0.51594	B6	Woodland	Kilelwa(Tugen),Tabilikwet	Kabarnet
34.19913	-0.59988	SH2	Agriculture	Maize,	Kaksingri West
35.83855	0.69204	B7	Forest	Eucalyptus,Cypress	Saimo
34.27898	-0.67476	SH3	Grassland	Setaria incrassata,Themeda triandra	Ruma
35.77515	0.59743	B8	Forest	Podocarpus falc	Ossen
34.24937	-0.63871	SH4	Grassland	Stipa dregeana,Cenchrus mitis	Ruma
34.09614	0.17541	BSB1	Agriculture	Bidens pilosa,maize,green gram	Bwiri
34.26195	-0.64959	SH5	Bushland	Acacia seyal,Carissa Edulis	Ruma
34.06219	0.23482	BSB2	Agriculture	Bidens pilosa,maize,Manihot esculenta	Agenga
34.24919	-0.63885	SH6	Bushland	Acacia seyal,Lantana camara	Ruma
34.14806	0.08625	BSB3	Agriculture	Hibiscuss callyphylus,Lantana camara	S.W Alego
34.44463	-0.81250	SH7	Woodland	Lipia javanica,Mimosa pigna	South Kabuoch
34.20182	-0.00625	BSB4	Bushland	Grewia simi,Embelia schimperi	S. Alego
34.44416	-0.81109	SH8	Woodland	Lantana camara,Grewia similis	South Kabuoch
34.16256	-0.03962	BSB5	Swamp	Cyperus papyrus,Votovae	S.C Alego
34.34812	-0.75590	SH9	Agriculture	Maize,amaranthus	Miranga
34.18766	-0.01929	BSB6	Bushland	Lantana camara, Mimosa gagra	S. C .Alego
34.38981	-0.79984	SH10	Agriculture	sorghum,maize	South Kanyikela
34.21014	-0.01409	BSB7	Swamp		S.C Alego
36.24790	0.59690	B1	Bushland	Mimosa	Arabal
34.22603	-0.04806	BSB8	Agriculture	Lantana camara,Solanum incunum	Maranda
35.66755	0.59625	B2	Bushland	Lantana camara	Kabutei
34.31116	-0.19498	BSB9	Agriculture	Solanum incunum,Ocimum suave	Kamieda Div-Nyaguko Loc
34.21106	-0.02336	BSB10	Bushland	Cyperus papyrus,Digitaria voluntina(grass)	Othach
34.18850	-0.56720	RN9	Bushland	Lantana camara,solanum incunum	Kadel
34.76750	-0.33957	RN1	Agriculture	Cow peas	Kobuya
34.88630	-0.30640	RN2	Bushland	Rhuss vulgaris,Lantana camara	Rakiyaro
34.54987	-0.46210	RN3	Agriculture	maize ,Rhuss vulgaris	Kanyaluo West

Insect Survey

Arthropods are the most successful group of organisms with the class insecta having the largest group or the highest percentage fauna among the animal groups. It is the group that carries the vectors, pollinators, predators and pests of trees and crops. Many of the most dangerous human and animal diseases are transmitted by insects. Tsetse control activities target removal of one the insects the *glossina* sp. from the environment. The method of removal could therefore affect other non-tsetse insects. However, these methods have been perfected to an extent that the methods are very specific in targeting tsetse alone. The project area is large and covers different habitats. Arthropod fauna in these areas is also likely to be diverse. We sampled each transect and got different insect orders.

The climate was very favorable for sampling of insects as the vegetation was still green. It was raining and occasioned with sunny periods. The insect sampling was quite successful because of the rich habitat and the farming activities in the two regions, the only exception being Baringo which experiences Semi – Arid climatic conditions. Some insect orders which appeared in almost all transects were:

Order: Lepidoptera: Family: papilionidae, pieridae,
Order: Hymenoptera: Family: Apidae formicidae
Order: Hemiptera: Aphididae, Pentatomidae
Order: Dictyoptera Family: Blattidae and mantidae
Order: Orthoptera Family: Acrididae
Order: Odonata: Libellulidae
Order: Coleoptera, Coccinellidae and Scarabaeidae.

Most of these insects could only be collected between 10.00 am – 4.00 pm. This is the time when temperatures start rising to improve on the physiology of the insects so that they become active to carry out the various activities like feeding. Most of the insects could be collected while feeding on crops like maize, cow pea, green gram Beans, and sorghum.

On these crops, major insect pests were also seen such as Chilo, Acanthomia, Coryna, Dysdercus and Thrips.

1.2 Descriptions of study sites

1.2.1 Lake Victoria Basin/ Winam Basin

The study site referred to as Lake Victoria basin is also sometimes called the Winam Basin that refers to the arm of Lake Victoria basin that extends into western Kenyan. We would prefer to use the name Winam Basin rather than Lake Victoria basin which also includes portions in Uganda and Tanzania. Lake Victoria, part of which lies in the Winam Basin is at 1134 m above sea level, and indeed most of the open land surface on the basin floor is below 1200m. Rainfall in the basin floor is about 800mm per year on average and falls mainly within two seasons, one from March to June and the other from November to December. The climate in the basin floor is typically hot and dry and vegetation consists of open grasslands with scattered bushes around hillside and along watercourses.

About half of the total length of the basin comprises of Grabens, the remainder having at least one shoulder comprising of antithetically fractured monoclines (Pickford, 1982; 1986). The basin is marked by a number of volcanic complexes some of which include the Gwasi Hills, Ruri Hills, Homa Hills and others in the area referred to as south Nyanza, and surrounding the Lambwe Valley. The entire basin floor has been a focus of sediment accumulation in the past and is at present comprised of recent sediment deposits from the surrounding highlands.

On the southern side the basin is bordered by the Kisii/ Kericho highlands, while on the northern side the basin is bordered by Nandi hills and the relatively higher elevated parts of western Province.

Districts covered in this study site include, Migori, Homa Bay, Suba, Rachuonyo, Nyando, Kisumu, Siaya, Bondo, Busia, Teso, Bungoma, and Kakamega. The degree of tsetse infestation varies from district to district.

1.2.2 Lake Baringo

Lake Baringo basin is the name given to the study area representing the central Rift Valley tsetse belt that extends a few kilometres from Nakuru through Lake Bogoria, Lake Baringo to the highlands north of the lake. Lake Baringo is situated in central rift Valley of Kenya. The drainage divide between Lake Baringo and Lake Bogoria is just 3 km north of Lake Bogoria, so that most of the freshwater drainage (surface and subsurface) is northward toward Lake Baringo and away from Bogoria. Lake Baringo is fresh and Lake Bogoria is saline-alkaline. East and West of the plain, the land rises abruptly in a series of step-fault to form the Laikipia Escarpment and Tugen Hills fault-block, respectively.

Immigration into the area around Lake Baringo occurred about 250 years ago. The early settlers from adjacent hills were pastoralists with goat herds. Population growth and associated land use changes has led to a general degradation of the landscape (loss of small trees and shrubs and stripping of top soil). Agriculture was introduced in the valley about 50 years ago and cultivation activity has increased as more of the population switch to subsistence farming as their main source of food. The main crop is corn (maize).

The area receives ~709 mm/yr precipitation (25-year average) on the rift valley floor; potential evaporation exceeds 2,500mm (LaVigne & Ashley, 2000). Mean annual temperature is 23-25° C. Annual rainfall is dominated by monsoons with highest occurring in April followed by another peak in November. Cloudbursts during dry months create sheet run-off and flashy river discharge. El Niño and La Niña events are interpreted from analyses of the 25-year record from a weather station just north of Lake Bogoria. A plot of the deviation from the mean, reveals 5-7 year cycles of interannular variability in precipitation.

1.2.3 Meru-Mwea Area

Districts included in this study area include: Thika, Muranga, Maragua, Embu, Kitui, Mwingi, Mbeere, Tharaka, Meru North, Meru Central Meru South and Machakos

Although the area has many districts, ecosystems and land use diversity is not as much. We identified areas below 1800m above sea level as the areas where tsetse exists and used this as our upper limit. Above this it is assumed that tsetse does not exist and in many areas this marks the tree line on Mt. Kenya.

The area is extensive, large and long extending a few kilometres from Thika town, going a cross the hydroelectric dams along Tana River, and extending along the plains. The area is delineated to the north by slopes of Mt. Kenya.

The area presents the wettest side of Mt. Kenya as it faces the rain bearing winds.
On the northern side the area borders the Nyambene hills that rise to above 8,000 ft above sea level and is a major feature influencing climatic conditions.

The region is characterized by extensive rangeland ecosystems that vary from open grasslands to closed vegetation with a substantial amount of woody vegetation. The region features as low elevation drainage plains of three major mountain systems that border the region (The Aberdare's, Mt. Kenya, and Nyambene ranges). Several rivers emanating from these mountains form a network

of rivers stranding the upper part of the region and collecting into the Tana and Athi River basins leading to the Indian Ocean.

The entire belt was divided into four transects which were cutting across various land use and land cover types. The Transects were Meru-North, Mbeere, Mwingi, and Kitui. The methodology for the entire baseline was triangulation in nature where different methods were used in collecting similar attributes which were later collated for reporting purposes. Questionnaires were administered to 20 randomly selected community members per transect in addition to holding focus group discussions with the veterinary practitioners together with key community informants within the project area. The insect sampling was done using a sweep net and insects of all forms and types were collected for identification and characterization per transect. For the vegetation data, random points generated by computers were located along transects where sampling was to be done. However, due to terrain on the project site, the locations of some of these points was altered by the field team and GPS locations recorded. At some point, due to the homogeneity, uniformity and similarity of vegetation structure and plant species, the team agreed to take less than 10 points but always more than 50% of the agreed 10 points. It was expected that 10 points be taken per land use and 2 quadrants per point. Point centered quadrant (PCQ), was the major method for sampling vegetation. A bigger circle of diameter 20 meters was used to collect tree samples within the area and at diameter of 10m shrubs were collected while at the diameter of 5m herbaceous layer was collected. The vegetation attributes that were looked at included, the number of plants per the species identified, the height and the percentage canopy cover. Identification of plant names was done in both local names as well as scientific names. What was not identified in the field was collected and pressed for further identification in Nairobi.

SECTION 2

LANDCOVER AND FARMING SYSTEMS

2.0 Data sources

Data from the field was used to create a database on vegetation in the three study sites and also to verify the interpreted landcover from the satellite imagery. The analysis presented here is part of the information that can be obtained from the database.

2.1 Land Cover Analysis

2.1.1 Developing an inventory on landuse/landcover at the three study sites

The objective at this stage was to generate digital information on the area covered by the various landuse/landcover types. This was carried out on the basis of Africover classification where the sites were characterized into various landcover types and their percentages calculated. Updates of the Africover classification were carried out where more up to date imagery and field surveys were used to adjust the various landcover areas of the Africover project. The areas under each landcover type are given for each of the three study sites in the body text and as individual districts in appendix 2. To visualise the tsetse threat and select areas on which to carry out ground truthing fieldwork of the image interpretations, the tsetse distribution layer of Lesssard, et al., (1990) was used as a guide. Transects were generated on the interpretations so as to capture maximum number of the landcover classes and to fall within a tsetse belt for each study site.

2.1.1.1 Lake Victoria Basin

Agriculture forms the greatest percentage (more than 80%) of the landcover in this basin with Bushland, Forests and water occupying the next set of relatively bigger percentages 4.5%, 4.4% and 4.1% respectively). Grassland, plantation and swamps consist of 0.2%, 1.8% and 3% respectively. Agriculture could therefore be concluded as the main landcover class in this belt. Table 2.1 gives the details of area cover for each of these landcover types whereas figures 2.1, 2.2 and 2.3 gives a visual dimension to these observations.

Table 2.1: Percentage of landcover types in Victoria basin

LANDUSE	Area(Hectares)	% Total
agriculture	1480419	81.68
bushland	80760	4.46
Forest	78893	4.35
grassland	3630	0.20
plantation	31649	1.75
Swamp	54533	3.01
Town	2073	0.11
water body	74695	4.12
woodland	5851	0.32

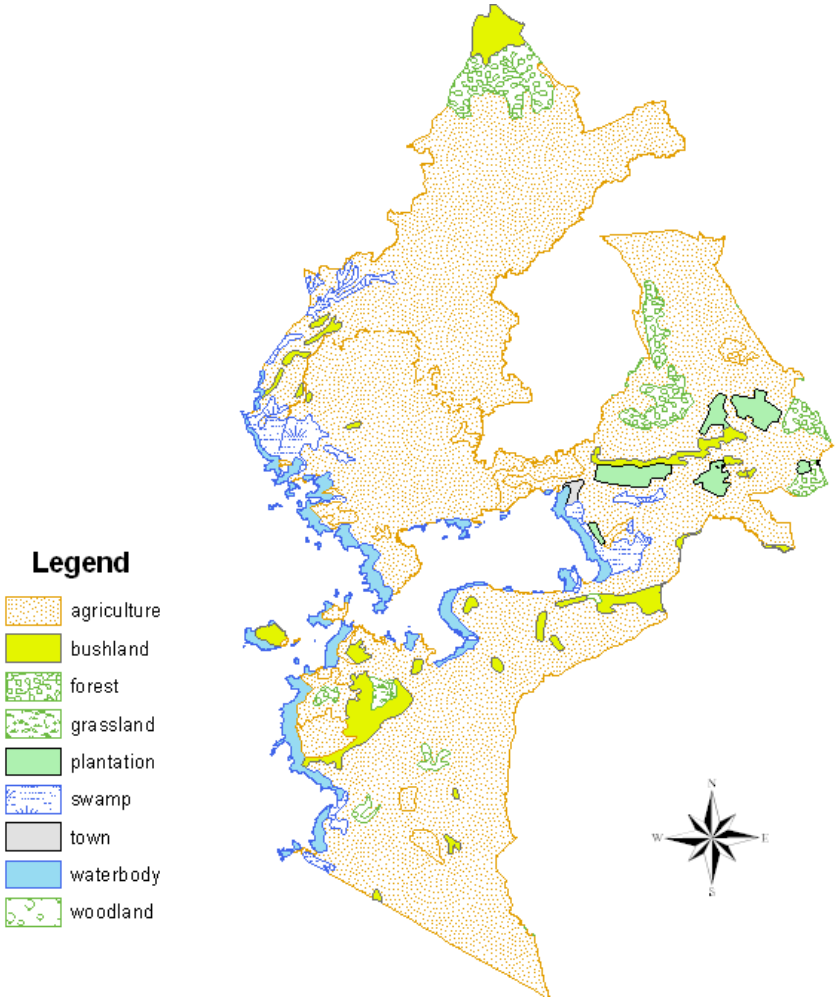

Figure 2.1: Lake Victoria Basin landcover types

From the figures, it is apparent that agriculture occupies almost all parts of the study area. The only other significantly spatially big polygons being those of bushland, forest and plantations. Bushland is mainly to the south with pockets in the north. Forests and grasslands are on the other hand concentrated in the north and eastern side respectively. From the bar graph (figure 2.2) it is evident that agriculture is dominant with the other covers being disproportionately small.

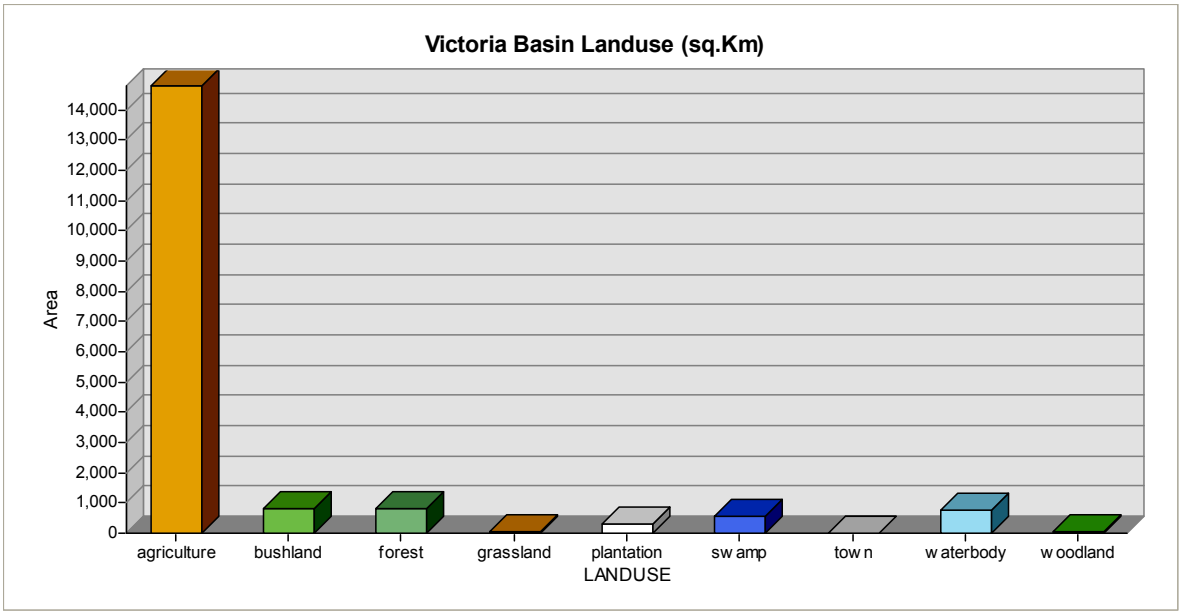

Figure 2.2: Area covered by different landuse types in Lake Victoria basin

Tsetse preference is mainly in those areas under agriculture a fact that could be attributed to its occupation of higher percentage cover. This gives a clear indication of the level of threat from tsetse in the area.

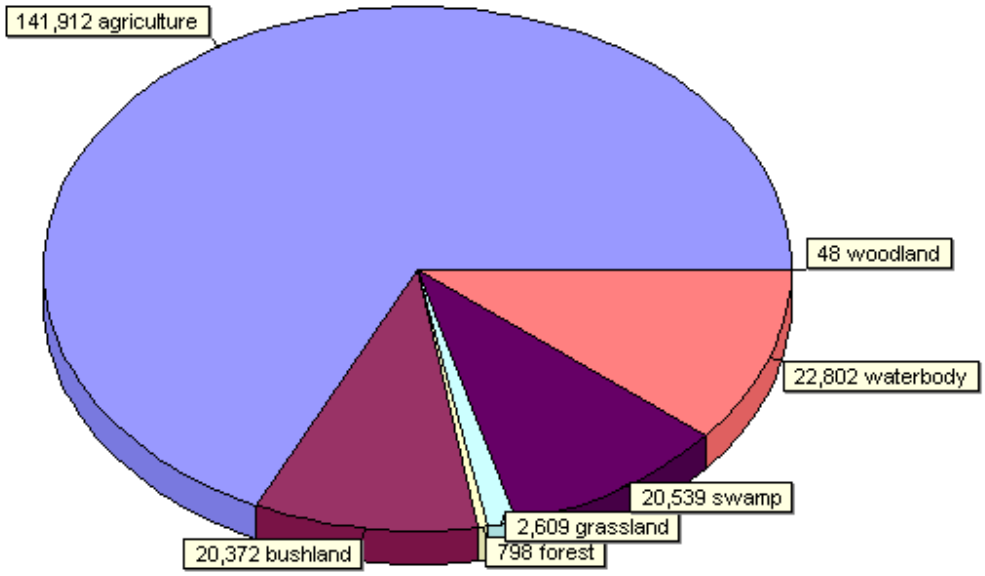

Figure 2.3: Proportion of landcover with reported tsetse

2.1.1.2 Lake Baringo Basin

Bushland occupy the greatest percentage of landcover (56%). Agriculture (11%), bare (9%), forest (6%), woodland (4%) and plantation (11%) occupy significant portions of the land in the area. Grassland, swamp and water each occupy small percentages of the remainder cover (table 2.2).

Table 2.2: Percentage of landcover types in Baringo basin

LANDUSE	Area(Hectares)	% Total
agriculture	680696	11.22
Barren land	567406	9.35
bushland	3397381	55.99
Forest	402055	6.63
grassland	20093	0.33
plantation	654285	10.78
Swamp	32266	0.53
Town	4759	0.08
Water body	25873	0.43
woodland	283369	4.67

Figures 2.4 show the geographical location of each landcover type where agriculture is seen to form pockets in the western region. The eastern region is mainly bushland and is used for grazing. A huge plantation area occupies the central region with two other smaller pockets towards the south of the study area. The plantations were found to comprise of sisal (bigger) and irrigated onions. The barren land is to the north with the water bodies concentrated in the west. The economic mainstay of the region is therefore of livestock based system.

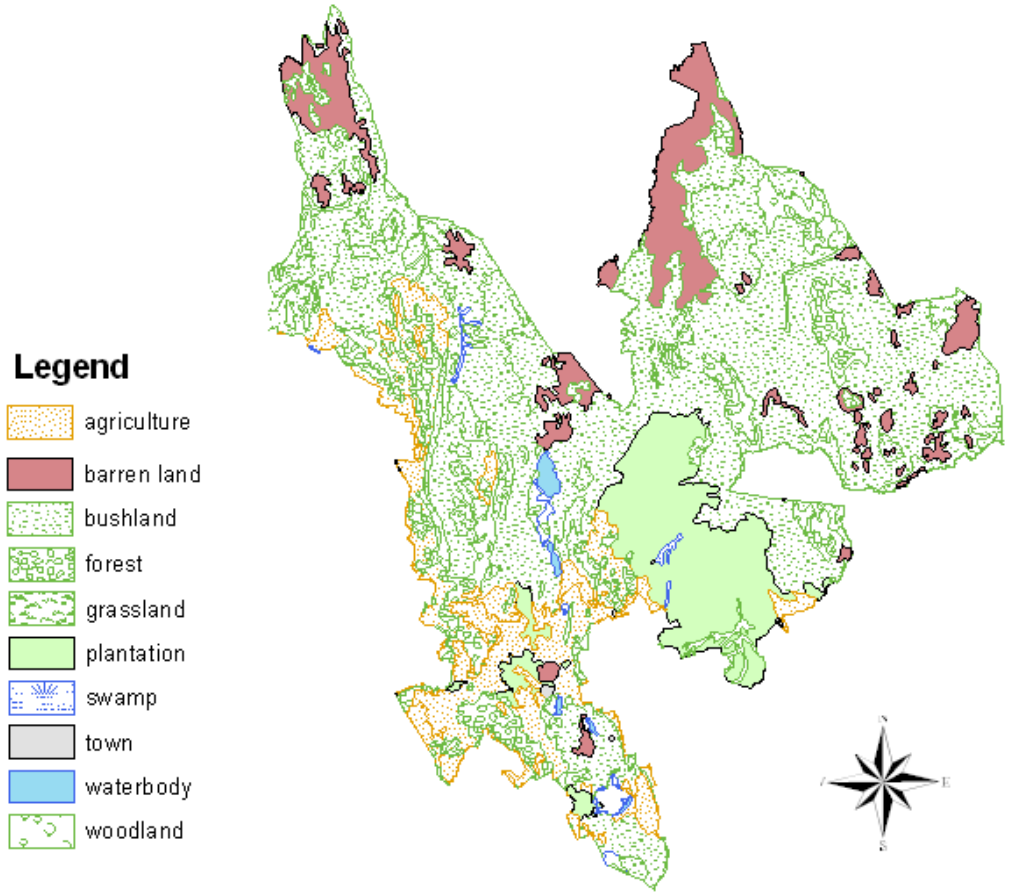

Figure 2.4: Lake Baringo Basin landcover types

Figure 2.5 shows a clear dominance of bushland in the area and the insignificant levels of grassland and swamp.

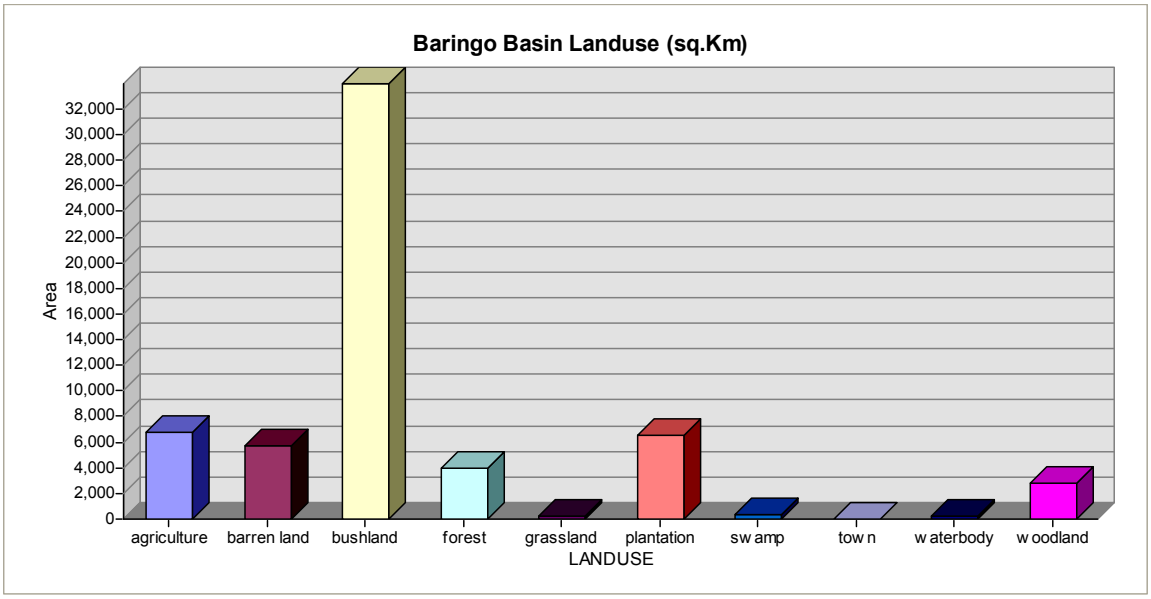

Figure 2.5: Area covered by different landuse types in Baringo basin

Tsetse preference is mainly in those areas under bushland and to some extent barren land. This might be due to the landcover being a good habitat for the vector even though its dominance of the total cover could be the reason behind this observed preference (figure 2.6).

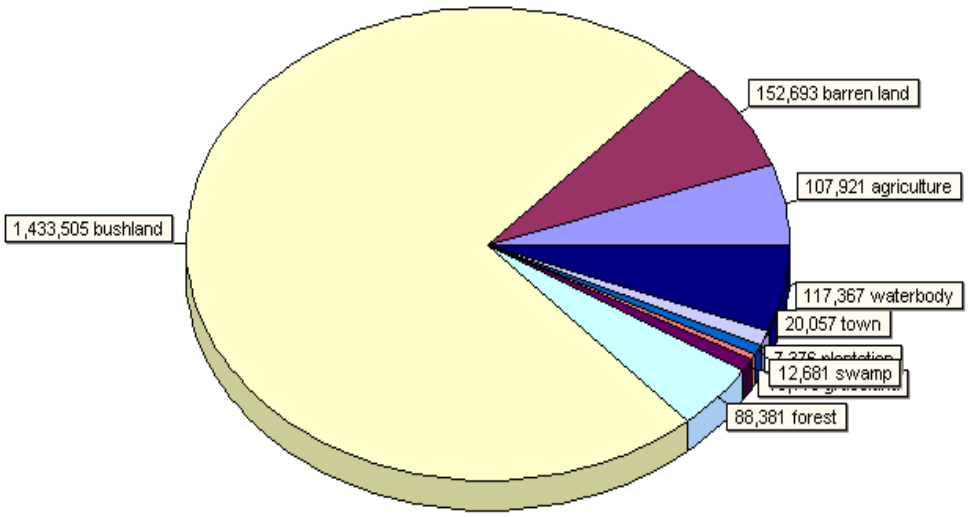

Figure 2.6: Proportion of landcover with reported tsetse

2.1.1.3 Meru-Mwea Region

Bushland form the greatest percentage landcover of the study region (50%) with agricultural occupying a significantly high percentage (33%). Other landcover types occupy lower percentage of the total with plantation, woodland, grassland, and barren land occupying 4%, 4%, 3% and 3% respectively. Forests and swamp occupy low percentages (2% and 1% respectively) with water standing at 0.2% (table 2.3).

Table 2.3: Percentage of landcover types in Meru Mwea region

LANDUSE	Area(Hectares)	% Total
agriculture	2829755	32.91
Barren land	263871	3.07
bushland	4316446	50.20
Forest	170451	1.98
grassland	224873	2.62
plantation	373669	4.35
Swamp	66425	0.77
Town	2922	0.03
Water body	14595	0.17
woodland	335096	3.90

Figures 2.7 and 2.8 are illustrative of the landcover geographical distribution relative area sizes respectively where bushland is mainly to the east and north of the region and agriculture mainly in the middle and western half of the area. Plantation is the other significant cover which is also to the west and is known to comprise mainly of sisal. Barren land is mainly to the north and is known to comprise of bare rocks with no vegetation growth. Pockets of forest are seen to the west with woodland to the south of the area. Swamps and grasslands are relatively small in size. The significant coverage of the bushland and agriculture is much more evident in the bar graph (figure 2.8) with those of plantation, woodland and barren land also standing out.

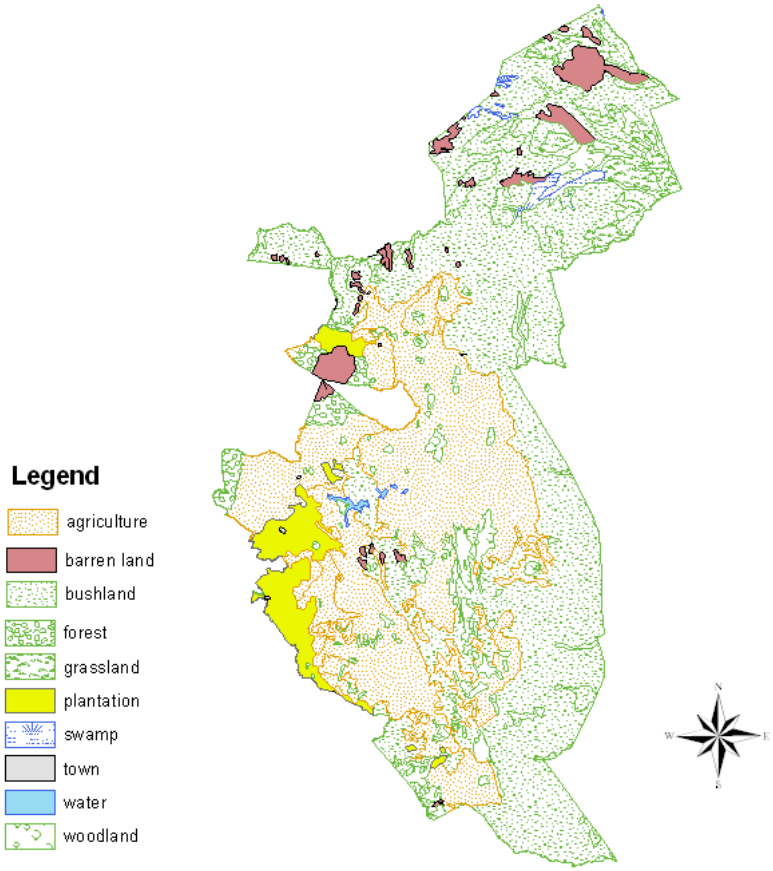

Figure 2.7: Meru-Mwea region landcover types

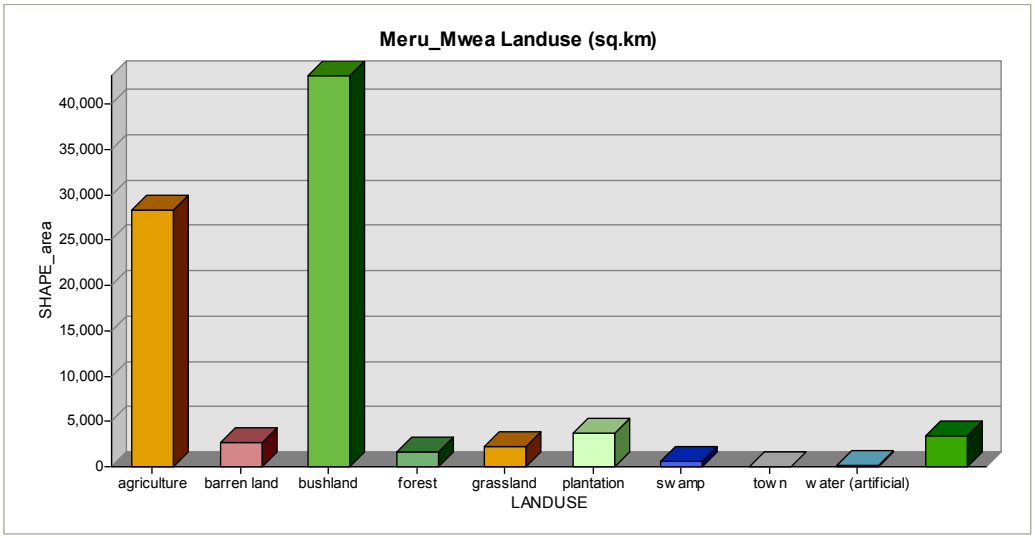

Figure 2.8: Area covered by different landuse types in Meru-Mwea Region

Reported tsetse preference is mainly in those areas under agriculture and bushland as seen in figure 2.9 and 2.10.

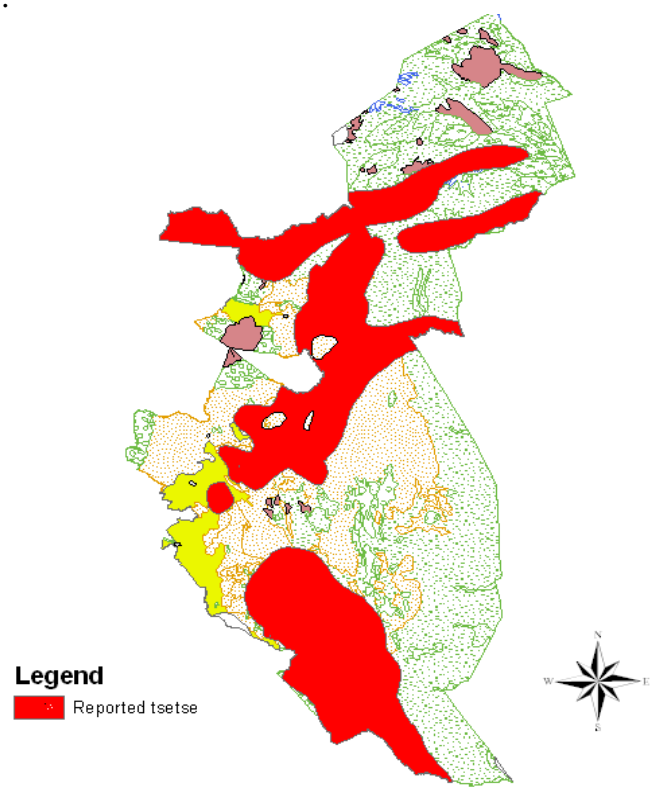

Figure 2.9: Reported tsetse presence in Meru Mwea region

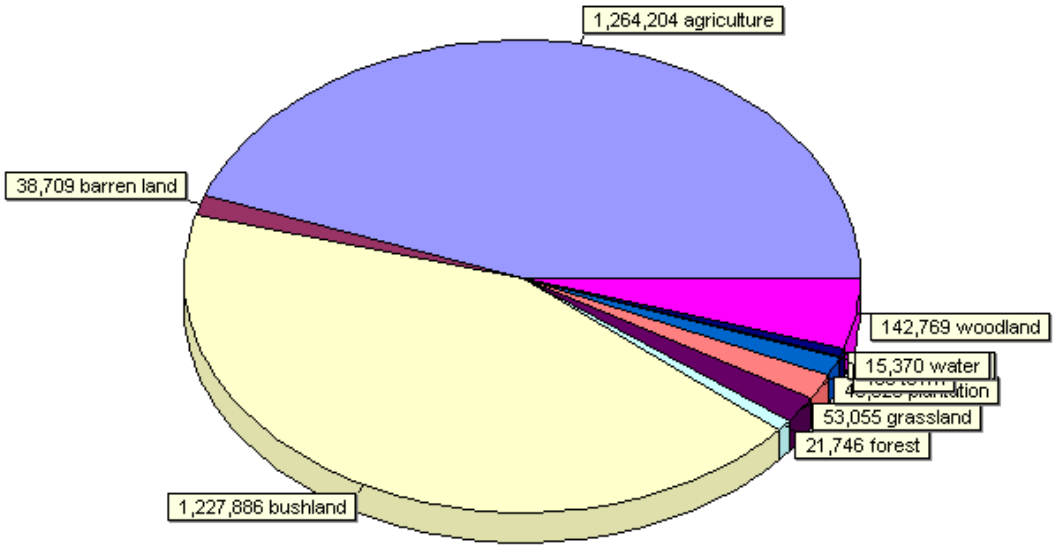

Figure 2.10: Area of landuse with reported tsetse in the Meru Mwea region

Overall, tsetse seem to favour areas of low precipitation as habitats mainly bushland and more prevalent in areas adjacent to protected areas. Even though it has not statistically been established, there seems to be a close relationship between tsetse presence and the location of protected areas. The fieldwork results reported a similar pattern and this could probably be attributed to the general natural environment in the wildlife sanctuaries thus good breeding ground of the vector to thrive.

Details of individual district landcover size for all the tsetse belts are given in appendix 2. What is easy to discern from these results is that the landcover distribution seem to follow general trends in climate with the exception of agriculture. Areas subject to long dry spells comprise mainly of bushland whereas those with sufficient rainfall fall into agriculture and natural forests.

2.2 Landuse Systems Analysis

Further classification of the landcover was done in terms of landuse where the total cultivated and non-cultivated areas for each region were calculated to enable future monitoring of changes in usage. The Sere and Steinfeld (1996) livestock farming systems classification was used to establish areas under the various farming systems. Table 2.4 summarizes the total coverage of each production systems in the regions used for this study.

Table 2.4: Area coverage for the various production systems in the three study regions

Farming System	LGA (Hectares)	LGH (Hectares)	LGT (Hectares)	MRA (Hectares)	MRH (Hectares)	MRT (Hectares)	OTHER (Hectares)	URBAN (Hectares)
Meru Mwea	4413069	0	141993	3155365	0	227654	673550	1198
Baringo	2353443	119	942494	791540	255	1676899	306261	3368
Victoria	21612	425	2464	431939	693305	469174	173177	3012

From the figures 2.11 and 2.12 it is evident that farming in the overall region here is dominated by livestock based system with mixed crop livestock system of the rainfed cropping in arid lands forming the next significant percentage. Other systems form a small percentage of the total area cover.

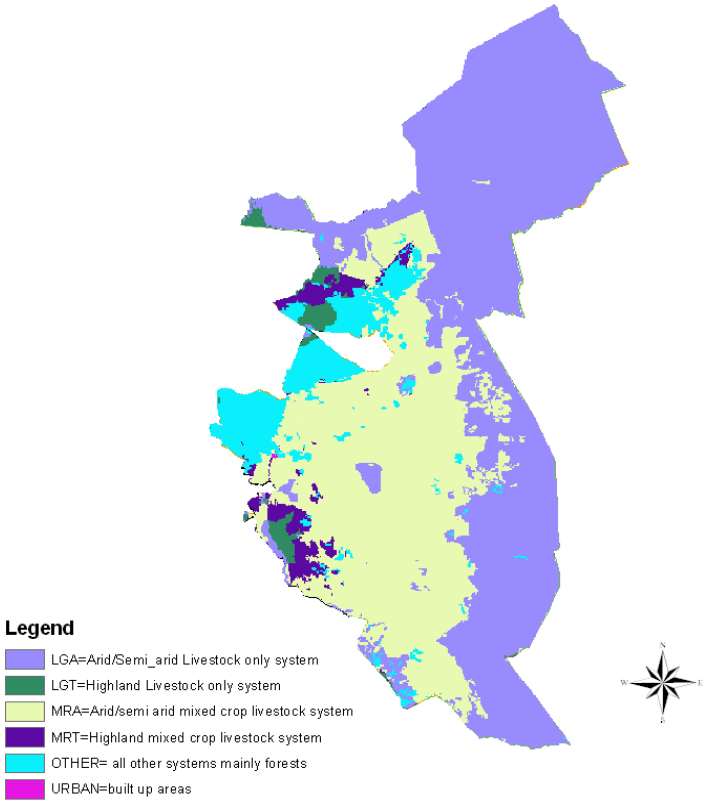

Figure 2.11: Farming systems in Mwea Meru site

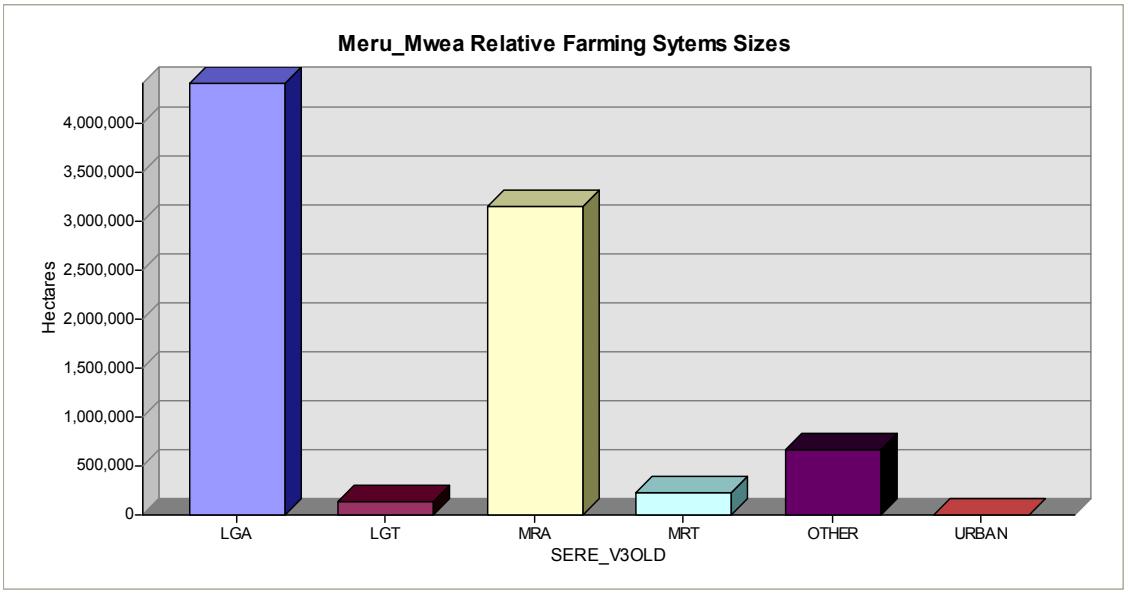

Figure 2.12: Farming systems sizes in Mwea Meru region

Table 2.5 gives the breakdown of individual districts where Isiolo and Kitui shows big acreage as being under livestock only system even though Kitui has a significant portion under mixed arid rainfed system. Machakos, Mbeere, Meru and Mwingi have mainly the mixed crop livestock systems. Forests and other systems form significant portions of the districts around Mount Kenya which include Embu, Muranga, Maragua, Meru and Kirinyaga.

Table 2.5: Farming systems summary in Meru Mwea region

DISTRICTS	LGA	MRA	OTHER	URBAN	MRT	LGT
KIRINYAGA	13	556	835	0	11	43
MURANGA	0	109	822	0	0	6
THIKA	0	804	997	15	80	0
MARAGUA	0	286	583	0	0	0
EMBU	1	120	583	0	1	18
ISIOLO	24550	230	11	0	1	192
KITUI	12539	7601	108	0	0	0
MAKUENI	903	6064	331	0	501	22
MACHAKOS	325	4475	87	0	818	464
MBEERE	0	2039	24	0	11	0
MERU CENTRAL	46	225	1304	0	688	685
MWINGI	3850	6027	123	0	3	0
MERU NORTH	1053	1920	770	0	175	6
THARAKA	345	1099	102	0	0	0

From the figures 2.13 and 2.14 it is evident that pastoral systems are dominant in this area with mixed crop-livestock systems forming pockets within some of these districts. Table 2.6 below shows the acreage of each farming system.

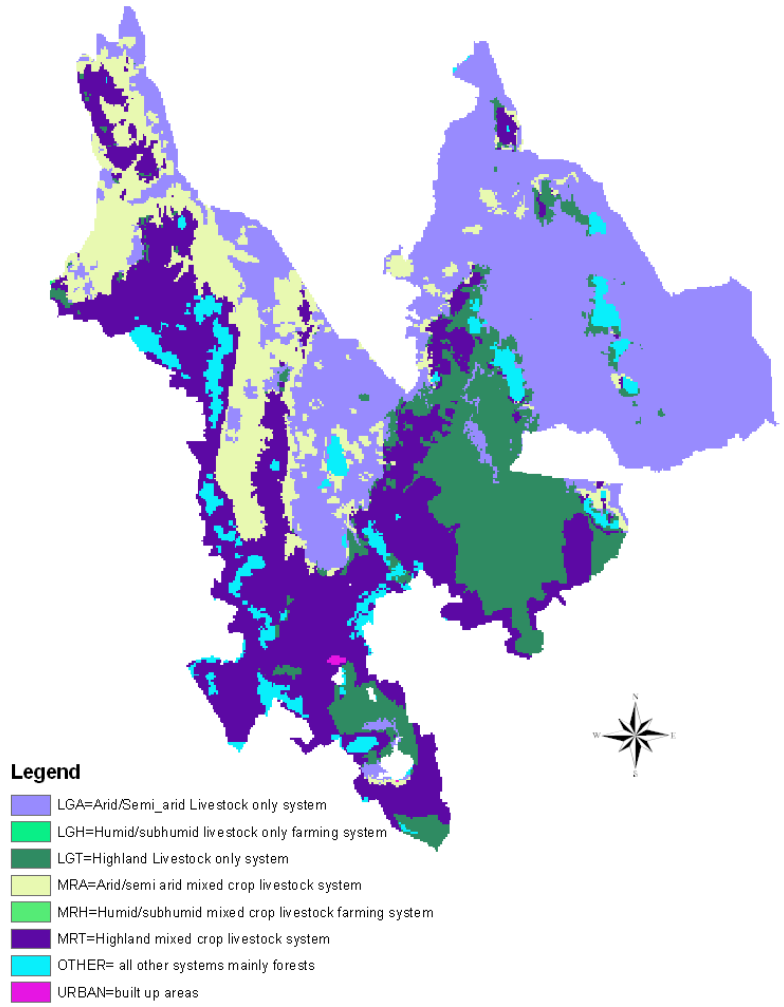

Figure 2.13: Farming systems in Baringo site

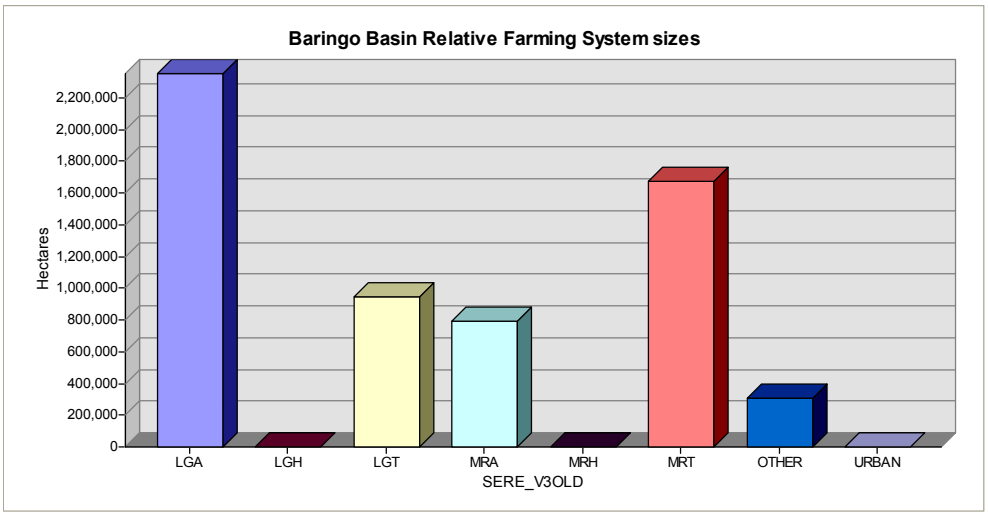

Figure 2.14: Farming systems sizes in Baringo basin

Table 2.6: Farming systems summary in Baringo basin

DISTRICT	OTHER(Sqkm)	LGA(Sqkm)	MRA(Sqkm)	MRT(Sqkm)	LGT(Sqkm)	URBAN(Sqkm)	MRH(Sqkm)	LGH(Sqkm)
BARINGO	262	4004	2806	1298	271	0	0	0
KEIYO	220	58	366	790	0	0	0	0
KOIBATEK	240	457	111	1399	109	0	0	0
LAIKIPIA	229	321	130	3253	5495	0	0	0
MARAKWET	441	1	260	882	0	0	0	0
NAKURU	689	166	45	4906	1298	32	0	0
SAMBURU	732	16566	630	860	2103	0	0	0
WEST POKOT	241	1786	3551	3244	139	0	3	1

The area under the various systems for each district as seen in table 2.6 vary from one district to the other where Baringo show a large portion to be under the livestock only system but with a significant portion under mixed rainfed system. Laikipia and Pokot are the two other districts with significant proportions of either of the two systems. Samburu on the other hand is heavily tilted to livestock only system with Nakuru being mainly in the mixed livestock cropping system. The general trend could be said to show a spread of risk among farmers in most districts where they try to grow crops and keep livestock.

The farming system here is dominated by humid-sub humid, tropical and arid to semi-arid type of mixed crop livestock systems as seen from figures 2.15 and 2.16. Other systems take a small percentage of the area among which is the livestock only system.

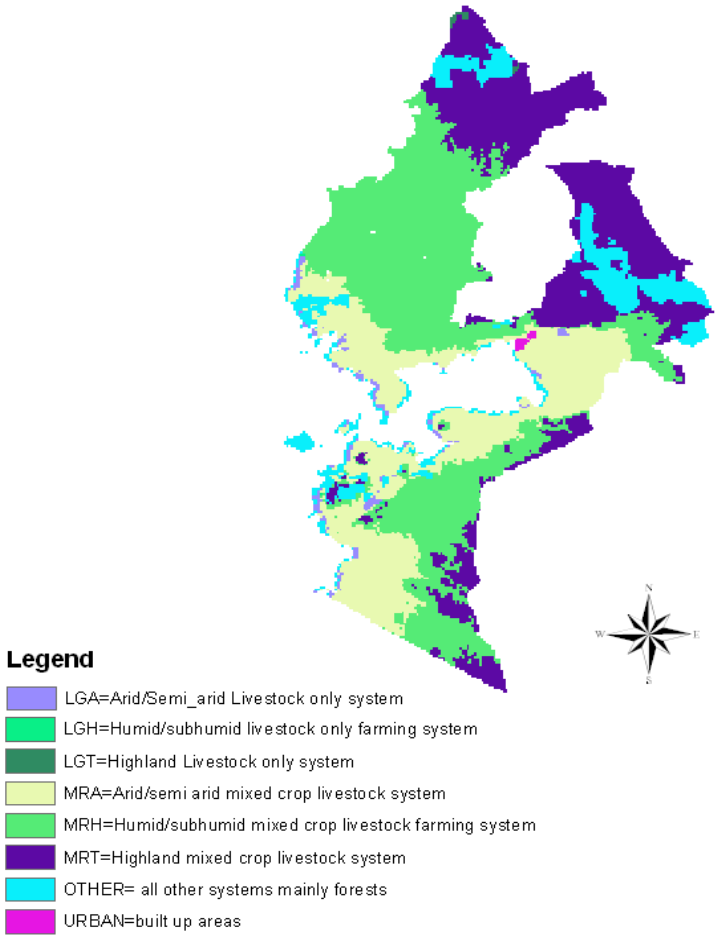

Figure 2.15: Farming systems in Victoria basin site

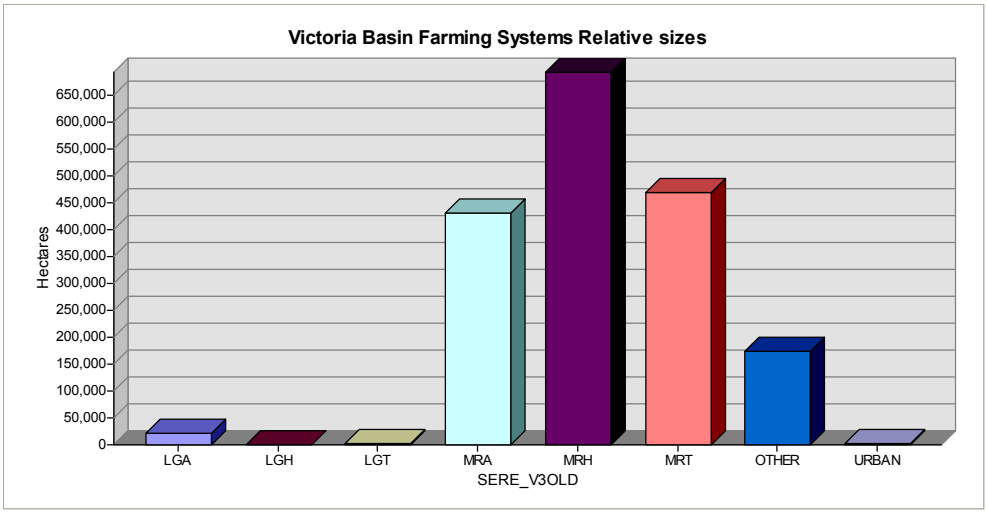

Figure 2.16: Farming systems sizes in Lake Victoria basin

Areas around the lake are dominated by the mixed rain fed of the arid to semi arid whereas rainfed of the humid to sub humid type together with the highland type form the bulk of the farming system in the area. Table 2.7 gives a breakdown of districts where in all districts the dominance of the mixed is much more evident, with the livestock only based system scoring low.

Table 2.7: Farming systems summary in Baringo basin

DISTRICT	MRA (Sqkm)	OTHER (Sqkm)	URBAN (Sqkm)	MRH (Sqkm)	LGA (Sqkm)	MRT (Sqkm)	LGT (Sqkm)	LGH (Sqkm)
HOMA BAY	259	38	0	832	4	28	0	3
KISUMU	401	46	29	335	15	56	0	0
KURIA	0	0	0	370	0	181	0	0
MIGORI	919	15	0	612	22	339	0	0
RACHUONYO	426	38	0	320	15	128	0	0
SIAYA	179	56	0	1275	0	0	0	0
SUBA	513	285	0	87	69	52	0	0
BONDO	690	77	0	111	56	0	0	0
NYANDO	816	6	0	270	1	78	0	0
NANDI	1	795	0	123	0	1905	0	0
BUNGOMA	0	0	0	765	0	1274	0	0
BUSIA	105	60	0	859	31	0	0	3
MT ELGON	0	275	0	4	0	575	22	0
BUTERE/MUMIAS	0	0	0	921	0	11	0	0

In the mixed crop production systems common crops include sorghum millet, maize, beans and bananas. This however varies within the regions where areas of extreme weather such as Kitui grow the drought resistant crops whereas those in the more humid climatic conditions such as Meru grow many more crop varieties. Detailed analysis of crop production is given in later text with frequency of each crop extracted from the questionnaire.

Crop Production

The main crops grown in the three areas are maize, beans potatoes, cassava, and groundnuts for the western region with Maize, beans and potatoes grown in the eastern region and being the three main staple foods in the two areas. Coffee and Miraa are the cash crops in the eastern area whereas sugar cane is the main cash crop in the western region. Other crops grown on a small scale included banana, millet, sweet potatoes and sorghum.

In terms of acreage, sugar cane, coffee and Miraa are generally allocated more land than the other crops. This could be attributed to the fact that these are the major income earners for the residents. Land allocation to maize was also significant whereas allocation to cassava, potatoes and such other crops was relatively lower. The following figures (2.17a-h) resulting from extraction of information from the questionnaire give an indication of the crop types grown around the areas where transects were carried out.

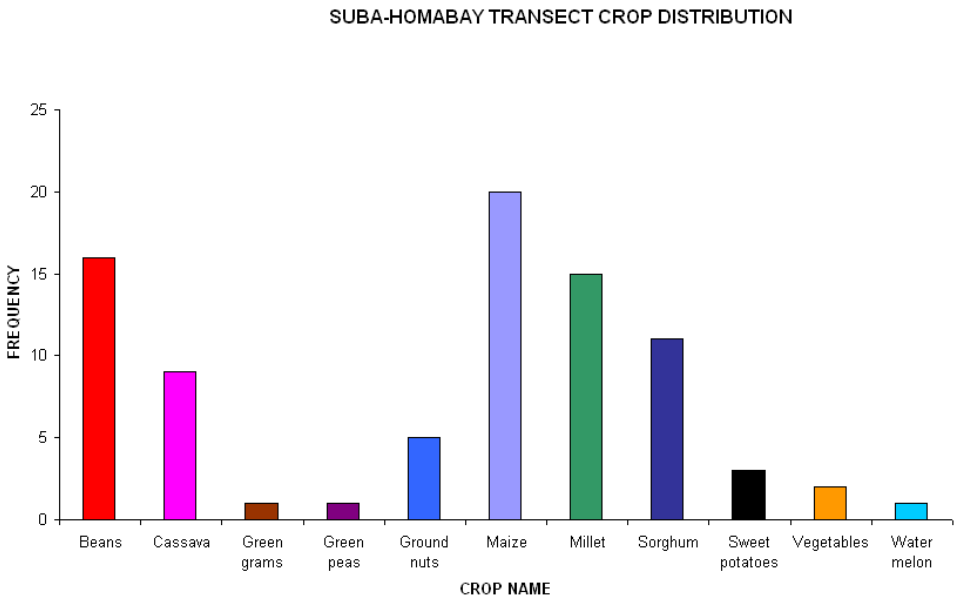

Figure 2.17a: Frequency of crops production among the respondents in Suba

From this transect it is evident that maize and beans are the major crops along with millet, cassava and sorghum. The other crops are grown at significantly low levels.

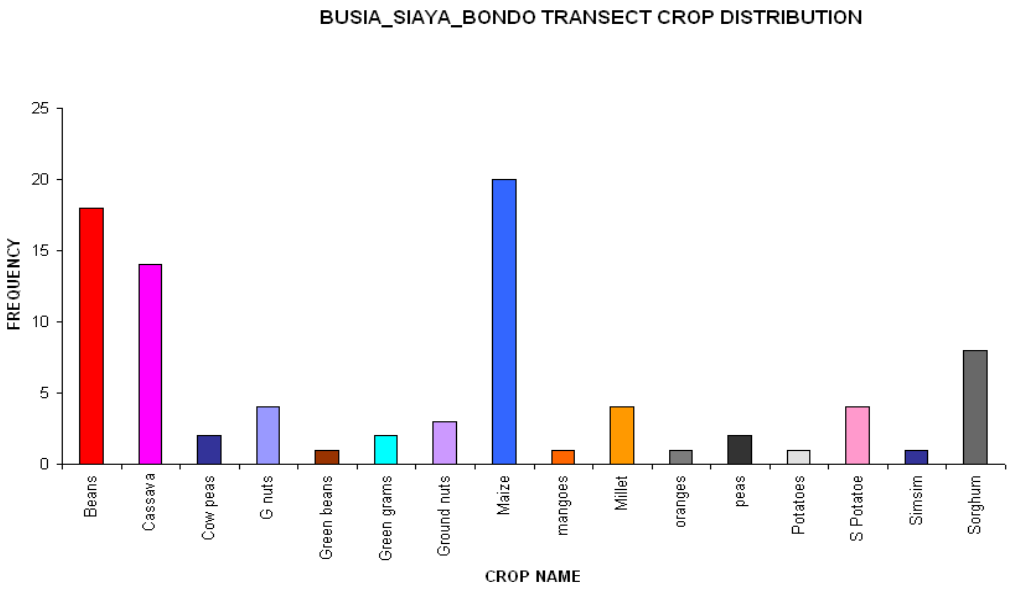

Figure 2.17b: Frequency of crops production among the respondents in Busia

Here maize, beans and cassava dominate though sorghum is also grown to a relatively good extent. Other crops again are grown at a low scale.

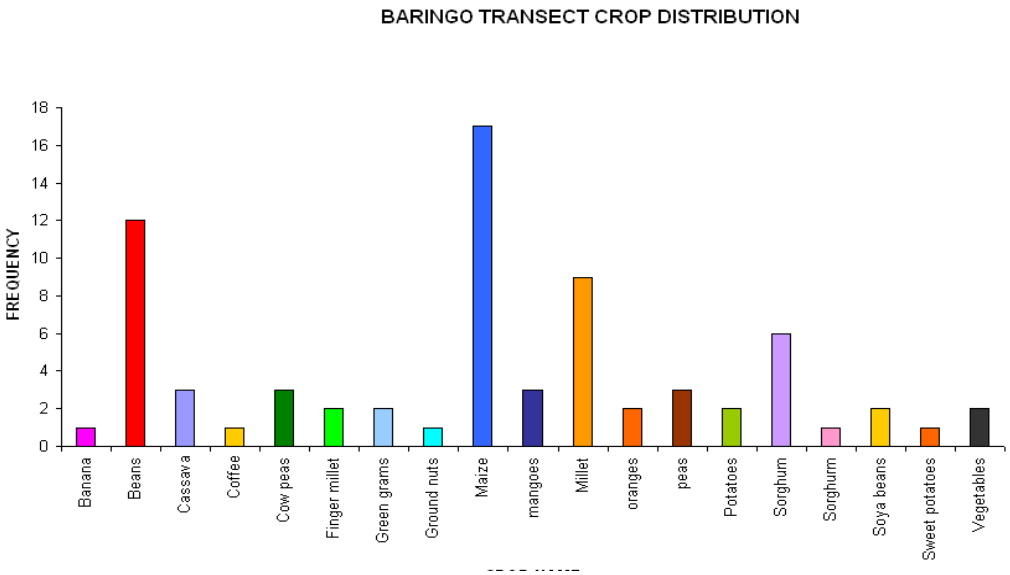

Figure 2.17c: Frequency of crops production among the respondents in Baringo

Even Baringo known to tend to semi-arid in terms of climate is seen to have the two staple crops of maize and beans as dominant with significant millet and sorghum. Cassava and cowpeas are also significant in the area.

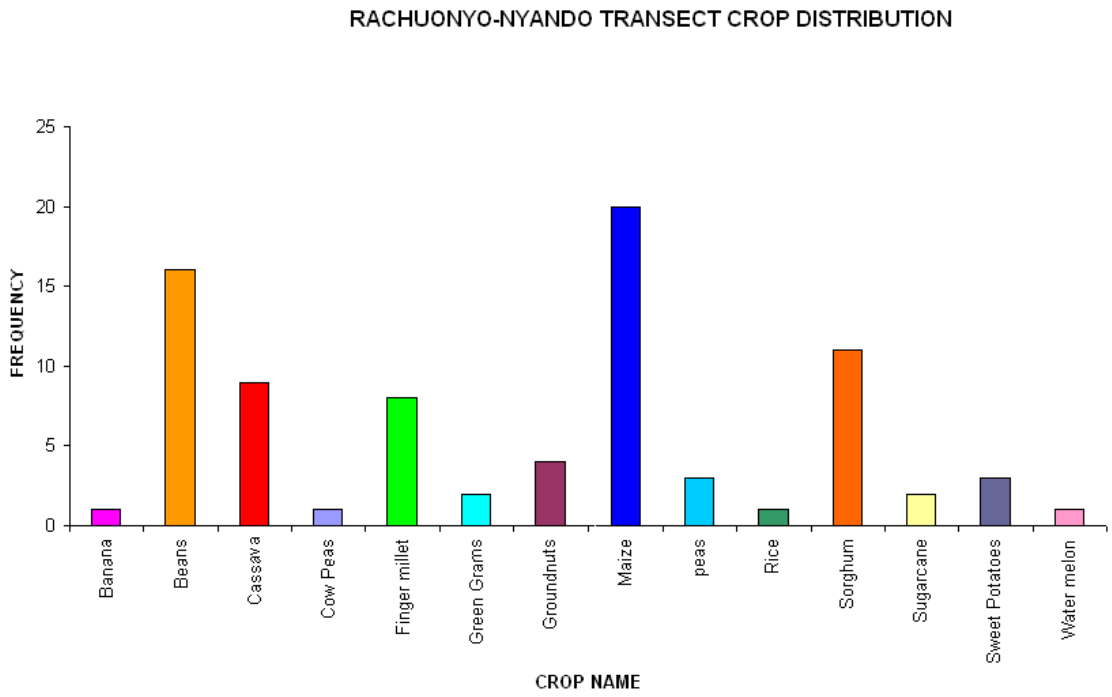

Figure 2.17d: Frequency of crops production among the respondents in Rachuonyo

In this transect maize, cassava, beans, and sorghum are dominant with other crops less significant. The overall crop production in the western region seems to be dominated by food crops which are mainly used as staple for consumption in the household within which they are grown.

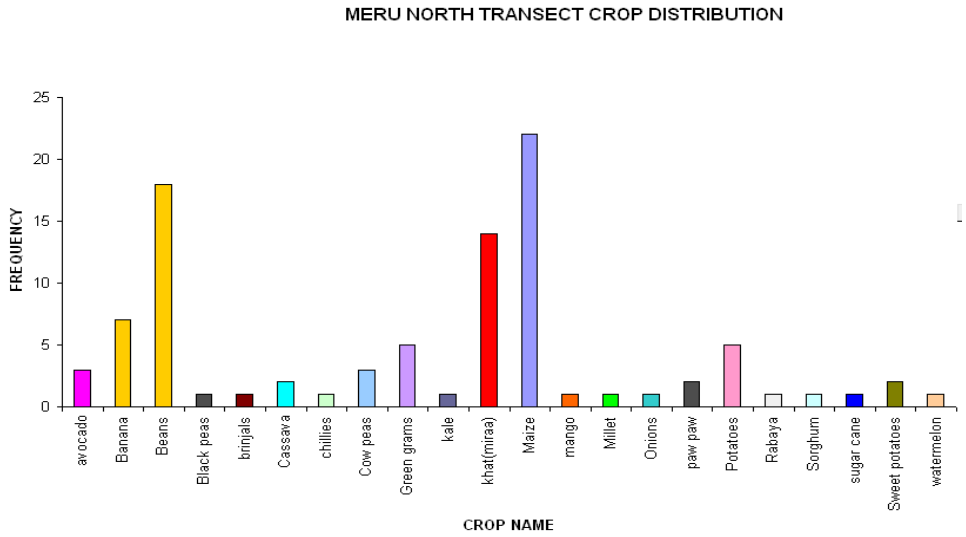

Figure 2. 17e: Frequency of crops production among the respondents in Meru North

This area crop production is dominated by mainly three crops maize, beans and banana. The cash crop is mainly Miraa though banana is also known to be a good source of income for the local community. The area being rich in soil nutrients support a host of other crops as seen in the graph among which is a variety of peas and also fruits.

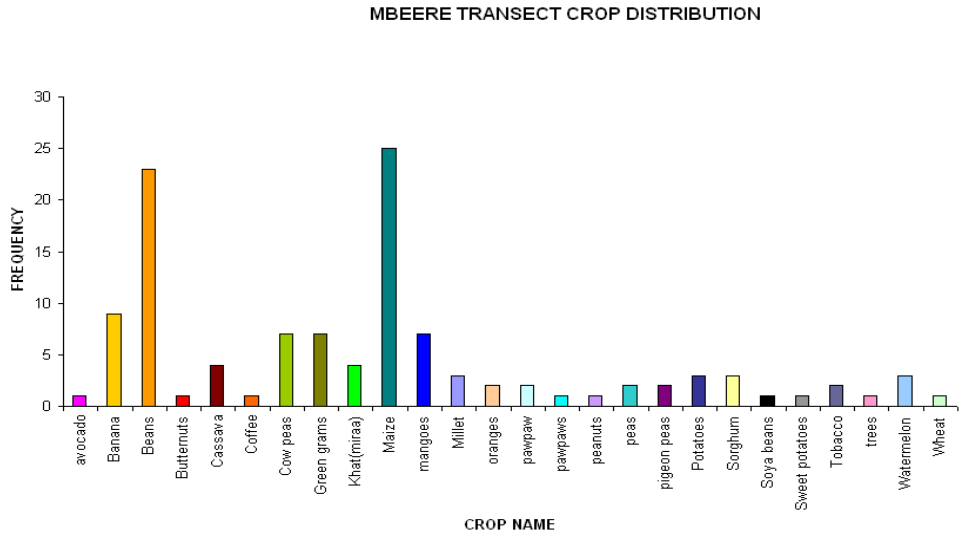

Figure 2.17f: Frequency of crops production among the respondents in Mbeere

This being a dry land area would be expected to support drought resistant crops among which is sorghum and millet. However as is evident maize and beans seem to be the main crops even in this region with bananas production also being significant. Jaetzold et al, (2006) describe the district to have about 56% of the arable land currently under cultivation.

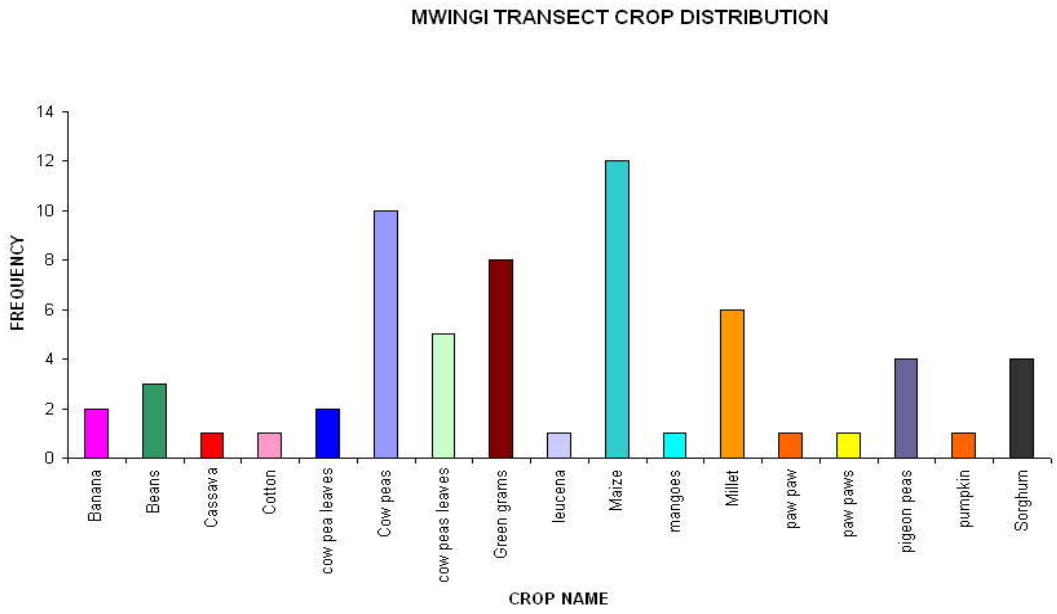

Figure 2.17g: Frequency of crops production among the respondents in Mwingi

This being a dry land area the various peas form the bulk of crop production together with other drought resistant crops such as millet, sorghum and green grams. Maize being a staple crop is also a major crop in the area. Other crops not found in the other transects such as cotton and Lucerne are grown in this area.

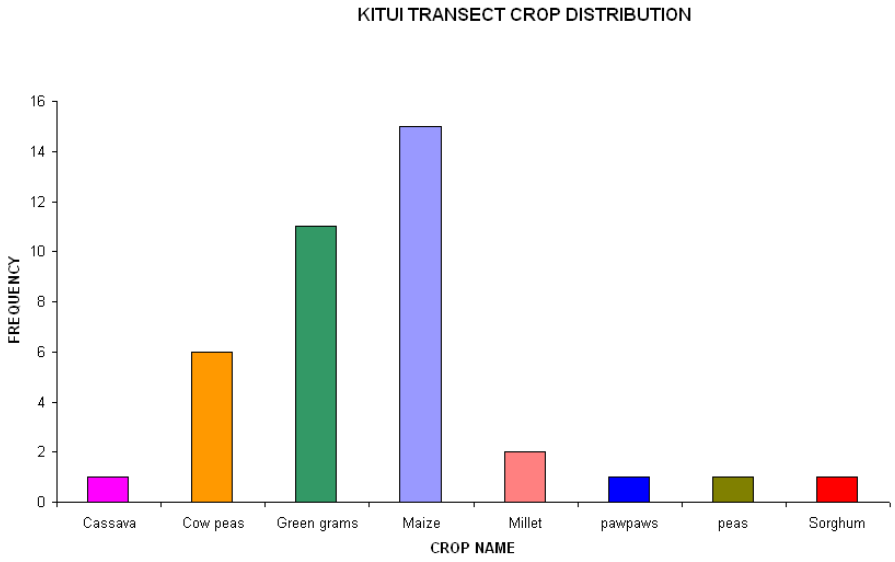

Figure 2.17h: Frequency of crops production among the respondents in Kitui

Kitui experiences similar climatic conditions to Mwingi and thus seem to share the type of crops grown. Even though maize is dominant cowpeas and green grams production are seen as produced at greater frequencies among the respondents. Other drought resistant crops such as millet and sorghum are also grown in the area. Other than maize and cassava most of the other crops are mainly grown as a source of income.

The overall observation in regard to crop production is that maize production is the most common across the three regions even though it might not necessarily be the best option in terms of optimisation of outputs. This could be attributed to the crop having been broadly accepted across the country as the most important source of family feed. The patterns in the growth of other crops seem to generally follow climatic conditions with the drought resistant crops such as millet, sorghum and a variety of peas grown in the arid-semi arid lands whereas less resistant crops such as banana being grown in the more favourable weather conditions. Tables in appendix 2 give information on the various crop production and yields in the individual districts.

Urban Areas

Though not very big in size, there are several urban areas within the study sites which are expected to grow both as a result of rural-urban migration and changes resulting from success of the eradication campaign. Estimates of the urban areas for each region are given in the table and show significant acreage where Baringo and the Mwea region are seen to have almost equal sizes whereas that in western is smaller (table 2.8).

Table 2.8: Size of urban centres in each study region

Region	Area (Hectares)
Baringo basin	3859
Victoria basin	1952
Meru Mwea region	3965

Protected Areas

These form a significant portion of all the three study sites as is seen in figure 2.18 with the Meru region having the biggest with more than one million hectares and the lowest being that in the Victoria basin with a size of less than 100 000 hectares (table 2.9). Field results showed areas around these protected areas are mostly affected by tsetse as was the case in both Victoria and Mwea Meru sites. Any campaign to suppress tsetse should therefore target the protected areas.

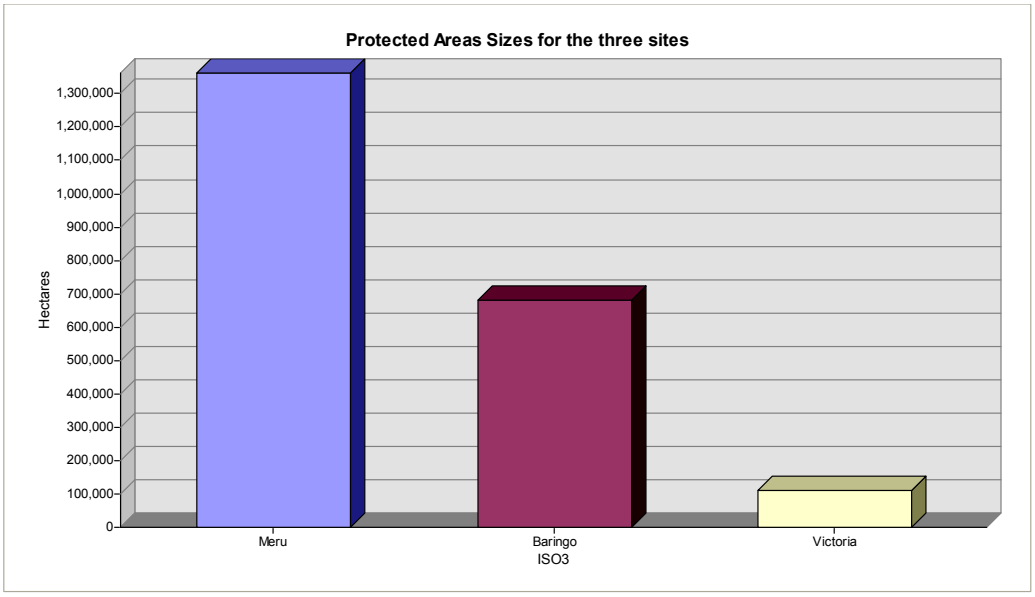

Figure 2.18: Protected Area sizes (Hectares) for the three sites

Table 2.9: Protected areas sizes

Site	Total area (Hectares)
Meru	1362058
Baringo	682614
Victoria	111567

Infrastructure

The figures 2.19a and 2.19b show the general infrastructure and distribution of social amenities in the study sites where it is evident that there is a fairly good distribution of social amenities such as schools and health centres in all the three sites. Infrastructure is also relatively fair even though there are regions such as Samburu and Isiolo which have relatively thin distribution.

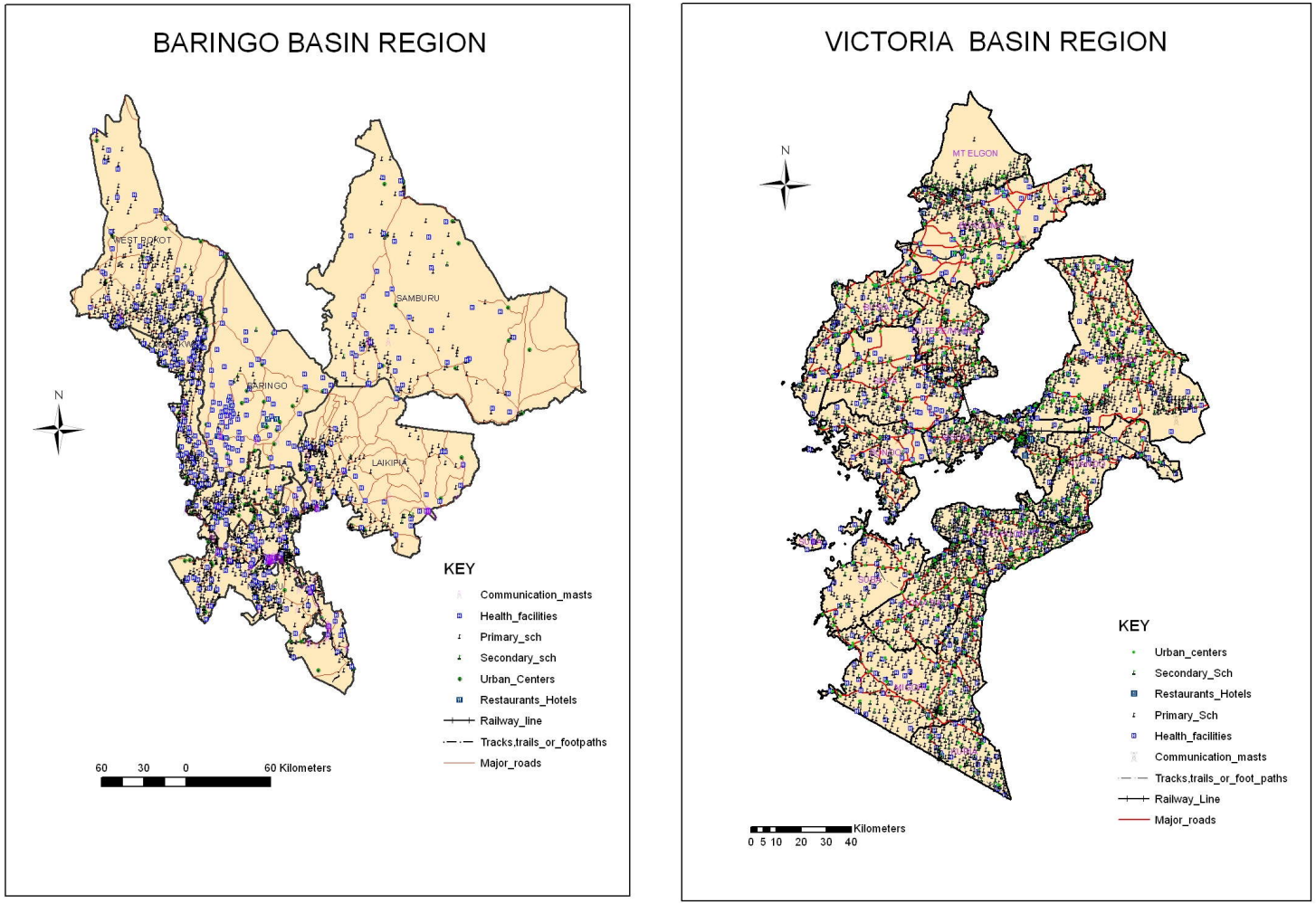

Figure 2.19a: Distribution of social amenities and infrastructure in Baringo and Victoria basins

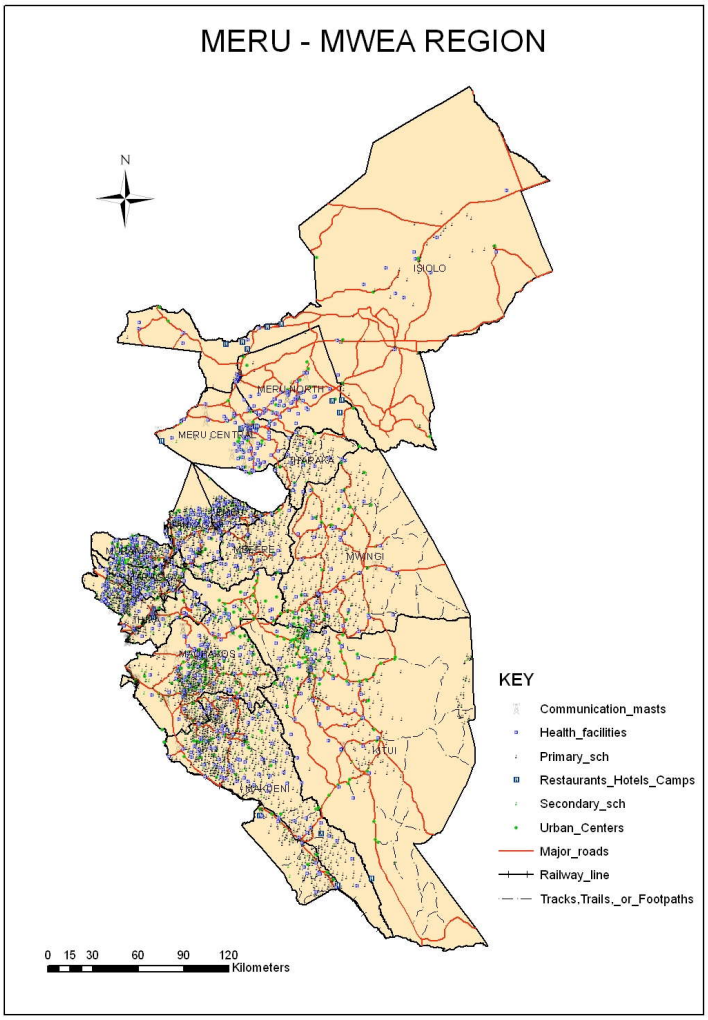

Figure 2.19b: Distribution of social amenities and infrastructure in Meru Mwea Region

2.3 Discussion

The results show the three areas to comprise of different landcover with the cover varying greatly from one site to the other and also within sites. From the foregoing, it is evident that most of the areas have agriculture as the major landcover. Bushland is also significantly large while other landcover types form a small portion of the total area. Dominance of agriculture is to some extent surprising given that large parts of the area of these sites are arid to semi-arid. One of the drivers of the agriculture area could be population growth where significant increases can be observed between the periods 1960-1990 and 1999. The increased population could be adding pressure on the already existing farms thus the encroachment of these areas. High population densities in the high

potential areas have been described to have forced people to move to the less populated lower areas, forested areas, steep hills, swamps and river banks, thus causing destabilization of the ecosystem (Jaetzold et al, 2006).

However from the analysis it is not evident that any one type of landcover is the one indicator of tsetse even though they have been described to favour bushland. A combination of factors could be contributing to their presence which include favourable climatic conditions and presence of thickets.

Farmers who migrate into the arid and semi-arid areas bring along with them inappropriate agricultural technologies for the drylands. These drylands have fragile ecosystems that require land uses, which mimic natural ecosystems such as shifting cultivation, Agroforestry and nomadic pastoralism. These are land uses that are characterized by temporal and spatial dynamics and have in-built recovery mechanisms. However as is evident from the results, farming systems in the areas comprise of mainly the mixed crop livestock rainfed systems in almost all the areas, an indicator of dependence of farming on rainfall making the risk posed by crop failure high in case of inadequate rain.

The cropping pattern could be said to confirm this despite the tendency for farmers in all the areas to grow maize which could be attributed to it being a staple for most communities in the country. Other crop production however seem to reflect the climatic conditions where drought resistant sorghum, millet and cassava common in areas falling within the arid- semiarid climatic zones and the more rain dependent types such as potatoes more common in the rain sufficient areas such as Meru.

Protected areas form a significant part of the landuse in the area, with the Meru Mwea region having the greater acreage of this. This makes the threat from tsetse in the surrounding areas even more based on tsetse being known to find better hosts in wildlife and to have a range of 4km movement. This therefore shows the need of close coordination between the eradication team and those in the wildlife service where wildlife managers should be encouraged to carry out similar campaigns within the protected areas.

SECTION 3

VEGETATION DESCRIPTION

3.1.1 General description of vegetation along transects in Meru-Mwea region

The following is a description of general features of vegetation along transects which ranged in length between 40 and 70 km.

Vegetation in Meru-north transect can be classified as sub humid type of vegetation characteristic of highland climatic conditions. Vegetation is dense characterized by tall indigenous trees. Unlike vegetation in the other transects (in Mbeere, Kitui and Mwingi) which can be described as having semi arid climatic conditions, plant in most of this transect are indicative of wetter conditions. This transect has more land use/cover types than other transects studied. These include: Forests, agriculture, Bush lands, Grassland and Swamps. Trees species were more diverse in the forest than other land use/cover types within the Meru-Mwea tsetse belt. For example in Meru-North forest alone, there were 27 different tree species compared to 5 species in grassland and 5 species agriculture. The trees were dominated by *Bridelia Micrantha* (Mutemana-Kimeeru) and *Merkhamia Lutea* (Muu-kimeru) which were counted in 8 out of 20 quadrants. Besides, the tallest tree species in forest land use were found in Njukiiri forest in Embu and Gaya forest in Meru-North which averaged 14m and 20m respectively. However, Gaya forest is a natural forest while Njukiiri is a Man made forest. In Kitui and Mwingi, common tree species appeared both in woodland and bushland with *Commiphora Baluensis (*Ikuu-Kikamba) as the dominant tree species in Mwingi while *Albizia anthelmintica, (*Kyoa-Kikamba) was the dominant species in Kitui. Important to note is that, there is a great distinction between the forest found in Meru and Embu compared to those in Kitui and Mwingi. Where forests found in Mwingi and Kitui are drier, thorny with very little canopy cover and located in hills mainly, those in Meru and Embu are thick and denser to penetrate. Forest has an average recorded higher canopy cover than other land uses in Meru where it had 14.7% compared to 6.6% in grassland 12.8% and agriculture. The tree canopy cover of Gaya forest in Meru (Natural forest) was close to that of the man made forest Njukiiri) in Embu which had a canopy cover of 18.5%.

Little herbaceous layer was recorded in some sampling points in Gaya forest and Njukiri forest due to the higher tree canopy cover that was almost 100% which hindered any form of undergrowth. On the other hand, in Kitui and Mwingi, herbaceous layer recorded a higher percentage in woodland, bushland, as well as forest because the trees in these transects were leafless and therefore not interfering with the growth of the herbaceous layers species. However, in some places, there was no herbaceous layer because the land was bare due to aridity problem. The condition of shedding leaves during the dry seasons for these trees is a form of survival strategy for trees to avoid loosing water through transpiration.

Agricultural land had more tree canopy cover in Meru than all other transects with 12% cover compared to 10% in Mwingi, 9% in Kitui and 11% in Mbeere. This could be attributed to the available economic activities in these different places. Whereas in Meru, Miraa (*Catha Edulis)* provides the major source of income to the local community, in these other places, charcoal burning has been seen to play the biggest role in providing income to the families and therefore contributing to the reduced presence of trees in agricultural farms. This could also be attributed to the prevailing dry climatic conditions that may have hindered growing of trees or lack of proper awareness of the need for tree planting to improve on the harsh conditions. However, in Mbeere as seen above, canopy cover is close to that of Meru maybe due to the upcoming practice of growing Miraa which has been seen as a recent major source of revenue to the families. Important to note is that where in Meru, the herbaceous layer comprised of crops and some weeds, in Mwingi and Kitui, majority of the herbaceous layer was food crops especially the dry land crops like Cow peas and Green grams. This could also be attributed to the dry conditions in the area that do not allow sprouting of much plant species and thus once the farmers do the weeding the land only remains green from the crops in the farms. Additionally the types of trees found in the agricultural farms differed across the transect, where in Meru a lot of bananas and avocado trees were reported, in Mbeere, Mwingi and Kitui, Mango trees, Oranges among other drought resistance fruit trees were found to be dominant. Timber tree species like *Melia volkensii* Mukau (Kikamba) was seen to dominate agricultural land in Mbeere and Kitui, which according to the locals is a source of income to the families.

In Kitui herbaceous cover was more in the dry woodland forest where only 30% of the required sample was taken. Thirty (30%) was collected because the team felt that there was a lot of similarity between this land use with that of a true woodland in terms of tree species and shrubs diversity and structure. However, the herbaceous canopy cover in the true woodland was 23% whereas in the dry woodland forest 42% was recorded in the 3 only points of the 10 taken with *Commelina benghalensis* (mukengesya-Kikamba) as the dominant herb layer in the later and *Cyanthula Cylindrica*/*Polycephala (*Kyamata-Kikamba)) dominating the woodland forest. The dry woodland forest in Kitui located in Nzoiyani Ranges, had high tree canopy cover as well as shrub and herbaceous cover. This could be attributed to the fact that the forest is under government management and therefore people have had no access to cut trees for charcoal burning a practice that is rampant in this area due to high poverty levels and few choices of income sources.

Bushland and woodland had similar tree canopy cover of 4.4% in Kitui with Kyoa (*Albizia anthelmintica)* dominating the woodland while Ikuu (*Commiphora baluensis*) dominated the bush land (figure 3.1). In Meru-North, the bush land sampling was done within and outside the park fence where Tsetse presence was reported by both the local farmers and the park management. To emphasize the fact that trypanosomiasis caused by tsetse was a major problem, KWS deputy director confirmed that buffalos had died in the park in year 2007 and were diagnosed to have died of trypanosomiasis. Moreover, presence of tsetse problem was also reported in Kina (Meru) areas in the bush land where farmers complained of the much expenses they were incurring in spraying the tsetse and thus called for expedient implementation of the project for the eradication of what they termed as barrier to a breakthrough in livestock farming. This could be attributed to the presence of bushes within the park which is conducive to tsetse habitation as well as the wild animal species that are preferred by the tsetse. This also can be attributed to opening up of the agricultural land and thus pushing the habitat for tsetse to the park.

The above was a similar scenario in Mbeere where bushland was located in the Mwea Game Reserve (MGR). In the reserve, presence of Tsetse was said to have been heavy 2-3 years earlier despite the presence of an International Centre of Insects Physiology and Ecology (CIPE) led Project. However, KWS warden and community representatives proudly reported that the PATTEC traps had done a commendable job in reducing the tsetse infestation by almost 100%. However, there were a few tsetse flies present in MGR especially in the bushland as well as in the woodland around Kianjiru and Kiambogo hills. Moreover, in Kitui, major tsetse areas sampled were around Nuu hills representing woodland and some points for bushland where farmers, government and Farm Africa officers reported that tsetse was a major problem that livestock farmers were trying to handle. Watering points and grazing areas are shared by the community members and according to the livestock

officer at the divisional headquarters; the grazing areas are infested with tsetse and thus trypanosomiasis a major problem in the areas. *Pistacia Aethiopica* (Musaai (Kikamba) is the dominant shrub in Kitui transect with a diversity of 35 species of shrubs.

In a nutshell, plant species composition was found not to be highly dissimilar comparing among land-use types, within transects except for the agricultural land use which generally was found to have different plant species although some trees were common in more than one land uses like *Cordia Africana (*Muringa) in Meru present in forest and agricultural land. In Kitui, Mwingi and Mbeere, more than one species appeared in bush land, woodland as well as in forests present in this region.

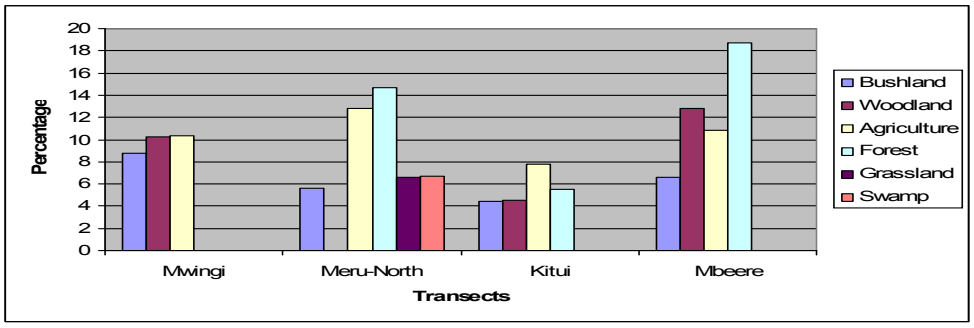

Figure 3.1: Percent canopy cover comparison within transects, across transects and across land uses

3.1.2 General description of vegetation along the transects in Baringo and Lake Victoria region

Baringo is semiarid with climates of moderate moisture. Elevation varies from approximately 900 meters in the Lake Baringo Basin and Njemps Flats to more than 2,300 meters on the rim of the Uasin Gishu Plateau. The variation in elevation is associated with corresponding changes in climate, soil, and vegetation. The general north-south trend of the physiographic features influences climate, landuse patterns, and natural rainfall conditions. Climatic patterns range from humid subtropical in the highlands to semiarid in the lowlands. Various relationships have been the bases of schemes of classification.

The dominant ethnic groups are the Tugen, and the Njemps. The Njemps are pastoralists in the lowlands. In their natural state highland forests are found at elevations between 2330 and 1800m above the sea level and are dominated by dense stands of *Juniperus procera*, *Rhus nata- lensis*, and *Trichoclndus ellipficus.* Much of the original forest has been cleared and the area converted to farmland. The remaining forest is found chiefly on the rugged terrain.

Areas of high elevation and deep clay soils support bushland where the *Rlzus* and *Olen* are dominant. Bushland dominated by *Combretum molle* but mixed with species of *Acacia* is found on the intermediate slopes.

Southwestern Nyanza's Suba and Homa Bay districts fall within the Lake Victoria regional mosaic plant belt of Africa, dominated by a graded vegetation landscape of relict tropical rainforest, bush grassland (*Themeda-Hyparrheni*a) and wooded grassland vegetation of the *Combreto-Dodonea*e-*Balanite*s-*Acacia* matrix (figure 3.2). Ruma National park is largely occupied by wooded, dry bushland and grassland vegetation with *Commiphora-Acacia-Combretum* communities.

In Rachuonyo and Nyando the vegetations variety included main species of woody vegetation Savanna woodland (*Acacia, Albizzia and Butyrospermum*) and the main species of herbaceous vegetation include: *Cymbopogon, Hyparrhenia*, *Londetia* and *Cyperus papyrus*.

The main type of crops in the Nyanza transect included maize, cotton, sisal, tobacco, beans, sugarcane, coffee, sorghum, millet, wheat and root crops (cassava). The major crops grown in Busia include millet, maize, ground nuts, cassava, cotton, sweet potatoes, soya beans, coffee, and sorghum.

Among the four transects it was in Baringo that the local people were observed to be more knowledgeable about plants. In Marigat area there was a mix of two languages, Tugen and Njemps making it difficult to name plants in local names. During the sampling period, it was a weeding season hence the reason for the relatively low vegetation, particularly in agriculture land use type.

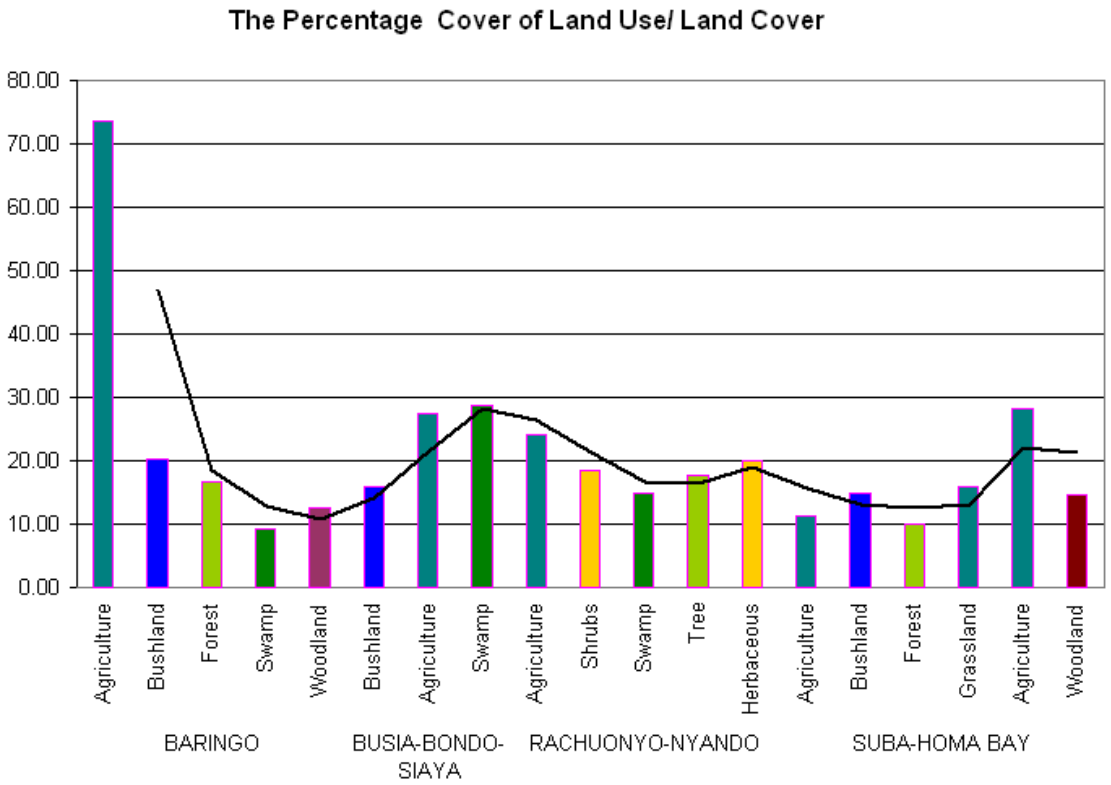

Figure 3.2: Percent species composition per landcover type

The results presented here give a general view of what was found to be the landcover and common vegetation/plant species in the tsetse belts, as well as the insects common in the transects targeted by the baseline survey and further highlights why most insects were common in some transects and not others. The report also compares the canopy cover of the plant species within transect and also across transects. In the report erosion indicators across the belt are well addressed at the same time pointing out why erosion was more in some farms and not on others. In addition efforts to manage soil erosion are highlighted and the methods mostly employed by farmers are provided in the report.

There are also appendices at the end of the report giving a summary of the common vegetation and insects in the entire belt.

Measure of diversity of plant species per transect e.g. relative density

Distribution of plant species is affected by land use. Variations in land cover over an area may be a reflection on the distribution of plant species. The composition of plant species on the other hand is influenced by land use. We have therefore studied the types of plant species in each land use and land cover type in transect laid to cover different ecosystems to show the types, distribution, coverage and relative density of different plant species

Table 3.1 below is an example of summaries of these analyses. Tables for all the 8 transects are presented in the appendix (see appendix 4). The database provided in the CD contains more detailed information on every sampling site to describe the location, plant species, phenology and any other information required in future monitoring and assessment exercise.

Table 3.1 Average number (count) and percent cover per species of plants sampled in the Baringo transect.

	LAND COVER/USE									
	Agr(mono crop)		Agri(mix crop)		Bushland		Forest		Woodland	
BOTNAME	count	% cover	count	% cover	count	% cover	count	% cover	count	% cover
Acacia drep									1.5	22.5
Acacia milliner							1.0	10.0		
Acacia seyal							2.5	25.0		
Acacia tortilis	4.5	6.0								
Acanthus emin								5.0		
Alchornea fruticosa				7.5				30.0		
Allium porrum				2.0						
Allophylus abys								1.0		
Aloe vera								1.0		7.3
Amaranthus gangeticus		3.5								
Ananas comosus				5.0						
Archornea fruticosa		6.5								
Asystasia schimperi				2.5						
Bidens pilosa		5.0		30.0						
Cissus rotundifolia				5.0						
Coffea sp				10.0						
Combretum moll					3.0	8.8				
Commelina trilocularis		2.0								
Croton alie								5.0		
Cupressus semperviens									2.0	7.5
Cynodon						60.0				
Cynodon dactylon		8.5		10.0						
Cynodoo plectosta		5.0		5.0						
Cyprus							6.9	26.9		
Datura stramonium				2.0						
Digitaria		2.0								
Dodonaea angu						40.0	5.0	40.0		
Dodonaea angustifolia				3.5				23.8		20.0
Dovyalis abyssinica				2.0						
Eragrostis tenuifolia				5.0				3.5		

Eucalyptus globulus					8.2	16.2		
Euclea divinorumnorum					4.0	10.0		
Euphorbia candalebrum					1.0	5.3		6.3
Grewia tricolor						5.0		
Kisilitoro			5.0					
Lantana camara				40.0		5.0		
Leonotis nepetifolia		1.0	5.0					
Leucas calostachys			2.0					
Leucas grandis			22.5					
Lipia Kituensis						5.0		
Maytenus			20.0					
Mexican marigold			1.5					
Ocimum suave			5.7					
Pavonia aren						5.0		
Phaseolus vulgaris	10.5		26.5		1.7	3.2		
Podocarpus falc					4.9	8.6		
Podorcarpus falc					4.0	10.0		
Pordocarpus calc					11.5	10.0	3.5	12.5
Pordocarpus falc					5.0	10.0	2.0	10.0
Portulaca quadrifolia	3.0							
Prosopis					30.0	60.0		
Psiadia punc						10.0		
Psidia guajava						40.0		
Psidia punctulata						18.8		
Salanum Incanum	5.0							
Senna didymobotrya	60.0							
Sorghum bicolor			25.0					
Sporobolus pyramidalis						20.0		
Sterculia Sten								
Talinum portulacifolium	1.0							
Tarchonanthus camp						24.3		
Themeda triandra			20.0					
Trichocladus elli			15.0					
Trimeria gran						19.3		
Unknown B3			2.0			10.0		

Unknown B5				2.0	
Unknown B6				1.0	
Unknown B8					10.0
Vanguaria mada				8.0	
Wondering jew		2.0			
Zea mays	47.5	34.6			
Ziziphus maur			11.3	2.0	

SECTION 4

ANIMAL BIODIVERSITY

4.1 Introduction

Impacts of T&T on biodiversity could be in either one or both of two ways: Direct impacts or indirect impacts. The direct impacts are those that occur directly from the intervention activities. Examples of these are the effects on the non-target organisms that are killed by insecticides on spraying, use of targets or clash pens or are caught in the traps along with tsetse flies. Direct impacts were the main concern during the early days of tsetse control when the methods of used to control tsetse and trypanosomiasis were ground spraying with DDT, vegetation clearing, bush burning and wildlife elimination among others. These concerns were addressed by the development of environmentally friendlier tsetse control activities like use of odor baited trapping techniques and targets.

The indirect impacts occur due to human use of land after trypanosomiasis challenge has been reduced. These impacts are due to changes in land use and land cover as people invest more on cultivation and grazing.

4.1.1 Direct impacts on birds and higher animals

There could be direct impacts of tsetse and trypanosomiasis control on birds and some members of the mammalian group. However, except for some species of birds, use of SAT or even ground spraying may not result in any death of large organisms because of the ultra low concentrations of the chemicals used. Although some birds may be affected directly by spraying of chemicals, majority of impacts on birds associated with T&T interventions are due to changes in land use that follow the interventions (Reid *et. al*. 1998, Cathy Wilson 1997). Survey on birds has been done in various parts of the study sites, but particular attention has been made on specific sites where birds are an important component of the ecosystem. These include Busia, Angurai, Lambwe valley, Teso, Lake Baringo, and parts of the shores of Lake Victoria. Table 4.1 – 4.4 provide information on birds. More detailed database is provided in the CD.

Previous studies on impacts of T&T on biodiversity have identified the components of biodiversity that can be used as indicators of change. Owing to the wide range of biodiversity groups found in natural habitats, enumeration of all groups of fauna present in the area is not only difficult but also expensive. It is therefore a common practice to use some selected indicator groups that can show changes. These include impacts on birds species, insects and to a small extent the mammals. In this study we have emphasized on insects in all study sites due to their vulnerability to tsetse control methodologies as they are closely related to tsetse flies. Birds are universally distributed across all sites and are known to be good indicators of habitat changes both in natural and man made

environments. We have therefore selected to analyze the distribution of birds in several study sites. In all the sites we have conducted a rapid appraisal of animal biodiversity in general capturing presence or absence of major groups of wildlife.

4.1.2 Methods for animal biodiversity surveys

Apart from non-target insect fauna all impacts of tsetse and trypanosomiasis control on animal biodiversity could be considered indirect. These are impact that arise due to changes in land use and increasing intensity of land use in the trypanosomiasis freed areas.

In all the three areas where this project was implemented, human occupation was already in place by the time of this survey with various land use activities ranging from farming, grazing, wildlife conservation, settlemets, urban developments and lots civil works of different forms. We therefore would like to point out that there is no place in the project area that the project will be responsible of conversions from natural habitats to human modified habits in such a way that PATTEC project activities will be the primary cause of changes in animal biodiversity especialy the large mammals.

In order to record the state of animal biodiversity in the study areas a rapid appraisal was conducted along all the transects both to reconstruct the changes in presence and relative abundance of these animals and to record the types of animals known to exist in the areas. In the terms of reference for this work it was agreed that the study should focus on a few selected biodiversity components that may serve as indicators of change. It was in this regard that the PATTEC - PCMU and the consultants agreed to focus on vegetation, insects, birds, and mammals as the major biodiversity components to be studied in addition to studies on land use / cover and soils.

Surveys on wildlife

As indicated above surveys on wildlife were conducted by a rapid appraisal techchnique by administering a well designed and very comprehensive questionnaire (see appendix 1). Wildlife, specifically mammals, birds, reptiles rodents etc, have a landscape distribution pattern rather than localized occurencies like plants and to some extent the insects. Our sampling strategy on wildlife was therefore at landscape level. The three project areas 1) lake victoria basin, 2) lake Baringo catchment, and 3) the Meru – Mwea region were considered to be the three landscape units where wildlife was sampled. In each unit several transects were laid and in each transect at least 10 questionnaires were administered.

4.2 Results of biodiversity surveys

Over the last 10 yrs, birds' composition according to farmers' perceptions has not varied in Baringo and Busia-Siaya-Bondo area (Figure 4.1). However, changes were noted in Rachuonyo – Nyando and Suba-Homa Bay. Unlike Rachuonyo-Nyando which recorded a slight increase in the number of birds, Suba-Homa Bay recorded a decline. The number of mammals declined over 10 yr period in all the sites, except Baringo, where they remained the same. Rodents and reptiles have generally increased in all the study areas.

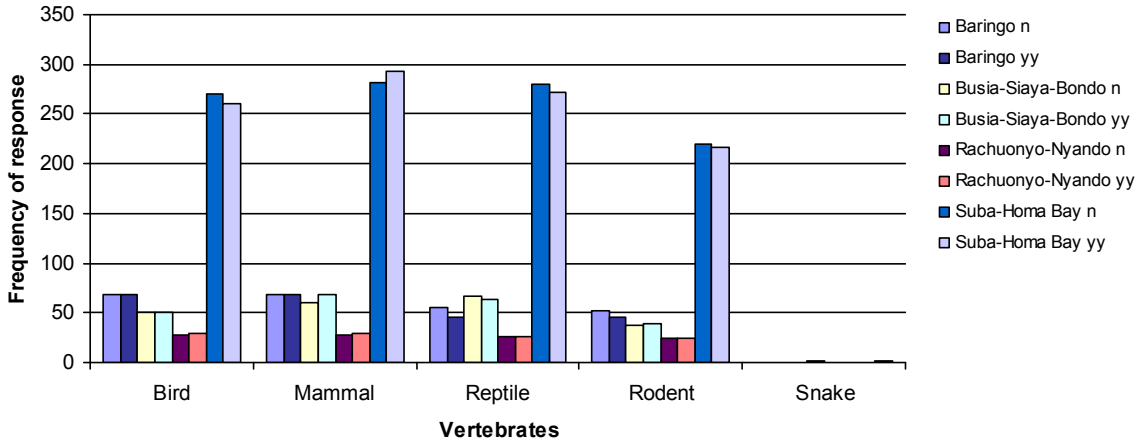

Figure 4.1 Farmers' perception of vertebrate species found in Baringo and Nyanza transects today (n) and ten years ago (yy)

Emergence of wildlife in Nyanza and Baringo is dominated by primates and rodents (table 4.1) which move into the area to feed on food crops. Predators such as Hyenas and snakes are attracted by domestic animals. Key reason given for the emergence of wildlife in this area is decrease of feed in their natural habitats such as bushes due to encroachment of cropland. Farm crops like maize are preferred diets particularly for primates and therefore are a major attraction. Other factors like emergence of ponds and salt licks have attracted new animals into some areas.

Table 4.1 Reasons for the emergence of wildlife in Nyanza Baringo transects

Name	Reason
Ant Eater	Don't know
Antelope	Emergence of bushes
Baboon	Decrease of feed
Buffalo	Decrease of feed
Guinea fowl	Don't know

Hare	None
hippo	Emergence of water
Honey Beaker	Food availability
hyena	Presence of domestic animal
Impala	Decrease of feed
	Ponds emergence
	Salt that emerged around
Monkey	Emergence of crops like maize
	Decrease of feed
Porcupine	Maize Farms
Snakes	Attracted by goats in the home
Warthogs	Maize Farms

Much of Kenyan wildlife exists in the rangelands as it constitutes the largest proportion of land cover. Since bush land is a major component of the Baringo and Nyanza transects, it accounted for the largest proportion of lost wildlife. Major land conversions have also occurred here, where the key factors that have led to wildlife disappearance from this area are anthropogenic in nature (figure 4.2).

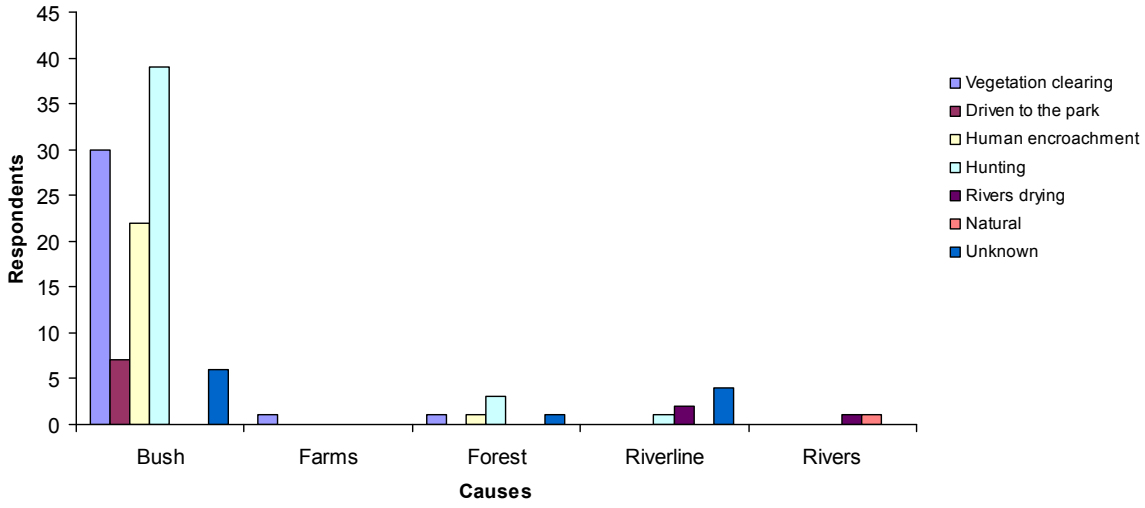

Figure 4.2 Causes of wildlife dissappearance in Baringo and Nyanza transects

Like in Baringo and Nyanza, factors that are perceived by the local farmers to have contributed to the decline in wildlife in the Meru Mwea transects are chiefly a result of human encroachament (figure 4.3). Alteration of land cover/use resulting from human encroachment accounts for more than twice the impact of relocating wildlife into the game reserves, which ranks second in importance. Encroachement into wildlife home ranges in the bushland and forests signify pressure for natural and land resources as more and more area become available following the tsetse

control. Other significant factors responsible for decline in wildlife include hunting, fencing and deforestation.

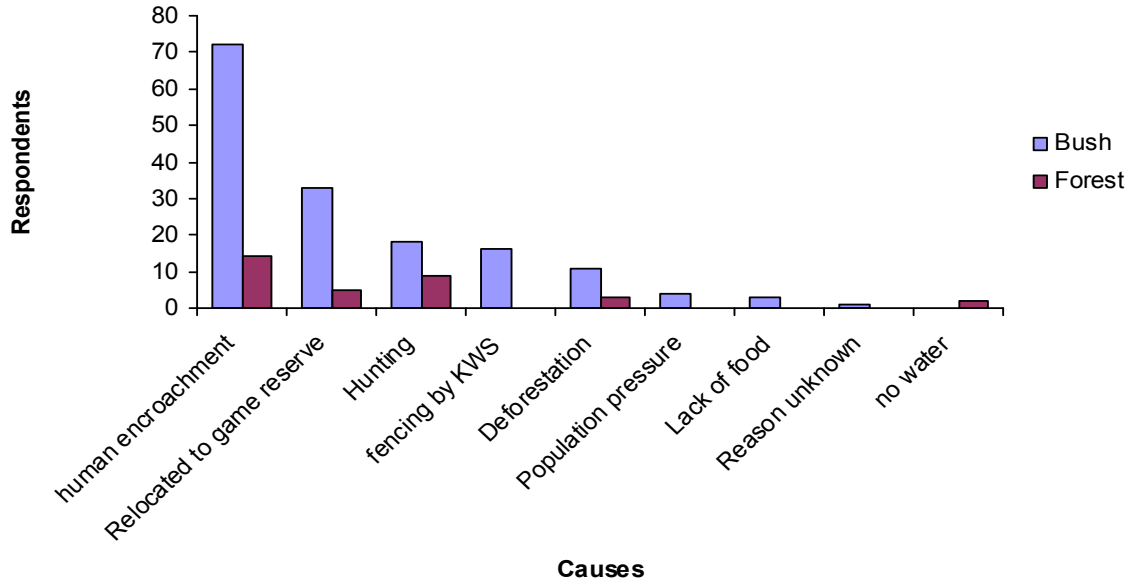

Figure 4.3 Factors contributing to wildlife disappearance in the Meru-Mwea tsetse belt.

4.2.1 mammalian and reptile biodiversity

Considerable decline in the abundance of mammals and other wildlife species (figure 4.4 a – 4.4c) in the Meru-Mwea and Baringo-Nyanza area have occurred over the last few decades. Large herbivores (elephants, bufallo, rhino, giraffee, zebra) and medium mammalian species (hyena, lion, leopard, cheetah, wild pig, warthog) are among those that have been reduced in numbers or have completely disappeared locally. Reptile and rodent prevalence has not changed much except for tortoise, which has declined rapidly over the period.

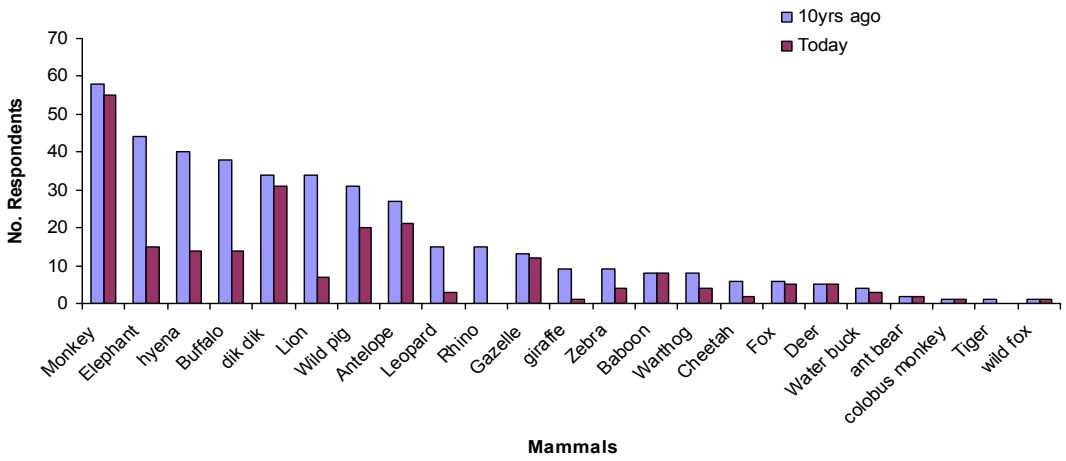

Figure 4.4a Mammals found in Meru-Mwea today and 10 years ago.

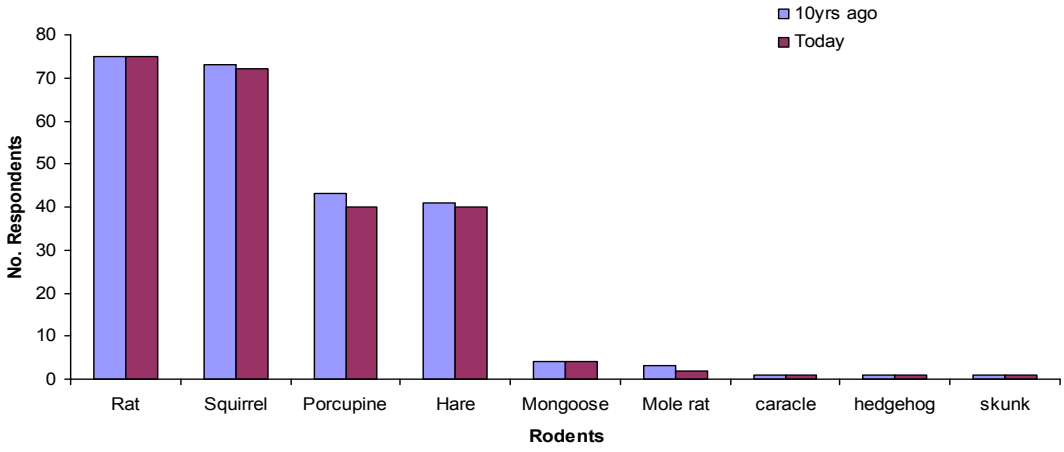

Figure 4.4b Rodents found in Meru-Mwea today and 10 years ago

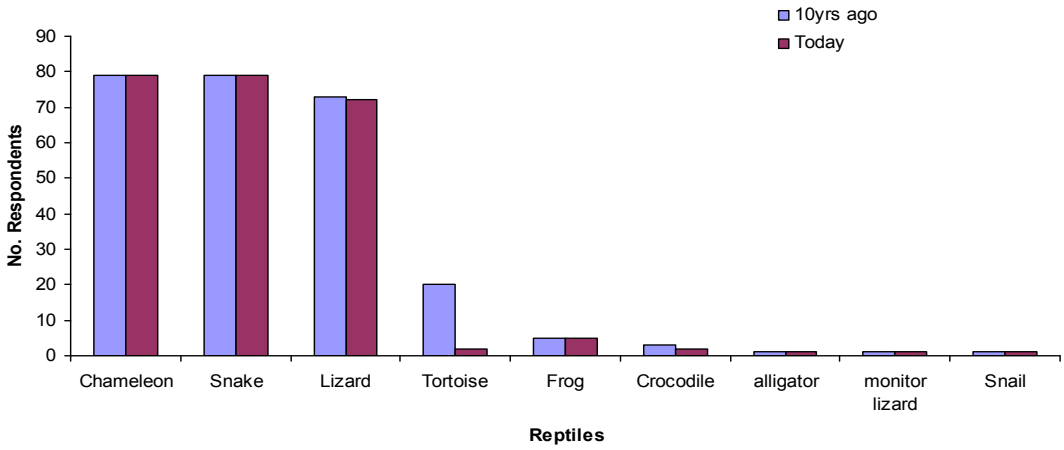

Figure 4.4c Reptiles found in Meru-Mwea today and 10 years ago

Crop damage is the main cause of human wildlife conflict both in Meru-Mwea and Baringo - Nyanza areas (figure 4.5 and figure 4.6). Primates, rodents and small to medium size herbivores such as mongooses, antelopes and dikdiks contribute significantly to crop raids. Other animals like leopards, hyena and buffalo cause death of livestock or damage to property.

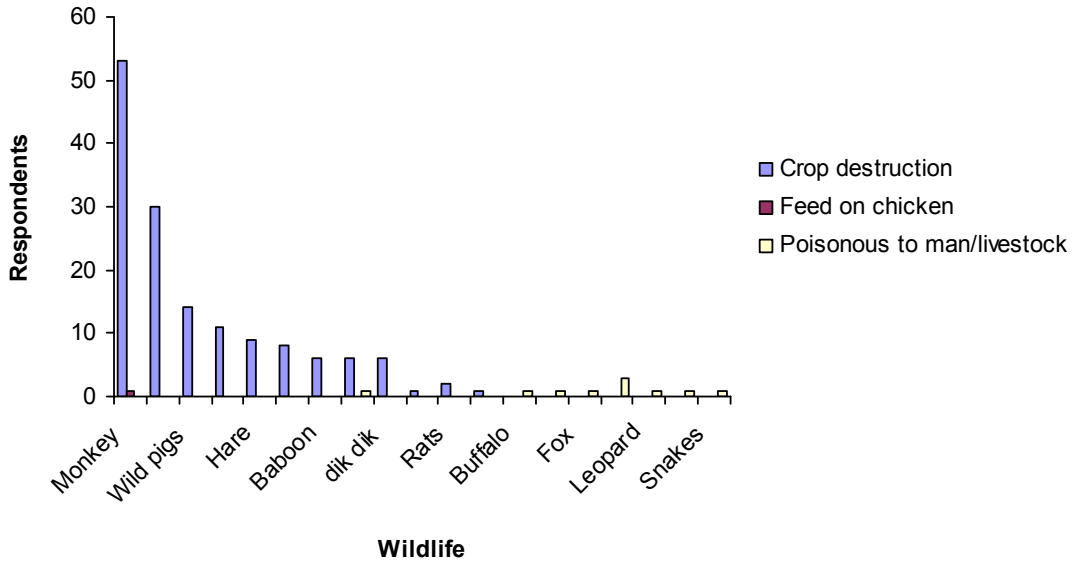

Figure 4.5 Human-wildlife conflicts in the Meru-Mwea tsetse belt.

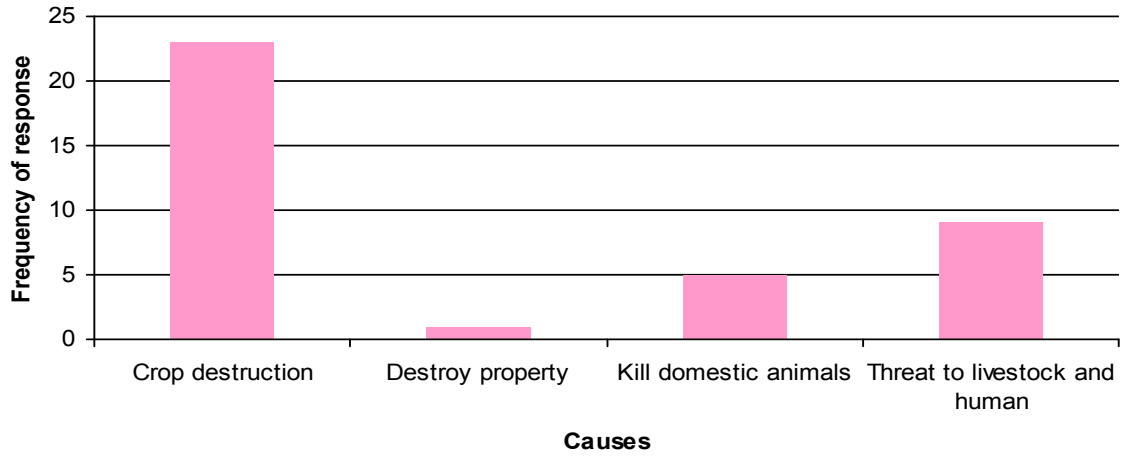

Figure 4.6 Causes of human wildlife conflict in Baringo and Nyanza transect.

Despite the extensive loss of wildlife in a relatively short period of time, farming communities in the area may percieve it as a potential relief to persistent crop raids and loss of livestock to wild animals (figure 4.7). Monkeys and wild pigs are seen as major crop raiders. This perception implies that some animals are targeted selectively for elimination as pests by the farming community. Crop raiders are however known to persist much longer in modified landscapes since the changes confers to them competitive advantage over non raiders which are readily lost. The effective wildlife loss therefore surpasses by a big marging the relief obtained from reduced crop raids.

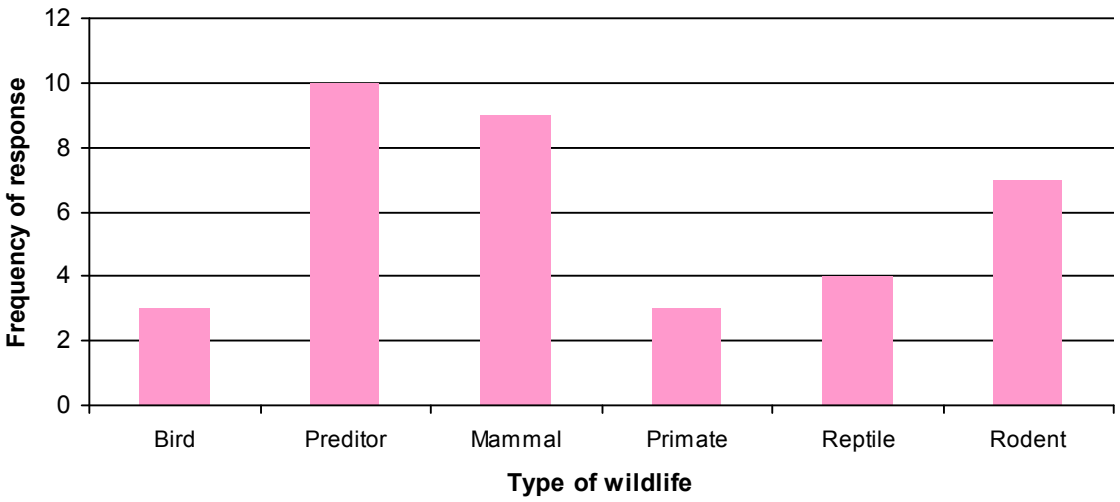

Figure 4.7 Types of wildlife and how they contribute to human wildlife conflict in Baringo and Nyanza tsetse belts.

4.2.2 Birds' biodiversity

Objectives

Birds' diversity was assessed in lambwe valley, angurai and busia areas in western Kenya. The objective of this study was to record the types of birds present in the study sites to provide an indicator of avian fauna found in the area and serve as an indicator of habitat suitability for animal habitation. These records will serve as indicators of presence or absence in later surveys and assessments

Methods

These surveys were focussed in Lambwe Valley, Angurai and Busia districts and were each visited over a period of seven days, and details of bird species were recorded in selected sites. Geographical coordinates of the sites in Angurai and Busia are as follows:

Angurai Gps Locations

CULT	36N	E0647709 / N0080225
FA	36N	E0623538 / N0050248
FLGZ	36N	E0647727 / N0079662
MZ	36N	E0647189 / N0079064
MZCA	36N	E0647633 / N0079631

WDBS	36N	E0647224 / N0078962
WDBS1	36N	E0647615 / N0080215
WDGR	36N	E0645755 / N0078905

Busia Gps Locations

PLOT 1	36N	E0623162 / N0048268	note: contiguous with Plots 2 & 4 and cleared
PLOT 2	36N	E0623088 / N0049147	note: contiguous with Plots 1 & 4 and cleared
PLOT 3	36N	E0623082 / N0048669	
PLOT 4	36N	E0623082 / N0048268	note: contiguous with Plots 1 & 2 and cleared
PLOT 5	36N	E0623607 / N0047803	
PLOT 6	36N	E0622881 / N0047811	
PLOT 7	36N	E0622861 / N0047139	
SRQP	36N	E0623624 / N0047782	

The surveys were conducted from a resting position during the optimum times of early morning and late afternoon. During the warmer part of the day when birds are usually inactive and quiet the sites were patrolled and the inhabitants searched. Birds were counted by both sighting and voice recognition. Species sighted during subsequent visits to a particular plot were recorded to indicate the frequency.

Results and discussions

With the exception of a small area of natural vegetation originally covered by a forest, in Angurai, all other areas were either cultivated or partly cultivated, and were found to be unsuitable for birds that require natural habitats (table 4.2). Despite consisting of native species, some areas were heavily modified and surrounded by extensive cultivation. In most places the vegetation cover was found to be inadequate for the woodland savannah species. In Lambwe Valley, the abundance of grasses that are used locally for thatching or cattle-feed, and many weeds that produce copious small seeds attract an impressive variety of estrildid finches (table 4.3) in the fields and scrubby edges because there is abundance of food for them. In wooded areas there would have been much fewer, and several species would not have been there at all.

Busia district is an extreme example of transformed land cover. Virtually all of the immediate vicinity to the sampling areas had been cultivated. Near the sampling points there have been no modification on the surrounding swampland, and the avifauna has probably not changed over the centuries (table 4.4). Because this is a rich area, there are incursions, where birds regularly visit the

few trees, and the weedy patches for foraging. This greatly distorts the importance of the vegetation, because it is an extension of habitat leading from the swamp.

In the scrubland, the areas are too small to support a viable bird population although there are a few species taking refuge here. The woodlands have more important cover, and maybe food resource, and contain a few woodland birds that would not normally be found in such a small patch of scrub. As stated before, all sampling plots are largely influenced by their immediate environments, and cannot stand as a refuge on their own right.

List of birds recorded in Angurai, Lambwe Valley and Busia

Table 4.2 List of birds found in Angurai

Common name	CULTIVATED SITES	NON CULTIVATED SITES
African black swift		X
African citril		X
African firefinch		X
African moustached warbler		X
Baglafecht weaver		X
Black & white mannikin		X
Black bellied firefinch		X
Black billed barbet		X
Black faced waxbill		X
Black headed batis		X
Black headed gonolek		X
Black headed heron		X
Black headed weaver		X
Black rumped waxbill		X
Black shouldered kite		X
Blue flycatcher		X
Blue spotted wood dove		X
Brimstone canary	X	
Bronze mannikin	X	X
Bronze sunbird		X
Brown crowned tchagra		X
Brown backed scrub robin		X
Brown throated wattle eye		X
Cabanis's greenbul		X
Common bulbul	X	X
Common waxbill		X
Compact weaver		X
Copper sunbird		X
Crested francolin		X
Croaking cisticola		X
Dark capped yellow warbler		X
Diederik cuckoo		X
Fawn brested waxbill		X
Great sparrowhawk		X

Common name	CULTIVATED SITES	NON CULTIVATED SITES
Greater honeyguide		X
Green headed sunbird		X
Grey backed camaroptera		X
Grey capped warbler		X
Grey headed sparrow		X
Grey winged robin chat		X
Greyish eagle owl		X
Klaas' cuckoo		X
Laughing dove		X
Little greenbul		X
Marsh tchagra		X
Olive bellied sunbird	X	X
Olive sunbird		X
Paradise flycatcher		X
Parasitic weaver		X
Purple banded sunbird		X
Purple grenadier		X
African Pygmy kingfisher		X
Red billed firefinch	X	X
Red cheeked cordon bleu		X
Red crested cuckoo		X
Red eyed dove		X
Red faced cisticola		X
Red headed lovebird		X
Red winged warbler		X
Ross's turaco		X
Scarlet chested sunbird		X
Siffling cisticola		X
Singing cisticola	X	X
Snowy headed robin chat		X
Speckled mousebird		X
Speckled pigeon		X
Spectacled weaver		X
Striped kingfisher	X	
Sulphur breasted bush shrike		X
Tambourine dove		X
Tawny flanked prinia	X	X
Violet backed starling		X
Whistling cisticola		X
White browed coucal		X
White browed robin chat		X
White chinned prinia	X	X
White headed saw wing		X
Yellow fronted canary	X	X
Yellow fronted tinkerbird	X	X
Yellow rumped tinkerbird	X	X
Yellow bellied wattle eye	X	X
Yellowbill		X

Table 4.3 List of birds found in Lambwe Valley

Common name	Grasslands in settled areas	Grasslands/Thickets in the National Park/settled areas	Grassland/thicket in protected area
Abdim's Stork			X
Abyssinian Scimitarbill		X	
Afr. Moustached Warbler	X		
Afr. Paradise Flycatcher			X
African Grey Hornbill			X
Angola Swallow		X	
Babbler spp.	X		
Bare-faced Go-away-bird			X
Barn Swallow		X	
Beautiful Sunbird	X		
Black Cuckoo Shrike	X		
Black-and-White Cuckoo		X	
Black-bellied Bustard		X	
Black-chested Snake Eagle		X	
Black-headed Gonolek	X		
Black-lored Babbler			X
Black-necked Weaver		X	
Black-shouldered Kite		X	
Black-throated Wattle-eye			X
Blue-naped Mousebird		X	
Broad-tailed Warbler			X
Brown Parrot			X
Cattle Egret	X		
Crowned Lapwing	X		
Emerald-sp. Wood-Dove		X	
Eurasian Hobby			X
European Bee-eater		X	
Fork-tailed Drongo		X	
Gabar Goshawk		X	
Green Wood-Hoopoe			X
Grey-backed Camaroptera		X	
Grey-backed Fiscal	X		
Hadada Ibis			X
Helmeted Guineafowl			X
Laughing Dove		X	
Lesser Masked Weaver	X		
Lesser Striped Swallow	X		
Little Swift			X
Long-crested Eagle		X	
Northern Black Flycatcher		X	
Pale Flycatcher	X		
Purple-banded Sunbird		X	
Rattling Cisticola	X		
Red-billed Quelea	X		
Red-eyed Dove		X	

Common name	Grasslands in settled areas	Grasslands/Thickets in the National Park/settled areas	Grassland/thicket in protected area
Red-faced Crombec		X	
Red-fronted Tinkerbird			X
Red-necked Spurfowl			X
Ring-necked Dove		X	
Rüppell's Long-tailed Starling		X	
Scarlet-chested Sunbird		X	
Slate-coloured Boubou		X	
Speckled Mousebird		X	
Spectacled Weaver		X	
Spotted Flycatcher			X
Sulphur-br. Bush-Shrike		X	
Superb Starling		X	
Tawny-flanked Prinia		X	
Wattled Starling		X	
White-browed. Robin-Chat		X	
White-brow. Scrub-Robin		X	
White-headed Saw-wing		X	
White-throated Bee-eater			X
Yellow Wagtail		X	
Yellow-fronted Canary	X		
Yellow-rumped Seed-eater			X
Yellow-spotted Petronia			X
Yellow-throated Longclaw		X	

Table 4.4 List of birds found in Busia

Common names	MODIFIED AREA (CULTIVATED, FALLOW & SETTLED)	UNMODIFIED AREA (BUSHLAND, SCRUBLAND AND WOODLAND)
African black swift		X
African citril		X
African moustached warbler		X
African palm swift		X
African pied wagtail	X	X
Baglafecht weaver	X	X
Bar breasted firefinch		X
Barn swallow		X
Black & white mannikin		X
Black headed gonolek		X
Black headed weaver		X
Black shouldered kite	X	X
Blue headed coucal		X
Blue spotted wood dove		X
Brimstone canary		X
Bronze mannikin	X	X
Brown babber		X
Brown crowned tchagra		X
Brown parrot	X	
Common bulbul	X	X
Common fiscal	X	X
Common waxbill		X
Compact weaver	X	X
Copper sunbird	X	X
Crested francolin	X	X
Dark capped yellow warbler		X
Diederik cuckoo		X
Eastern grey plantain eater		X
Yellow bellied waxbill		X
Fawn breasted waxbill		X
Greater swamp warbler		X
Grey capped camaroptera		X
Grey capped warbler		X
Grey headed sparrow		X
Grey woodpecker		X
Hadada ibis		X
Holub'sgolden weaver		X
Klaas' cuckoo		X
Laughing dove		X
Lesser honeyguide		X
Lesser striped swallow		X
Little bee eater		X
Marsh tchagra		X
Olive bellied sunbird		X
Papyrus canary		X
Pied crow		X

Common names	MODIFIED AREA (CULTIVATED, FALLOW & SETTLED)	UNMODIFIED AREA (BUSHLAND, SCRUBLAND AND WOODLAND)
Pigmy kingfisher		X
Pin tailed whydah	X	X
Red billed firefinch		X
Red billed oxpecker		X
Red cheeked cordon bleu		X
Red chested sunbird		X
Red eyed dove		X
Red faced cisticola	X	X
Ruppell's starling		X
Scarlet chested sunbird	X	X
Senegal coucal		X
Slender billed weaver		X
Speckled mousebird		X
Spectacled weaver		X
Striped kingfisher		X
Tawny flanked prinia	X	X
Triped kingfisher		X
Tropical boubou	X	X
Variable sunbird		X
White browed coucal		X
White browed robin chat	X	
White browed scrub robin		X
Winding cisticola		X
Woodland kingfisher	X	X
Yellow fronted canary	X	X
Yellow fronted tinkerbird		X
Yellow mantled widowbird		X
Yellow throated leaflove	X	
Yellow throated longclaw	X	X
Yellow white eye		X

In addition to the above classic studies done on birds, observations were made for other sites (table 4.4).

Table 4.5 Transect summaries of Baringo and western / Nyanza PATTEC sites

Common Names	Species names	Baring o	Suba - Hom	Rachu- Nyando	Busia-Siaya- Bondo
African fish eagle	*Haliaeectus vocifer*	x			
African jacana	*Actophilornis africanus*	x			
African paradise flycatcher	*Terpsiphone viridis*	x	X		
African spoonbill	*Platalea alba*	x			
Alpine swift	*Apus melba africanus*	x	X	x	X

Beautiful sunbird	*Nectarinia pulchella*	x	X		
Bennet s woodpecker	*Campethera bennettii scriptoricauda*	x	X		
Black crowned crane	*Balearica pavonina ceciliae*		X		
Black crowned night heron	*Nycticorax n. nycticorax*		X		
Black headed gull	*Larus rudibundus*		X		
Black headed heron	*Ardea molanocephala*	x	X		
Black tailed godwit	*Limosa l. limosa*	x			
Black tern	*Chlidonias n. niger*	x	X		
Black winged lapwing	*Vanellus melanopterus minor*	x			
African Black headed oriole	*Oriolus larvatus rolleti*	x	X		X
Blue-cheeked bee-eater	*Merops p. persicus*	x	X		
Blue-naped mouse bird	*Urocolius macrourus pulcher*	x		x	X
Bridled tern	*Sterna anaethetus anartarctica*	x	X		
Cardinal woodpecker	*Dendropicos fuscescens*	x		x	
Cattle egrets	*Bubulcus i. Ibis*	x		x	X
Cinnamon-Chested bee-eater	*Merops oreobates*	x	x		
Collared dove	*Streptopelia*	x			
Common bulbul	*Pychinonotus barbatus*	x	x		
Common drongo	*Dicrurus adsimilis*	x		x	X
Common greenshank	*Tringa nebularia*	x	x		
Common ostrich	*Struthio camelus*	x			
Common sandpiper	*Actitis hypoleucos*	x			
black winged stilt	*Himantopus himantopus*	x		x	X
Common tern	*Sterna h. hirundo*	x			
Crab plover	*Dromas ardeola*		x		
Crested barbet	*Trachyphonus vaillantii suahelicus*	x	x		X
Dimorphic egret	*Egretta dimorpha*	x			
Dwarf bittern	*Ixobrychus sturmii*	x			
Egyptian goose	*Alopochen aegyptiacus*	x		x	X
Fire fronted bishop	*Euplectes diadematus*		x		
Fulvous whistling duck	*Dendrocygna bicolor*		x		
Glossy ibis	*Plegadis f. falcinellus*	x			
Golden tailed woodpecker	*Campethera abingoni kavirondensis*	x	x		
Goliath heron	*Ardea goliath*	x	x		
Great black headed gull	*Larus ichthyaetus*		x		
Great Cormrant	*Phalacrocorax carbo*		x		
Great white egret	*Casmerodius albus*	x	x		
Great white pelican	*Pelecanus onocrotalus*	x			
Greater flamingo	*Phoenicopteus (ruber) roseus*	x			
Greater painted snipe	*Rostratula b. benghalensis*	x	x		
Green backed heron	*Butorides striatus atricapillus*	x	x		
Green winged pytilia	*Pytilis melba soudanensis*	x	x		
Grey backed fiscal	*Lanius e. excubitoroides*	x	x		

Grey crowned crane	*Balearica regulorum gibbericeps*	x			
Grey headed bush-shrike	*Malaconotus blanchoti approximans*	x	x		X
Grey headed gull	*Larus Cirrocephalus poiocephalus*	x	x		
Grey headed heron	*Ardea cinenea*		x		
Grey headed kingfisher	*Halcyon l. leucocephala*	x	x		
Hamercop	*Scopus u. umbrella*	x	x	x	X
Helmeted guinea fowl	*Numida meleagris*	x	x		X
Hemprich's hornbil	*Tockus hemprichii*	x	x		
Heuglins francolin	*Francolinus icterorhynchus*	x	x		
Holub's golden weaver	*Ploceus xanthops*	x	x		
Eurasian epops	*Upupa epops*	x			
Horus Swift	*Apus h. horus*	x		x	X
Jackson's hornbill	*Tockus jacksoni*	x			
Knob-billed duck	*Sarkidiornis melanotos*		x		
Laughing dove	*Streptopelia senegalensis*	x			
Lesser flamingo	*Phoeniconaias minor*	x			
Lesser Jacana	*Microparra capensis*	x			
Lesser sandplover	*Charadrius mongolus pamirensis*	x	x		
Lilac-breasted roller	*Coracias caudata*	x	x		
Little bee-eater	*Merops pusillus cyanostictus*	x			
Little egrets	*Egretta g. garzetta*	x	x	x	X
Little weaver	*Ploceus l. luteolus*	x	x		
Long-tailed cormorant	*Phalacrocorax a. africans*	x			
Madagascar bee-eater	*Merops superciliosus*	x	x		
Malachite kingfisher	*Alcedo cristata galeita*	x			
Marabou Stork	*Leptoptilus crumeniferus*	x			
Marsh sandpiper	*Tringa stagnatilis*	x			
Medagascar squacco heron	*Ardeola idae*		x		
Mosque swallow	*Hirundo senegalensis*		x		
Mouse-coloured sunbird	*Nectarinia veroxii fischeri*	x	x		
Namaqua dove	*Oena c.capensis*	x	x		
Northern brown throated weaver	*Ploceus castanops*	x	x		
Northern red bishop	*Euplectes franciscanus*		x		
Orange weaver	*Ploceus aurantius*	x			
Pied kingfisher	*Ceryle r. rudis*	x	x		
Pink backed pelican	*Pelecanus rufescens*	x			
Pintail snipe	*Gallinago stenura*		x		
Purple heron	*Ardea purpurea*		x		
Red and yellow barbet	*Trachyphonus erythrocephalus*	x	x		
Red billed hornbill	*Tockus erythrorhynchus*	x	x		
Red knobbed coot	*Fulica cristata*	x	x		
Ring necked dove	*Streptopelia capicola somalica*	x			
Ringed plover	*Charadrius hiaticula*		x	x	X
Ruddy turnstone	*Arenaria interpres*		x		

Ruppell's long-tailed starling	*Lamprotornis purpuropterus*	x	x		X
Sacred ibis	*Threskiornis a. aethiopicus*	x	x		
Senegal thick-knee	*Burhinus senegalensis inornatus*	x	x		
Slender billed gull	*Larus genei*		x		
Socotra cormorant	*Phalacrocorax nigrogularis*	x	x		
Sooty boubou	*Laniarius leucorhynchus*	x	x	x	X
Southern black flycatcher	*Melaenornis pammelaina*	x	x	x	X
Southern red bishop	*Euplectes orix nigrifrons*		x		
Speckled pigeon	*Columba guinea*		x		
Speke's weaver	*Ploceus spekei*	x	x		
Spur-winged lapwing	*Venellus spinosus*	x		x	X
Common Squacco hero	*Ardeola ralloides*	x	x		
Square-tailed drongo	*Dicrurus ludwigii sharpei*	x			
Vitelline masked weaver	*Ploceus velatus uluensis*	x	x		
Water thick knee	*Burhinus v. vermiculatus*		x		
Chest nut crowned	*Plocepasser superciliosus)*	x			
White eyed slaty flycatcher	*Melaenornis f. fischeri*	x	x		
White faced whistling duck	*Dendrocygna viduata*	x	x		
White headed buffalo weaver	*Dinemellia dinemelli boehmi*	x	x		
White stork	*Ciconia c. ciconia*	x	x		
White-bellied go-away bird	*Criniferoides laucogaster*	x			
White-throated bee-eater	*Merops albicollis*	x	x		
African White-winged dove	*Streptopelia reichenowi*	x			
Wood sandpiper	*Tringa glareola*		x		
Yellow billed stork	*Mycteria ibis*	x			
Yellow crowned bishop	*Euplectes afer ladoensis*		x		
African drongo			x	x	
African mourning dove		x			
African pied wagtail			x	x	
Archers' Robbin chat		x			
black headed			x		
Black headed shrike			x		
Black Headed Weaver			x	x	X
Black kite	*Mulvus nigrans*		x		
Black treaded			x		
Black-headed bushshrike			x		
Black-headed gull	*Lavus viribundus*		x		
brown head sparrow		x			
Bush shrike			x		
Cape eagle owl	*Bubo capensis*		x		
Cisticola			x	x	
Common Names	*Scientific Names*				
d'Arnaud's barbet	*Tracchyphonus darnaudii*	x			
Emerald spotted wood dove	*Turtier charearpilas*	x			
Heuglins bustard	*Neoti heuglinii*		x	x	
Eurassioan cuckoo	*Cuculus canorus*		x		

Fiscal shrike			x	x
Francolin			x	x
Golden backed weaver	*Ploceus xanthops*	x		
Green wood head		x		
Grey-headed sparrow	*Pasa griseus*		x	
Hadada			x	x
Kingfisher			x	x
Klaas's cuckoo	*Chrysococcya klaas*		x	
Little Grebe	*Trachyphonus roficollis*		x	
Long crested eagle	*Lephatus accipitalis*		x	
Long tailed widowbird			x	
Marabou			x	
Marked weaver			x	
Pin-tailed whydah			x	
Red eyed dove	*Streptopelia senitorquaka*	x	x	x
Red-throated bee eater	*Merops bullocki*		x	
Reuppel's long-tailed starling			x	x
Rueppel's robin chat	*Cossypha semiluva*		x	
Speckled mouse bird			x	x
superb starling	*Lamprotornis superbus*	x	x	
Tropical boubou	*Laviavus aethiopicus*		x	
Warblers		x		x
Wattled starling		x		
Wahlberg's eagle	*Aquiva walbergi*		x	x
White billed buffalo weaver	*Blubalornis albirostris*	x		
white browned coucal		x	x	
Yellow wagtail			x	

4.2.3 Insect Studies

Of all categories of biodiversity, arthropods are the most susceptible to applications of tsetse control technologies. We have therefore taken special attention to survey insects in every one of the transects studied to establish the types present. This survey did not include tsetse flies as they are covered separately in another study. Appendix 5 lists the species of insects observed in different land use types in Suba - Homa Bay; Busia – Siaya – Bondo; Rachuonyo – Nyando; Baringo; Kitui; Mbeere; Mwingi and Meru North

4.2.4 Butterflies

Butterflies and tsetse flies are insects sensitive to the same pesticides. One could suppose that the tsetse control directly affects the other insects. In fact, both types of insects are not attracted by the same targets: the risk for butterfly to be killed by the tsetse control procedure is very low.

Moreover, butterflies are sensitive indicators of changing environmental conditions. During the early stages, the caterpillars, and later the adult butterflies depend on host plants: the species are attached to specific plants or groups of plants. The change of vegetation resulting on the evolution of landscape and the extension of cropping areas indirectly affects the butterfly populations.

Butterflies belong to one of the best-known order of invertebrates, the Lepidopterae, due to the enthusiasm of butterfly collectors. They are colourful, often handsome, and readily identified.

The objective of the present work is to conduct a survey of the butterfly diversity in very precise sample areas, the data representing the present situation (T_0) of the biodiversity in these areas. These data will be available for future studies in order to monitor the evolution of biodiversity.

There is a strong influence of *Graminaceous* Grass Species where the majority of the *Hesperid*/Skipper Butterflies are grass feeders and both influence of *Cymbopogon, Cynodon, Imperata, Hyparrhenia* are all host plants. Three species, which are living in the farmer fields, are the *Acraea acerta*, which will feed on the cultivated Sweet Potato *Ipomoea batatas* and the Swallowtail Butterflies *Papilio demodocus*, *Papilio nireus* that will feed on the *Rutacae* Citrus Oranges. *Toddlia* sp. The figtree species are usually important host plants for butterflies but there was scant evidence of association in the area surveyed.

Our thoughts are that man's influence on the environment, which is much greater than any tsetse control programme and may be as a result of a lesser *Glossina* (Tsetse) pressure, might make arable agriculture more feasible.

There are certain Pioneer species, which occur in/around cultivated land often related to the foodplants that occur as a result of land preparation. There are only 2 species of Butterflies that have been known to be of pest status economic importance on crops in Uganda (nearby). *Acraea acerata* which breeds on Sweet Potato- *Ipomoea batatus* and the second is the citrus Swallowtail butterfly *Papilio demodocus* both species occur frequently in the study areas.

The following are pioneer species in Busia tsetse control areas and if found to occur in future studies will show the influence of man on the environment.

Species		**Food Plant**
P. demodocus	Citrus Swallowtail	*Rutacae Citrus*
P. nireus	Narrow Green Banded Swallowtail	*Rutacae Citrus*
Catopsilia florella	African Migrant	*Cassia africana*
Eurena hecabe	Common Grass Yellow	*Cassia spp.*
E. brigitta	Samll Grass yellow	*Cassia spp.*
Belenois creona	African Caper Whittle	*Maerua spp.*
Mylothris chloris	Western Dotted Border	*Loranthaceae (Mistletoes)*
Deudorix antalus	Brown Playboy	Seed/Pods many species
Lampides boeticus	Pea Blue	*Leguminosae Pods*
Danaus chrysippus	*African Monarch*	*Milkweed Gomphocarpus*
Leptotes pirothous	Common Zebra Blue	*Leguminosae Pods*
Ypthima asterope	Common three Ringlet	*Annual grasses (spp.)*
Junonia sophia	Little Commodore	*Asystasia*
Junonia chorimene	Golden Pansy	*Asystasia*
Acraea eponina	Orange Acraea	*Triumfetta spp.*
Acraea acerata	Falls Acraea	*Ipomoea spp.*

Following species currently occur, but may disappear with human population pressure:

Species		**Foodplant**
Mylothris rubricotata	Eastern Swamp Dotted Border	*Polygonum spp.*
Euchrysops albistrictus	Cupid species	Terestrial sp. Ant living
Thermoniphas togara	Cupid species	?
Ypthimamorpha itonia	Swamp Ringlet	Swamp Grass
Pseudoargynnis hegemone	False fritillary	*Dissotis* sp.
Prooepalpus styla	Sylph species	?

4.2.4 Butterfly surveys in Teso District

In Teso the survey was conducted in Angurai on the slopes of Mt. Elgon where tsetse infestation is considered to be very high and is a focus for tsetse control under PATTEC.

In Angurai, the pioneer butterfly species that are recognized of man's interventions are the following:

Species		**Food Plant**
P. demodocus	Citrus Swallowtail	*Rutacae Citrus*
P. nireus	Narrow Green Banded Swallowtail	*Rutacae Citrus*
Catopsilia florella	African Migrant	*Cassia africana*
Eurena hecabe	Common Grass Yellow	*Cassia spp.*
E. brigitta	Small Grass yellow	*Cassia spp.*
Belenois creona	African Caper Whittle	*Merua spp.*
Mylothris chloris	Western Dotted Border	*Loranthaceae* (Mistletoes)
Deudorix antalus	Brown Playboy	Seed Pods many species
Lampides boeticus	Pea Blue	*Leguminosae* Pods
Leptotes pirothous	Common Zebra Blue	*Leguminosae* Pods
Danaus chrysippus	African Monarch	Milkweeds *Gomphocarpus*
Ypthima asterope	Common three Ringlet	Annual grass sp.
Junonia sophia	Little Commodore	*Asystasia*
Junonia chorimene	Golden Pansy	*Asystasia*
Acraea eponina	Orange Acraea	*Triumfetta* spp.
Acraea acerata	Falls Acraea	*Ipomoea spp.*
Papilio dardanus	Mocker Swallowtail	*Rutacae, Teclea*
Charaxes picta	Viola Charaxes	*Albizza spp.*
Eurytela dryope	Golden Piper	*Ricinus,Tragia*

Among the species, which might disappear with human cultivation and intervention:

Zerites nerine	Northern Gem	?Ant associated
Epamera iasis	Iasis Sapphire	*Loranthaceae*
Euchrysops albistriatus	Cupid species	Terrestrial ant living
Junonia coelestina	Western Commodore	*Acanthaceae*

SECTION 5

SURVEY ON SOILS

5.1 Introduction

Soil is a naturally occurring capital existing as an environmental asset such as the atmosphere, water, forests, fish, wildlife, and wetlands. Human activities have steadily deteriorated the state of these natural capital assets reducing their ability to deliver goods and services. Soil fertility decline for example has become an important limiting factor to economic development in Sub Saharan Africa, therefore the need to move to areas that have challenges such as the tsetse prone areas in Kenya. This report therefore looks at soil fertility in relation to land use in these tsetse belts. There are three areas of focus in PATTEC phase 1 project: the Lake Victoria basin, the Mwea-Meru tsetse belt and the Baringo transect.

Figure 5.1 General description and land use of study area

The districts of Busia, Siaya, Bondo, Rachuonyo, Nyando, Kisumu, Suba and Homabay are located in Western Kenya in the Lake Victoria basin. This is one of the tsetse prone areas of Kenya (Figure 5.1). Busia district boarders Uganda to the West while Lake Victoria is 70km south of Busia town. The districts have a bimodal rain pattern with the first long rains falling between March and May and the short rains falling between October and December.

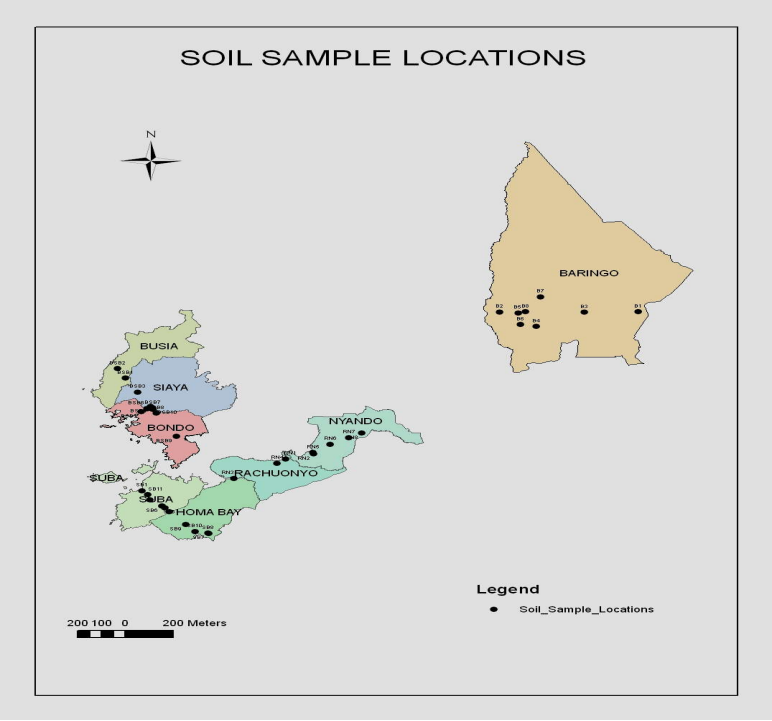

Figure 5.1. Soil sampling sites in the PATTEC study areas in Kenya

Subsistence farming is the main human activity that supports livelihoods in the region (Table 5.1). The main crops that are grown for food include cassava, maize, beans, sorghum, sweet potatoes, bananas, simsim, and a number of other subsistence crops. Cotton, sugar cane, tobacco and pepper are the main cash crops. In addition to cultivation, livestock keeping is practiced and the local breeds and cross breeds are kept either in free range or under zero grazing systems. Several farmers in the peri-urban areas keep exotic cattle under zero grazing in an effort to improve productivity per unit area of land. This is mainly because they have very small land parcels. There are a few areas that are under natural vegetation such as bush land, swamps, woodland and grassland. However there is a lot of encroachment into these areas mainly due to population pressure and the quest for more farmland.

Table 5.1. Site sampled and the land use in the Lake Victoria Basin Region

TRANSECT NAME	LOCATION	Sub-Location	LAND USE
BUSIA	Bwiri	Bwiri	Agriculture
	Agenga	Agenga	Agriculture
SIAYA	S.W Alego	Kaugagi	Agriculture
	S. Alego	Bar Olengo- Karemo division	Bushland
	S.C Alego	Kadenge	Swamp
	S. C .Alego	Kadenge	Bushland
	S.C Alego	Kadenge	Swamp
BONDO	Maranda	Usire	Agriculture
	Rarrieda Div-Nyaguko Loc	Nyaguko	Agriculture
	Othach	Othach	Bushland
RACHUONYO	Kadel		Bushland
	Kobuya	Kobuya East	Agriculture
	Rakiyaro		Bushland
	Kanyaluo West		Agriculture
	Rambira	Yuth	Agriculture
NYANDO	Nyalunya	West Kabuoch	Agriculture
	Gem Rae	Koloo	Agriculture
	Awasi	Ayweyo	Shrubs
	Awasi	Pala	Agriculture
SUBA	Kaksingri east	Central(Sindo)	Agriculture
	Kaksingri West	Rangua East	Agriculture
	Ruma	Ruma	Grassland
	Ruma	Ruma	Grassland
	Ruma	Ruma	Bushland
	Ruma	Ruma	Bushland
HOMABAY	South Kabuoch	Koguta	Woodland
	South Kabuoch	Koguta	Woodland
	Miranga	North Kobura	Agriculture
	South Kanyikela	Koguta	Agriculture

5.2 General soils description in the study sites

5.2.1 The Lake Victoria Basin

Busia

Busia district is in western Kenya and borders Uganda on the west. Mt. Elgon is a major landmark in the area it is north of Busia town. The area is relatively dry and in the northern and central parts of the district, poor parent materials prevail: granites, sandstones and mudstones. In the southern part intermediate igneous rocks predominate. Acrisols are by far the most common soil type in the district. In north Busia the soils are developed on granites. In Central Busia soils are developed on sandstones and arkoses. These are shallow to deep, Ferralo-orthic Acrisols and Ferralsols, mostly overlying petroplinthite, are prevalent. Swamp soils occur in the south and are mainly humic Gleysols and are developed on alluvial deposits.

Homa bay

Homa bay district is characterized by heavy textured soils that are almost exclusively developed on basic igneous rocks that are Vertisols, Gleysols, Planosols and vertic subgroups of other soil orders. There are also moderately deep haplic and verto-luvic Phaeozems. The Phaeozems are relatively well drained, deep and of high inherent fertility. The soils are non saline, non sodic with a friable to firm consistency and have a high moisture holding capacity. The vertisols are poorly drained and can be water logged. Generally, the soils are suitable for cotton, sorghum, maize, cowpeas and beans.

Kisumu

Kisumu district is on the shores of Lake Victoria in western Kenya. In the uplands, foot slopes and plateau areas of the district are characterized by soils developed on granites and intermediate igneous rocks. Around Awach in the northern part of the district has shallow and moderately deep ferralo-orthic Acrisols, overlying petroplinthite. This unit has a wide distribution in western province and Siaya district. The plateau south of Maseno and around Kisumu town have very deep nito-rhodic Ferralsols, shallow ferralic and dystic Cambisols, overlying hard rock. On the plains we have poorly drained soils developed on alluvial deposits. In the Miwani area and the Awasi area the soils are mainly chromic Vertisols and verto-eutric planosols. In the eastern part of the district around Koru are chromic Vertisols. The swamps in the district has poorly drained and waterlogged soils developed on alluvial deposits. These are mainly humic Gleysols and dystic Histosols found in the swamps around Lake Victoria.

5.2.2 Meru-Mwea tsetse belt

Meru district

The Meru district is situated around the eastern slopes of Mt. Kenya. On the northern side the rainfall is scattered due to the rain shadow of the mountain. Here wheat and barley are grown on large scale farms. Further north the rain is even more scarce and the area is not suitable for farming except for early maturing millet varieties. On the south-western parts of Meru are the Aberdares-Mount Kenya toposequence. The soils here are mainly humic Andosols developed on basic igneous rocks. Eutric Nitisols has a wide distribution in the district. The northern parts of the district have shallow soils near Isiolo and moderately deep to very deep soils around Kangeta. The humic Nitisols found around Kaguru are well drained, extremely deep, of high inherent fertility with an acid humic topsoil that is non saline, non sodic with very high moisture holding capacity. The nito-rhodic Ferralsol soils around Tunyai are well drained, of poor inherent fertility with a non-humic topsoil properties. The soils are very deep, dark reddish brown to dusky red in color and consist of very friable to friable clay. The soil structure is weak to moderate sub-angular blocky and very high soil bioporosity.

Embu

Embu district is situated in the Eastern Province of Kenya. The soils are predominantly Andosols, Ferralsols and Cambisols. Andosols are deep reddish-brown friable clays, acidic and suffer from low nutrient availability especially Phosphorus as well as aluminium and manganese toxicities. The staple crops are maize and beans, but farmers also grow Irish potatoes, and a wide range of fruits and vegetables. There is a steady decline in soil fertility in this region mainly attributed to crop residue removal, soil erosion and leaching combined with low inputs of organic and mineral fertilizers. Soil fertility and its management is however influenced by the inherent properties of the soil, land use and cropping history, livestock and land ownership.

Kitui

A vast majority of the soils in the area East of Tseikuru in Mwingi district can be classified as rhodic Ferralsols. These are coarse textured ferralo-chromic Acrisols and ferralic Arenosols but parts are highly alkaline. West of this area we have predominantly moderately deep to deep chromic Luvisols and Cambisols. These are mainly sandy clay loams. The district has patches of pellic Vertisols especially in the Yatta plateau. The Acrisols are well drained deep but with poor inherent fertility. There is little humus in

the top soil giving it high friability with little ability to store excess water. The area is suitable for maize, pigeon peas, sorghum, cowpeas and cotton when the rains are favorable.

5.2.3 Baringo

In the Baringo cluster soils were sampled from 8 locations across the district. The area is characterized by bush land, woodland and forest with small areas under agriculture (Table 5.2). The district is mainly semi arid to arid (ASAL) with low rainfall that can hardly support agricultural production. 35% of the district is semi-arid and therefore very risky for rainfed agriculture. The average annual rainfall ranges from less than 500mm in the inner lowlands to >1400mm in the higher areas around Kabartonjo and south of the district. There is a lot of contrast in the rainfall variability within the district from 50mm to >450mm in the March to May rains and <100mm to >600mm in the October to December rains. The district is classified as livestock-sorghum and livestock-millet zones (UM 5 and LM 5). Water harvesting in dams and irrigation are the only viable means of crop production as is seen in Perkera irrigation scheme in Marigat. The main crops grown in the wetter areas are maize, beans, millet, sorghum, groundnuts and wheat. However a wide range of horticultural crops such as onions, pepper, water melon, pawpaw, banana and tomato are grown under irrigation.

Table 5.2 Sampling sites and land use in Baringo district

TRANSECT NAME	LOCATION	Sub-Location	LAND USE
BARINGO	Arabal	Nyalecha	Bushland
	Kabutei	Kabutei	Bushland
	Bartum	Kampi Samaki	Agriculture
	Morop-Tirikwir village	Morop	Agriculture
	Katiorin	Kapkirwok	Woodland
	Kabarnet	Kaptimbor	Woodland
	Saimo	Saimo	Forest
	Ossen	Pemwai	Forest

The soils in the district vary greatly and can be classified into four large areas:

i) Kerio valley

ii) Tugen hills around Kabarnet

iii) Main Rift valley

iv) Baringo South around Eldama Ravine

Kerio valley

The soils on the eastern banks of the Kerio river are predominantly saline, sodic and /or calcarious, thus range from deep Orthic Solonchaks, calcic Cambisols, calcic Fluvisols to calcic Xerosols.

Tugen hills

The soils here are developed on undifferentiated tertiary volcanic rocks (olivine basalts, rhylites, andesites) and ashes of older volcanos. There are also some shallow Lithosols and shallow to moderately deep chromic Cambisols surrounding predominantly very deep eutric and dystric Nitisols.

Main Rift Valley

The soils are developed on basic igneous rocks. 50% of the Rift Valley area in Baringo district are moderately deep, ando-chromic cambisols in the bouldery phase. Lava flows, flood plains and piedmont plains predominate around and north of Lake Baringo.

Baringo south

The soils here are developed on basic igneous rocks. The major agricultural areas in Baringo district is around Eldama Ravine. It comprises extremely deep eutric Nitisols and deep to very deep nito-chromic Luvisols and a complex of the two

.

5.3 Soil sampling and analysis

A total of 70 soil samples were collected from three tsetse prone sites in the Lake Victoria basin, the Meru-Mwea tsetse belt and the Lake Baringo cluster. The soil samples represent different land use systems in these areas ranging from forest to agricultural land.

Objective

To determine the soil fertility levels based on the chemical and physical soil characteristics as affected by the land use.

5.3.1 Methodology

A visit was made to each of the sites above and composite soil samples collected based on the land use systems in the areas. Three soil samples were collected per land use and soil type randomly at 20cm depth, mixed together to give one composite sample. Half a kilo of the composite sample was then put in a plastic paper bag and properly labeled indicating the sample number, land use and area where collected. GPS points were also used to indicate the point of sampling. The visits were district based as follows: The lake Victoria Basin: Bondo, Busia, Homabay, Kisumu, Nyando, Rachuonyo, Siaya, and Suba. In the Meru-Mwea tsetse belt the districts are: Embu, Isiolo, Kitui, Kirinyaga, Machakos, Makueni, Maragua, Mbeere, Meru central, Meru North, Muranga, Mwingi, Tharaka and Thika. In the Lake Baringo cluster, there is Baringo and Marakwet.

The soils were analyzed at the National Agricultural Research Laboratories (NARL) using the Mehlich double acid method (Mehlich et al., 1964; Hinga et al., 1980). Soil samples were oven dried at 45^{o}C, crushed and sieved to 2 mm to increase the surface area for better chemical reaction. All soil analysis was carried out on the soil fraction < 2mm. Approximately 5g of the soil was extracted for 5 minutes with 25ml 0.1N HCl + 0.025N H_2SO_4.

pH and electrical conductivity (EC)

These were determined in a 1:1 and 2.5 soil-water suspensions, respectively. EC was done to soils with pH > 7.0. The soil suspension was read using a glass-calomel electrode while the EC was read using an EC meter.

Organic carbon (%) and total nitrogen (%)

Total C was analyzed using calorimetric method while total N was determined using the Kjeldahl method (Anderson and Ingram, 1993). The total N was determined calorimetrically on a flow analyzer.

Other nutrients (P, K, Ca, Mg, Na and Mn)

Elements such as Ca, K and Na were determined by flame electron spectrometry (FES) after treating the filtered extract with dilute mineral acid (0.1 N HCl + 0.025N H_2SO_4) at a ratio of 1:5 for one hour and for Ca with anion resin. Determination of Mg and Mn were done by reading directly from the Atomic absorption spectrophotometer (AAS).

P-Olsen (for soils with pH > 7.0)

Soils were extracted using 0.5NaHCO3 of pH 8.5 for ½ hour giving a soil extractant of 1:5. To this extractant, was added a reagent mixture of H2SO4, ammonium molybdate, ascorbic acid and antimony potassium/titrate solution. The color intensity was measured using the spectrophotometer or a calorimeter. The color intensity is proportional to the P concentration in the extract and hence the soil (Watanabe and Olsen, 1965).

Analysis of trace elements Fe, Zn, Mn and Cu

The trace elements Iron, Zinc and Copper were extracted from the finely ground soil by dilute HCl (0.1N HCl) as described by Hinga *et al* (1980). The soils were extracted for one hour at a soil:extract ratio of 1:10. The extracts were filtered using filter paper 1. Fe, Zn, Mn and Cu concentrations were read from the AAS with specific lamps for each element. The results were given in parts per million (ppm)

Table 5.3 Meru soil properties

	Soil Analytical Data							
Field	**Meru National park, Meru swamp**				**Meru bushland**			
Sample Ref.	**1**		**2**		**1**		**2**	
Lab. No/2008	1211		1212		1213		1214	
Fertility results	value	class	value	Class	value	class	value	class
Soil pH	7.58	medium alkaline	7.89	medium alkaline	6.97	near neutral	6.48	slight acid
Total Nitrogen %	0.23	adequate	0.29	adequate	0.23	adequate	0.22	adequate
Org. Carbon %	2.25	moderate	2.88	adequate	1.63	moderate	2.45	moderate
Phosphorus ppm	71	high	13	adequate	141	high	235	high
Potassium me%	1.58	high	0.90	adequate	1.94	high	1.52	high
Calcium me%	32.8	high	10.4	adequate	11.8	adequate	9.8	adequate
Magnesium me%	9.02	high	7.47	High	7.89	high	8.48	high
Manganese me%	0.81	adequate	0.96	adequate	0.70	adequate	0.69	adequate
Copper ppm	6.60	adequate	0.52	Low	6.39	adequate	3.95	adequate
Iron ppm	165	adequate	4.81	Adequate	41.7	adequate	44.8	adequate
Zinc ppm	3.87	low	trace	Low	2.75	low	5.35	low
Sodium me%	3.78	high	0.86	Adequate	0.92	adequate	0.82	adequate
Elect. Cond. mS/cm	0.75	adequate	0.55	High				
Field	**Meru National park, Meru grassland**				**Meru forest**			
Sample Ref.	**1**		**2**		**1**		**2**	
Lab. No/2008	1215		1216		1217		1218	
Fertility results	value	class	value	Class	value	class	value	class
Soil pH	6.53	slight acid	6.30	slight acid	6.67	near neutral	6.86	near neutral
Total Nitrogen %	0.20	adequate	0.16	Low	0.33	adequate	0.33	adequate
Org. Carbon %	1.91	moderate	2.18	Moderate	7.08	high	6.06	high
Phosphorus ppm	61	adequate	142	High	79	adequate	87	adequate
Potassium me%	1.50	adequate	1.32	Adequate	1.16	adequate	1.30	adequate
Calcium me%	7.6	adequate	8.0	Adequate	8.8	adequate	8.8	adequate
Magnesium me%	7.62	high	7.77	High	6.19	high	7.36	high
Manganese me%	0.70	adequate	0.72	Adequate	0.81	adequate	0.66	adequate
Copper ppm	0.67	low	5.31	Adequate	1.01	adequate	1.64	adequate
Iron ppm	15.8	adequate	50.7	Adequate	11.5	adequate	17.9	adequate
Zinc ppm	2.73	low	2.53	Low	23.7	adequate	28.8	adequate
Sodium me%	0.50	adequate	0.54	Adequate	0.74	adequate	0.66	adequate
Field	**Meru agriculture**				**Embu forest**		**Mbeere/Embu forest**	
Sample Ref.	**1**		**2**				**2**	
Lab. No/2008	1219		1220		1221		1222	
Fertility results	value	class	value	Class	value	class	value	class
Soil pH	6.52	slight acid	6.28	slight acid	5.80	medium acid	4.93	strong acid
Exch. Acidity me%							1.0	high

Total Nitrogen %	0.26	adequate	0.26	Adequate	0.32	adequate	0.32	adequate
Org. Carbon %	2.31	moderate	2.44	Moderate	3.84	adequate	4.19	adequate
Phosphorus ppm	134	adequate	76	Adequate	34	adequate	19	low
Potassium me%	2.12	high	1.68	High	1.34	adequate	0.90	adequate
Calcium me%	12.0	adequate	8.6	Adequate	8.8	adequate	8.8	adequate
Magnesium me%	7.52	high	6.89	High	6.30	high	4.00	high
Manganese me%	0.75	adequate	0.82	Adequate	1.16	adequate	1.29	adequate
Copper ppm	4.62	adequate	5.07	Adequate	0.90	low	0.37	low
Iron ppm	83.9	adequate	101	Adequate	36.1	adequate	27.9	adequate
Zinc ppm	35.5	adequate	14.3	adequate	25.0	adequate	24.2	adequate
Sodium me%	0.88	adequate	0.58	adequate	0.72	adequate	0.86	adequate

Table 5.4 Mbeere soil properties

	Soil Analytical Data							
Field	**Mbeere bushland**				**Mbeere agriculture**		**Mbeere woodland**	
Sample Ref.	**P1Q1**		**Q1+Q2**		**P5Q2**		**1**	
Lab. No/2008	1223		1224		1225		1226	
Fertility results	value	class	value	Class	value	class	value	class
Soil pH	6.94	near neutral	7.10	slight alkaline	6.90	near neutral	6.03	slight acid
Total Nitrogen %	0.22	adequate	0.23	Adequate	0.20	adequate	0.22	adequate
Org. Carbon %	2.14	moderate	1.77	Moderate	1.68	moderate	2.14	moderate
Phosphorus ppm	95	adequate	5	Low	162	high	20	low
Potassium me%	1.00	adequate	1.06	Adequate	1.54	high	0.58	adequate
Calcium me%	8.6	adequate	7.6	Adequate	8.8	adequate	7.6	adequate
Magnesium me%	3.51	high	4.75	High	4.06	high	4.27	high
Manganese me%	0.56	adequate	0.53	Adequate	0.49	adequate	0.30	adequate
Copper ppm	1.60	adequate	2.62	Adequate	1.70	adequate	1.08	adequate
Iron ppm	18.6	adequate	18.9	Adequate	52.2	adequate	24.9	adequate
Zinc ppm	3.65	low	2.32	Low	16.8	adequate	1.50	low
Sodium me%	0.82	adequate	0.64	Adequate	0.62	adequate	0.86	adequate
Elect. Cond. mS/cm			0.35	Adequate				
Field	**Embu agriculture**		**Meru (Mavyani) grazing area**		**Meru (Kamburu) bushland**		**Mbeere (Kamburu dam)**	
Sample Ref.	**composite**				**P2Q1**		**P1Q2+Q1**	
Lab. No/2008	1227		1228		1229		1230	
Fertility results	value	class	value	Class	value	class	value	class
Soil pH	6.59	slight acid	6.68	slight acid	5.93	medium acid	5.77	medium acid
Total Nitrogen %	0.20	adequate	0.19	Low	0.12	low	0.12	low
Org. Carbon %	1.44	moderate	1.78	Moderate	0.70	low	0.80	low
Phosphorus ppm	29	adequate	50	Adequate	11	low	5	low
Potassium me%	1.24	adequate	1.10	Adequate	0.50	adequate	0.44	adequate

Calcium me%	4.6	adequate	8.8	Adequate	5.8	adequate	5.8	adequate
Magnesium me%	3.32	high	6.43	High	0.94	low	0.48	low
Manganese me%	0.43	adequate	0.93	Adequate	0.36	adequate	0.30	adequate
Copper ppm	1.26	adequate	4.37	Adequate	0.62	low	0.53	low
Iron ppm	20.5	adequate	36.4	Adequate	16.7	adequate	19.7	adequate
Zinc ppm	6.90	low	4.67	Low	0.54	low	0.46	low
Sodium me%	0.92	adequate	0.82	Adequate	0.66	adequate	0.70	adequate

Field	**Mbeere woodland**		**Forest woodland Kitui**		**Woodland Kitui P5**		**Kitui woodland**	
Sample Ref.	**2**		**1**		**2**		**composite 1**	
Lab. No/2008	1231		1232		1233		1234	
Fertility results	value	class	value	class	value	class	value	class
Soil pH	5.93	medium acid	7.30	slight alkaline	7.57	medium alkaline	6.93	near neutral
Total Nitrogen %	0.09	low	0.24	adequate	0.31	adequate	0.17	low
Org. Carbon %	0.31	low	1.88	moderate	2.14	moderate	1.39	moderate
Phosphorus ppm	6	low	50	high	78	high	235	high
Potassium me%	0.16	low	0.68	adequate	1.40	adequate	1.24	adequate
Calcium me%	5.2	adequate	6.8	adequate	8.8	adequate	7.6	adequate
Magnesium me%	0.12	low	6.25	high	7.51	high	2.80	adequate
Manganese me%	0.09	low	0.68	adequate	0.72	adequate	0.28	adequate
Copper ppm	0.52	low	5.46	adequate	1.55	adequate	1.00	adequate
Iron ppm	17.3	adequate	37.9	adequate	43.3	adequate	91.6	adequate
Zinc ppm	0.61	low	5.86	low	9.29	adequate	4.98	low
Sodium me%	0.70	adequate	0.74	adequate	0.70	adequate	0.64	adequate
Elect. Cond. mS/cm			0.22	adequate	0.50	adequate		

Table 5.5 Kitui & Baringo soil properties

	Soil Analytical Data							
Field	**Kitui bushland**		**Agriculture Kitui forest**		**B4 bushland 0.59711**		**Kitui-Kanziku agriculture**	
Sample Ref.	**P1Q1 & Q2**		**P6Q1 & Q2**		**36.20376**		**1**	
Lab. No/2008	1235		1236		1237		1238	
Fertility results	value	Class	value	class	value	class	value	class
Soil pH	7.39	Slight alkaline	7.54	medium alkaline	6.40	slight acid	7.93	medium alkaline
Total Nitrogen %	0.19	Low	0.17	low	0.25	adequate	0.19	low
Org. Carbon %	1.08	Low	1.17	low	0.90	low	0.33	low
Phosphorus ppm	16	Adequate	48	high	25	low	13	adequate
Potassium me%	1.24	Adequate	0.90	adequate	1.76	high	2.36	high
Calcium me%	6.6	Adequate	9.6	adequate	11.8	adequate	7.6	adequate
Magnesium me%	2.90	Adequate	3.21	high	5.37	high	3.53	high

Manganese me%	0.59	Adequate	0.60	adequate	1.39	adequate	0.51	adequate
Copper ppm	2.39	Adequate	1.62	adequate	0.84	low	1.21	adequate
Iron ppm	4.68	Low	6.01	low	8.04	low	4.10	low
Zinc ppm	2.85	Low	47.6	adequate	8.31	adequate	2.76	low
Sodium me%	0.62	Adequate	0.74	adequate	0.70	adequate	0.62	adequate
Elect. Cond. mS/cm	0.35	Adequate	0.45	adequate			0.45	adequate

Field	**Kitui bushland**		**Baringo Saimo**				**Baringo Osen**	
Sample Ref.	**2, P4Q1 & Q2**							
Lab. No/2008	1239		1240		1241		1242	
Fertility results	value	class	value	class	value	class	value	class
Soil pH	6.76	near neutral	6.43	slight acid	6.32	slight acid	6.27	slight acid
Total Nitrogen %	0.21	adequate	0.20	adequate	0.21	adequate	0.16	low
Org. Carbon %	1.12	low	2.05	moderate	2.02	moderate	2.12	moderate
Phosphorus ppm	205	high	65	adequate	60	adequate	63	adequate
Potassium me%	1.02	adequate	0.82	adequate	0.82	adequate	0.90	adequate
Calcium me%	7.8	adequate	7.8	adequate	7.0	adequate	6.8	adequate
Magnesium me%	3.00	adequate	9.29	high	9.42	high	8.58	high
Manganese me%	0.56	adequate	0.58	adequate	0.54	adequate	0.59	adequate
Copper ppm	3.13	adequate	3.28	adequate	3.34	adequate	2.57	adequate
Iron ppm	52.9	adequate	69.6	adequate	69.5	adequate	75.6	adequate
Zinc ppm	2.26	low	2.93	low	2.17	low	2.45	low
Sodium me%	0.72	adequate	0.82	adequate	0.90	adequate	0.64	adequate
Field	**Baringo bushland N-0.59698**		**Agriculture Baringo, Sesila Village 35.80698**		**Baringo Kabutie 0.60876**		**B13 Baringo 0.59848**	
Sample Ref.	**E-36.27435**		**0.49497**		**35.56917**		**36.01837**	
Lab. No/2008	1243		1244		1245		1246	
Fertility results	value	class	value	class	value	class	value	class
Soil pH	5.49	medium acid	5.92	medium acid	6.51	slight acid	6.94	near neutral
Exch. Acidity me%	0.3	adequate						
Total Nitrogen %	0.18	low	0.24	adequate	0.18	low	0.22	adequate
Org. Carbon %	1.58	moderate	2.41	moderate	1.39	moderate	1.39	moderate
Phosphorus ppm	19	low	67	adequate	38	adequate	259	high
Potassium me%	1.18	adequate	1.00	adequate	1.14	adequate	1.20	adequate
Calcium me%	5.2	adequate	5.8	adequate	7.2	adequate	13.6	adequate
Magnesium me%	3.53	high	3.17	high	3.22	high	6.73	high
Manganese me%	1.10	adequate	1.50	adequate	1.74	adequate	0.57	adequate
Copper ppm	1.00	adequate	0.89	low	1.00	adequate	1.73	adequate
Iron ppm	47.1	adequate	11.7	adequate	26.7	adequate	21.4	adequate
Zinc ppm	3.66	low	14.2	adequate	7.58	adequate	4.86	low
Sodium me%	0.42	adequate	0.48	adequate	0.62	adequate	1.50	adequate

Field	B14 Baringo North 0.58287		Baringo Kambi Samaki 0.59161		Mwingi woodland		Mwingi bushland	
Sample Ref.	**35.92956**		**30.18378**		**2, P1Q1**		**2, P1Q2**	
Lab. No/2008	1247		1248		1249		1250	
Fertility results	value	class	value	class	value	class	value	class
Soil pH	7.26	slight alkaline	7.52	medium alkaline	6.85	near neutral	7.05	slight alkaline
Total Nitrogen %	0.23	adequate	0.15	low	0.17	low	0.06	low
Org. Carbon %	1.31	low	0.71	low	1.76	moderate	0.97	low
Phosphorus ppm	30	high	18	adequate	33	adequate	10	adequate
Potassium me%	1.36	adequate	3.24	adequate	0.96	high	0.66	high
Calcium me%	9.4	adequate	13.6	adequate	6.4	adequate	7.0	adequate
Magnesium me%	8.36	high	6.09	high	2.68	adequate	3.68	high
Manganese me%	0.62	adequate	1.71	adequate	0.72	adequate	0.61	adequate
Copper ppm	1.71	adequate	0.82	low	1.07	adequate	3.10	adequate
Iron ppm	28.3	adequate	64.6	adequate	0.10	low	31.8	adequate
Zinc ppm	6.89	Low	4.09	low	1.78	low	1.94	low
Sodium me%	0.86	adequate	0.90	adequate	0.58	adequate	0.72	adequate
Elect. Cond. mS/cm	0.70	adequate	0.65	adequate			0.21	adequate

Table 5.6 Mwingi soil properties

	Soil Analytical Data							
Field	**Mwingi agriculture**		**Nuu Hills Mwingi woodlands**		**Mwingi agriculture**		**Mwingi bushland**	
Sample Ref.	**2, P2Q1+ Q1**		**P2Q1 & Q2**		**composite P1Q2**		**1, P5Q1 & Q2**	
Lab. No/2008	1251		1252		1253		1254	
Fertility results	value	Class	value	class	value	class	value	class
Soil pH	7.00	Slight alkaline	6.90	near neutral	6.95	near neutral	6.81	near neutral
Total Nitrogen %	0.19	Low	0.14	low	0.12	low	0.11	low
Org. Carbon %	1.34	moderate	1.14	low	0.46	low	0.49	low
Phosphorus ppm	12	adequate	182	high	111	high	183	high
Potassium me%	0.60	adequate	0.60	adequate	0.55	adequate	0.66	adequate
Calcium me%	6.0	adequate	5.8	adequate	5.3	adequate	7.6	adequate
Magnesium me%	4.42	High	2.33	adequate	1.32	adequate	1.79	adequate
Manganese me%	0.39	adequate	0.28	adequate	0.31	adequate	0.50	adequate
Copper ppm	2.93	adequate	0.42	low	0.89	low	2.36	adequate
Iron ppm	40.3	adequate	3.02	low	10.0	adequate	13.1	adequate
Zinc ppm	10.0	adequate	2.58	low	1.90	low	3.17	low
Sodium me%	0.62	adequate	0.62	adequate	0.54	adequate	0.84	adequate
Elect. Cond. mS/cm	0.24	adequate						

Table 5.7 Rachuonyo soil properties

	Soil Analytical Data							
Field	**Rachuonyo Kadel**		**Rachuonyo 26/4/08**		**Rachuonyo Kadel**			
Sample Ref.								
Lab. No/2008	1255		1256		1257		1258	
Fertility results	value	Class	value	class	value	class	value	class
Soil pH	6.33	slight acid	6.84	near neutral	6.25	slight acid	6.26	slight acid
Total Nitrogen %	0.35	adequate	0.09	low	0.35	adequate	0.35	adequate
Org. Carbon %	3.68	adequate	0.76	low	3.97	adequate	4.19	adequate
Phosphorus ppm	182	High	18	low	150	high	160	high
Potassium me%	1.78	High	0.40	adequate	1.80	high	2.00	high
Calcium me%	11.8	adequate	6.2	adequate	9.6	adequate	11.2	adequate
Magnesium me%	6.68	High	1.61	adequate	6.43	high	6.91	high
Manganese me%	0.98	adequate	0.21	adequate	0.99	adequate	1.08	adequate
Copper ppm	2.60	adequate	1.50	adequate	1.85	adequate	2.43	adequate
Iron ppm	60.9	adequate	16.8	adequate	71.5	adequate	74.5	adequate
Zinc ppm	10.9	adequate	2.51	low	8.61	adequate	10.0	adequate
Sodium me%	1.02	adequate	0.72	adequate	0.76	adequate	0.90	adequate

Table 5.8 Busia, Bondo & Homa Bay soil properties

	Soil Analytical Data							
Field	**Busia**						**Bondo agric. Uyoma**	
Sample Ref.								
Lab. No/2008	1259		1260		1261		1262	
Fertility results	Value	Class	value	class	value	class	value	class
Soil pH	6.28	slight acid	6.25	slight acid	6.20	slight acid	6.24	slight acid
Total Nitrogen %	0.16	Low	0.18	low	0.25	adequate	0.35	adequate
Org. Carbon %	2.23	moderate	2.15	moderate	2.17	moderate	3.55	adequate
Phosphorus ppm	82	adequate	74	adequate	70	adequate	152	high
Potassium me%	0.94	adequate	0.92	adequate	0.94	adequate	1.84	high
Calcium me%	8.8	adequate	8.0	adequate	6.8	adequate	10.2	adequate
Magnesium me%	8.37	High	8.28	high	9.90	high	7.24	high
Manganese me%	0.75	adequate	0.74	adequate	0.71	adequate	1.16	adequate
Copper ppm	3.96	adequate	3.25	adequate	4.19	adequate	2.42	adequate
Iron ppm	51.5	adequate	49.6	adequate	52.9	adequate	60.8	adequate
Zinc ppm	1.45	Low	2.48	low	2.71	low	8.23	adequate
Sodium me%	0.92	adequate	0.80	adequate	0.62	adequate	0.84	adequate
	Soil Analytical Data							
Field	**Bondo agric. Uyoma**		**Homabay extra**				**Homabay extra 2**	
Sample Ref.								
Lab. No/2008	1263		1264		1265		1266	

Fertility results	Value	Class	value	class	value	class	value	class
Soil pH	6.26	slight acid	6.41	slight acid	6.25	slight acid	6.30	slight acid
Total Nitrogen %	0.35	adequate	0.35	adequate	0.35	adequate	0.35	adequate
Org. Carbon %	3.63	adequate	3.01	adequate	3.82	adequate	3.17	adequate
Phosphorus ppm	168	High	182	high	159	high	163	high
Potassium me%	2.00	High	1.28	adequate	1.50	adequate	1.60	high
Calcium me%	11.0	adequate	7.8	adequate	9.2	adequate	9.4	adequate
Magnesium me%	6.74	High	7.00	high	6.99	high	6.87	high
Manganese me%	1.00	adequate	0.90	adequate	1.02	adequate	1.03	adequate
Copper ppm	2.56	adequate	2.49	adequate	2.87	adequate	2.86	adequate
Iron ppm	80.3	adequate	73.3	adequate	74.5	adequate	80.1	adequate
Zinc ppm	8.66	adequate	9.43	adequate	9.30	adequate	10.6	adequate
Sodium me%	0.88	adequate	0.58	adequate	0.70	adequate	0.72	adequate
Field	**Homabay Kanyidoyo agric.**				**Homabay agric. Miranga**			
Sample Ref.								
Lab. No/2008	1267		1268		1269		1270	
Fertility results	value	Class	value	class	value	class	value	class
Soil pH	6.28	slight acid	6.27	slight acid	6.28	slight acid	6.27	slight acid
Total Nitrogen %	0.34	adequate	0.34	adequate	0.34	adequate	0.34	adequate
Org. Carbon %	3.90	adequate	4.15	adequate	4.02	adequate	3.96	adequate
Phosphorus ppm	174	High	164	high	163	high	173	high
Potassium me%	1.60	High	1.44	adequate	1.60	high	1.60	high
Calcium me%	10.4	adequate	10.0	adequate	12.2	adequate	10.6	adequate
Magnesium me%	6.12	High	7.08	high	7.09	high	7.20	high
Manganese me%	1.06	adequate	1.08	adequate	1.23	adequate	1.05	adequate
Copper ppm	2.58	adequate	3.01	adequate	3.03	adequate	3.15	adequate
Iron ppm	78.4	adequate	79.3	adequate	79.1	adequate	74.9	adequate
Zinc ppm	10.9	adequate	11.4	adequate	23.3	adequate	7.79	adequate
Sodium me%	0.80	adequate	0.82	adequate	1.10	adequate	0.88	adequate
Field	**Homabay W. Kanyanwa bushland**				**Usenge Siaya**		**Bodo Siaya swamp 0.03965**	
Sample Ref.							**34.16254**	
Lab. No/2008	1271		1272		1273		1274	
Fertility results	value	Class	value	class	value	class	value	class
Soil pH	6.26	slight acid	6.27	slight acid	6.32	slight acid	6.36	slight acid
Total Nitrogen %	0.34	adequate	0.34	adequate	0.22	adequate	0.14	low
Org. Carbon %	3.44	adequate	3.65	adequate	2.31	moderate	1.13	low
Phosphorus ppm	155	High	160	high	77	adequate	30	adequate
Potassium me%	1.60	High	1.64	high	0.86	adequate	0.58	adequate
Calcium me%	9.6	adequate	10.4	adequate	6.0	adequate	6.8	adequate
Magnesium me%	6.99	High	6.11	high	8.44	high	5.40	high
Manganese me%	1.09	adequate	1.11	adequate	0.76	adequate	1.56	adequate
Copper ppm	3.05	adequate	5.03	adequate	5.81	adequate	5.63	adequate
Iron ppm	79.4	adequate	81.5	adequate	65.5	adequate	67.9	adequate

Zinc ppm	9.55	adequate	10.7	adequate	2.55	low	2.70	low
Sodium me%	0.76	adequate	0.86	adequate	0.58	adequate	0.70	adequate
Field	**Uranga S.W. Alego 0.08625**		**Uranga S.W. Alego 29/4/08**		**Nyando Gemyae 0.24502**		**Nyando**	
Sample Ref.	**34.14806**				**34.95461**		**36.01837**	
Lab. No/2008	1275		1276		1277		1278	
Fertility results	value	Class	value	class	value	class	value	class
Soil pH	6.15	slight acid	5.98	medium acid	5.29	medium acid	6.28	slight acid
Exch. Acidity me%					0.3	adequate		
Total Nitrogen %	0.11	Low	0.10	low	0.13	low	0.19	low
Org. Carbon %	0.95	Low	0.40	low	1.07	low	1.68	moderate
Phosphorus ppm	20	Low	13	low	40	adequate	59	adequate
Potassium me%	0.30	adequate	0.22	adequate	1.06	adequate	1.20	adequate
Calcium me%	5.2	adequate	5.2	adequate	8.6	adequate	9.4	adequate
Magnesium me%	1.75	adequate	1.28	adequate	4.13	high	3.83	high
Manganese me%	1.07	adequate	0.82	adequate	0.96	adequate	0.89	adequate
Copper ppm	2.95	adequate	2.46	adequate	2.93	adequate	2.34	adequate
Iron ppm	118	adequate	70.0	adequate	70.1	adequate	86.3	adequate
Zinc ppm	1.51	Low	1.33	low	4.07	low	4.39	low
Sodium me%	0.62	adequate	0.70	adequate	0.82	adequate	0.82	adequate

Table 5.9 Kisumu & Nyamasaria soil properties

	Soil Analytical Data							
Field	**S. Central Kadongo 0.03965**		**Kisumu Busia / Nyama Sario**					
Sample Ref.	**34.16254**							
Lab. No/2008	1279		1280					
Fertility results	value	class	value	class	value	class	value	class
Soil pH	6.97	slight acid	5.78	medium acid				
Total Nitrogen %	0.27	adequate	0.17	low				
Org. Carbon %	1.92	moderate	1.79	moderate				
Phosphorus ppm	261	high	37	adequate				
Potassium me%	1.58	high	0.42	adequate				
Calcium me%	5.4	adequate	2.4	adequate				
Magnesium me%	5.62	high	3.54	high				
Manganese me%	0.98	adequate	1.27	adequate				
Copper ppm	8.26	adequate	4.52	adequate				
Iron ppm	53.3	adequate	153	adequate				
Zinc ppm	8.34	adequate	7.52	adequate				
Sodium me%	0.20	adequate	0.20	adequate				

SECTION 6

Survey on Historical Changes

6.1 Introduction

Tsetse control and eradication will affect many aspects of land use, land management, grazing and cropping systems as well as the composition and distribution of many natural resources due to the absence of tsetse and trypanosomiasis. Reduced trypanosomiasis challenge will potentially allow people to have more access to the natural resources and therefore increase the intensity of their use.

Sampling on specific points along transects do provide point data that may sometimes be very limited in capturing the dynamics in time and space. To capture data at wider spatial and temporal scales on some variables, we used a questionnaire (appendix 1). The questionnaire was administered on at least 10 homesteads in different land use and land cover types along transects.

6.1.1 Rapid Appraisal

A very comprehensive questionnaire was administered in each of the eight transects in the three study areas. The three study areas are here considered as the sampling areasand that the transects help to distribute the sampling points with each of the three landscapes. The questionnaire samples within all the transects in each of the three landscapes should therefore be treated as samples for the same samplying area (the population). Due to lack of a good estimation of the population size the consultants followed the guidelines of selecting a sample size (Maitima et. al., 2007) that suggests a sample size of atleast 20 to 30 respondents. Considering each of the three areas of study as the sampling units we further randonmly distribted the samples along the trnsects and further varied the samples along land use and land cover types.

Detailed data on questionnaire administration are provided in the CD Rom accompanying this report. Here below we provide synopsis of some of the analysis on this historical surveys. The CD provides a complete database on all respondents and their geographical locations to facilitate any future monitoring of changes.

6.1.2 Land use history

Tsetse control affects land use in a number of ways. Areas where trypanosomiasis challenge has been reduced do attract cultivators and herders or mixed crop growers and livestock keepers depending on the agro-ecological zone or ecological potential of the land. This therefore either

changes the land use of the area or increases the intensity of land use depending on whether the land was occupied before or not. In the areas adjacent to the disease challenge reduced areas, the change might reduce the pressure on land due to outward migrations into the newly opened areas.

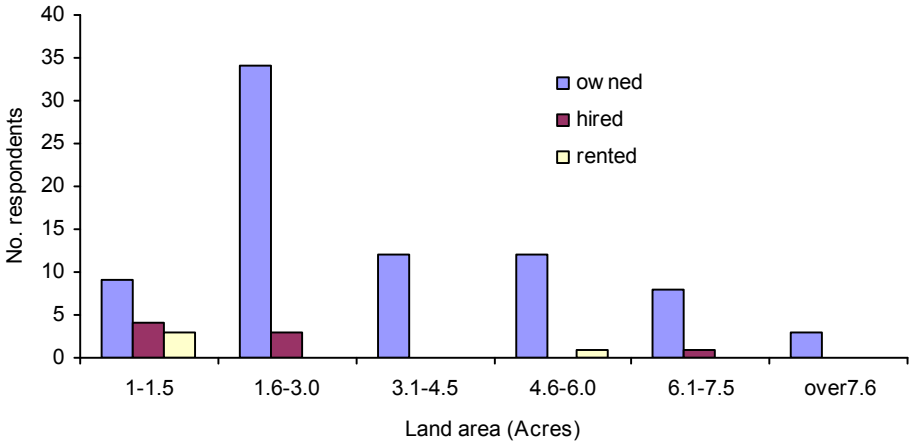

Figure 6.1 Land acreage owned, hired or rented by farmers today in PATTEC sites

6.2 Results

6.2.1 Cropping patterns

When trypanosomiasis challenge is reduced cropping patterns are expected to change due to introduction of new crop varieties as new investors with new land use practices come in and as the government and development agents inject in new ideas in farming. Reduced state of animal trypanosomiasis enables the farmers to utilize animal traction thereby being able to engage in commercial farming. The expected change in cropping system is therefore an increase in commercial farming in addition to subsistence farming

It is therefore good to develop a baseline of cropping systems prior to the implementation of PATTEC activities so that assessments of impacts of PATTEC on cropping systems can me measured.

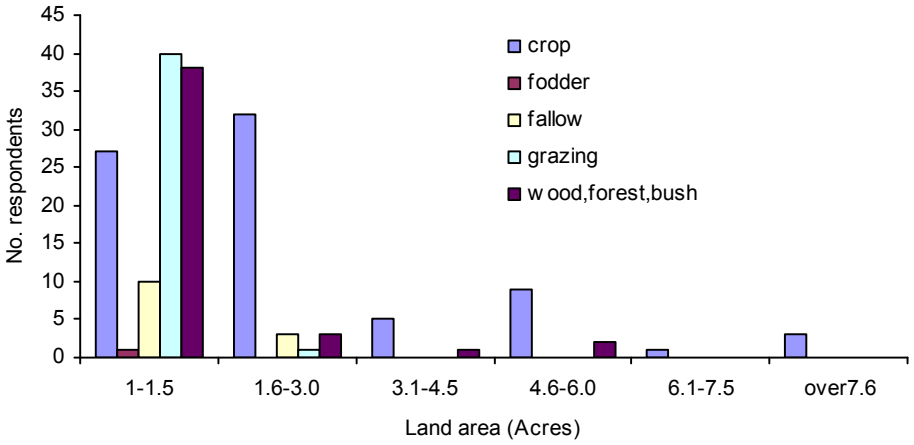

Figure 6.2 Land acreage under various types of utilization in PATTEC sites

6.2.2 Livestock grazing patterns

With a reduction in animal trypanosomiasis constraints of livestock grazing orbits are reduced. Animals can graze in areas they never used to graze during some seasons thereby reducing grazing pressure in areas they used to graze. This reduces land degradation and increases livestock productivity. It is therefore important to monitor the impacts grazing patterns and hence a need for baseline on the initial grazing patterns at the start of the project

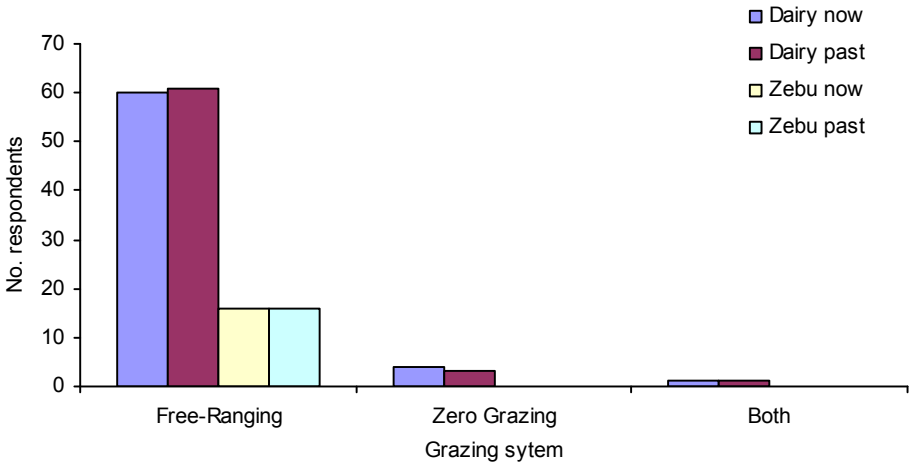

Figure 6.3 Livestock systems today and in the past in the PATTEC sites

6.2.3 Natural resources and uses (vegetation, water and wildlife)

Reduction in trypanosomiasis results in increased human activities which may affect the abundance and distribution of natural resources. These include vegetation, soils, water resources and wildlife in general.

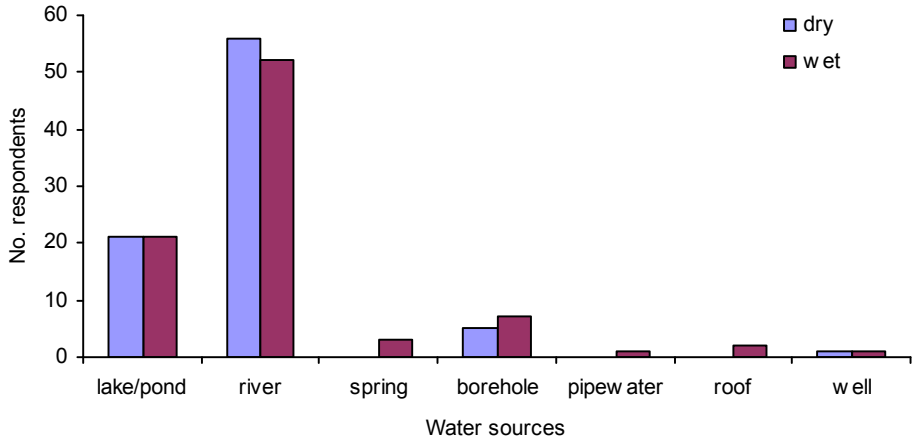

Figure 6.4 Sources of water during wet and dry season in PATTEC sites

6.2.4 Fuel usage

Fuel usage could be a measure of economic potential of a community. It is also an indicator of how developments in the area are affecting the natural resources especially in use of firewood and charcoal.

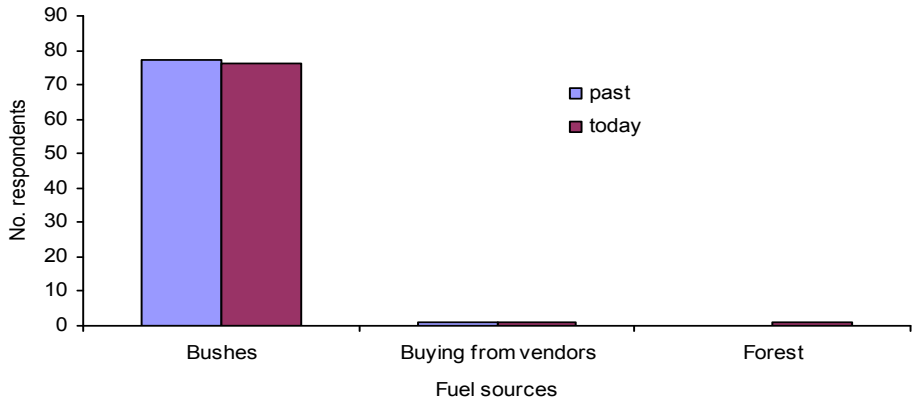

Figure 6.5 Sources of wood fuel in the past and today in pattec sites

Bushland is the dominant source of fuel, while forest and vendors constitute a small percent, today (fig 6.5). Majority of residents in the study areas take atleast half an hour to walk to and from the areas where they collect firewood (fig 6.6). Forest and bush sources are reported to be on the decline, due to land clearing to create farmlands.

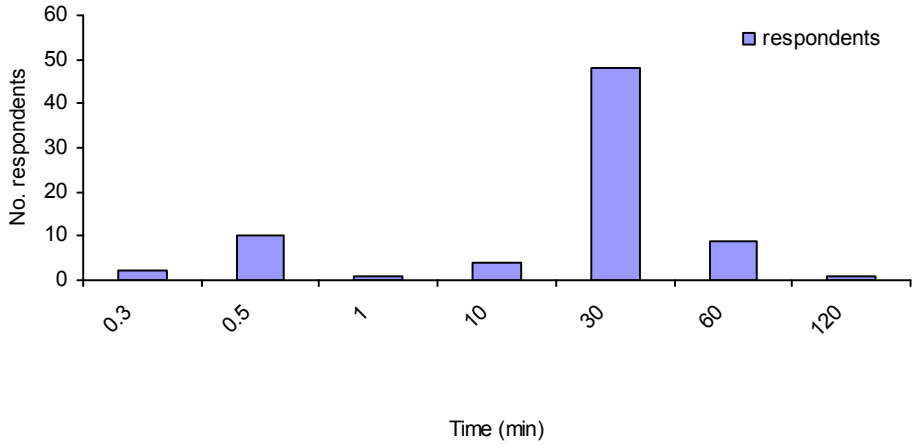

Figure 6.6 Time (min) taken to collect wood fuel in pattec sites

Detailed database on the findings in each of these fields are provided in the annexes. Further to database provided the information will be very useful in future analysis of impacts.

CONCLUDING REMARKS

Changes in land use pattern are common phenomena in areas experiencing gradual human settlement. Such changes reflect long term indirect impacts of removing environmental constraints that hinder human activity like tsetse and trypanosomosis. In this report we explored the current status of biodiversity, land cover and soils' physical and chemical characteristics. The objective of the study was to assess the composition and situation of various environmental parameters and present them so as serve as baseline for future impact assessments and monitoring of changes. The land use and land cover component was carried out on the basis of Africover classification where improvement was made based on available new data. The report comprises of synthesis and summaries of data collected in the field, and it also provides raw baseline data in an interactive CD. During field surveys, it was evident that habitats close to protected areas seem to have higher tsetse density. This could be attributed to the presence of bushes within the park that acted as reservoir for tsetse habitation as well as the host wild animal species that are preferred by the tsetse.

Most of the data reported here were collected during the month of May and June 2008. However, there is also a substantial amount of data that was acquired through field surveys done earlier by the authors and or data available at ILRI from previous projects and through literature surveys as provided in the terms of reference. Nevertheless data presented here either from our previous projects or from literature confirmation was made to make sure that the information is correct as at the time when the field surveys were done.

Tsetse and trypanosomiasis control has been going on in many parts of Kenya to an extent that there is no single place within the study areas where control activities of either tsetse or trypanosomiasis had not been done before. However, no PATTEC activities had been initiated in any of the three areas prior to the surveys done for this study. As discussed elsewhere in this report and as is well presented in the literature, tsetse and trypanosomiasis control has negligible direct effects on land cover and land use. Most of the effects of tsetse and trypanosomiasis control on environment and land use take place as indirect effects and may be observed several years after the control interventions.

Data presented in this report will serve as baseline to analyze impacts for the implementation of PATTEC activities in the three regions. For the purpose of impact analysis – this data should be taken to represent the situation as at May / June 2008. Any variations from the information presented here could be associated with natural or human induced changes that take place between May / June 2008 and the time the assessment is made. In determining these impacts considerations

must be made to identify and separate impacts from tsetse and trypanosomiasis interventions from those that could be un related to the interventions.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Pamela Olet the PATTEC Kenya coordinator for working with us throughout the project period, and her entire team at PCMU. We thank many experts who provided inputs in various areas of this study and whose work is presented in various sections of this report. We thank the ministry of Livestock for providing a platform under which this work was done. We are very thankful to the African Development Bank who provided funds for undertaking this study. Finally we thank Dr. William Ogara who reviewed the draft of this report and gave many useful comments that have been very helpful.

References:

Jaetzold, R., Schmidt H., Hornetz B., and Shisanya C., 2006. Farm Management Handbook of Kenya, Vol. 2, Part C Eastern Kenya

Lessard P. et al., (1990) Geographical Information System for studying the epidemiology of cattle diseases caused by Theileria parva. Veterinary record (1990) 126, 255-262

Seré C. and Steinfeld H. 1996. World livestock production systems: Current status, issues and trends. FAO Animal Production and Health Paper 127. FAO (Food and Agriculture Organization of the United Nations), Rome, Italy. 89 pp.

Maitima, J.M., Rondriguez. L.C., M. Kshatriya and Mugatha, S. (2007). Guidelines for assessing environmental and socio-economic impacts of tsetse and trypanosomiasis interventions. ILRI Manuals and guidelines No. 5. ILRI Nairobi.

Reid, R.S., and Swallow B.M., (eds.) (1988) Final technical report for IFAD TAG grant 284 –ILRI, "An integrated Approach to the Assessment of Trypanosomiasis Control Technologies and their impacts on agricultural production, human welfare and natural resources in tsetse affected areas of Africa". Phase 1. ILRI, Nairobi.

Appendix 1 Questionnaire used in survey

PATTEC KENYA BASELINE ENVIRONMENTAL DATA-SHEET

Survey Questionnaire

Date of interview: _____

Start time_____ End time_____

Household Code No: _____

District: _____

Division: _____

Location: _____

Sub Location: _____

Village: _____

Location of interview: _____

Name of Farmer: _____

Category of Farmer: _____

Household GPS reading: Latitude (N/S) _____ Longitude (E/W) _____

Alt _____

Filled questionnaire reviewed by:

Reviewer's Name	**Date**

Household Information

1. Name of Household head _____
2. Educational Level 01. None 02. Primary
   03. Secondary 04. Post-secondary
3.
4. How long have you lived in this area? 01. <10 years 02. 10-20 years
   03. 21-40 years 04. >40 years
5. How is the respondent related to the household?01. Husband 02. Wife 03. Son 04. Daughter. 05. Other specify_____

Land use

6. What is the main occupation of the household head now?
   01. Farming 02. Trading 03 Fishing 04. Employed
   05. Others Specify_____
7. If a farmer what kind? 01. Mixed 02. Crop based 03. Animal based
8. How much land do you own? _____Acres
9. How much land have you hired for crop production? _____ Acres
10. How much land have you rented out? _____Acres
11. What proportion of your land in acreage is allocated to each of the following?

	Cropped		Un-cropped		
Homestead	Food /Cash crop	Fodder crop	Fallow	Grazing	Bush/forest/wood
_____	_____	_____	_____	_____	_____

12. State different crop / land management methods **today** in the following categories. Provide the information using at least five most important crops. ***(Important crops are those with higher acreage in comparison to others)***

Crop Name	**Land preparation**	**Planting**	**Method of weeding**	**Soil fertility management**	**Harvesting**	**Source of labour**

Key

Land preparation / planting / method of weeding
Hoe
Ox-plough
Tractor

Harvesting
Machine
Manual

Soil fertility management
Fertilizer
Manure
Both
None

13. How do you clear land (bush) today? 01. Pangas /axes 02. Burning 03. Machine

14. How were you clearing land (bush) in the past? 01. Pangas /axes 02. Burning 03. Machine

15. Which crops have disappeared? State the crops name and explain the reason why you no longer grow them.

Crop Name	**Reasons for not growing the stated crops**

16. Is there any erosion on your farm? 01. Yes 02. No

17. If yes how are you controlling soil erosion? 01. Terracing 02. Trash lines
03. Strip cropping 04. Other (specify)_____

18. What in your opinion is the cause of soil erosion in your farm? _____

_____

19. Do you think there is soil infertility in your farm? 01. Yes 02. No

20. If **yes** what are the indicators of soil infertility? _____

Livestock

21. State the **number** of animals you kept in the **past** and **today** and give reasons for any differences.

Type	**Number of animals**		**Reasons for differences in past and present livestock numbers**
	Past	**Today**	
Native Cattle			
Graded			
Cross- Breed			
Goats			
Sheep			
Donkey			
Pigs			
Dogs			
Chicken			

22. In the past did you own? 01. Oxen 02. Ox-plough

23. Do you own any now? 01. Oxen 02. Ox-plough

24. Explain the reasons for any differences in **21 & 22** above

_____

25. Which of one of these do you hire most to cultivate your farm?
01. Oxen 02. Ox- plough 03. Tractor 04.None

26. From which of the following livestock products do you make income?
01. Milk 02. Calves 03. Adults
04. Renting of ox-plough 05. Manure 06. Hides and skin
07. Any other specify _____

27. What is your main system of keeping cattle now and what was it 10 years ago, if established then? (Put the answer in the table)

	Presently	10 years ago
Dairy cattle		
Zebu cattle		

Key
01. Only grazing (free-range or tethered)
02. Grazing with some stall feeding
03. Only stall feeding (zero grazing)

28. What are your main grazing areas during different seasons **today**? (✔ **)**

Grazing areas	Dry season	Wet season
Own pasture/un-cropped land		
Own post harvest cropped		
Neighbours post harvest cropped		
Neighbours pasture/un-cropped		
Public land		
__		
__		

29. What were your main grazing areas during different seasons in the **past?** (✔ **)**

Grazing areas	Dry season	Wet season
Own pasture/un-cropped land		
Own post harvest cropped		
Neighbours post harvest cropped		
Neighbours pasture/un-cropped		
Public land		
__		
__		

30. Where do you water your livestock?

01. Lake / pond 02. River / Stream 03. Spring 04. Bore hole

05. Piped 06. Roof catchments 07 Well

31. Is trypanosomosis disease problem to your livestock?

01. Yes 02. No 3. Unknown

32. Which control measure do you apply for **trypanosomosis**?

01. No control 02. Traps/ Target 03. Bush clearing

04. Use of drugs/chemo-therapeutics 05. Use of pour-on, etc (vector control**)**

06. Crush pen 07. Net Zero grazing Unit

08. Other (specify) _____

33. If Trypanosomosis is present but **no control measure is employed**, why?

01. Do not know where to get drugs 02. Do not know how to control

03. Drugs are expensive 04. Drugs do not work

05. Other (specify) _____

34. What in your opinion is the implication of the trypanosomosis control method to the environment? _____

Vegetation

35. Name **three** main plant species found in the area in the past and today in the following habitats.

Species Habitats	**Species Names**	
	Past	**Today**
Bush/forest		
Farms (weeds)		
Swamp / River line		

36. Do you know of any particular plant species that has disappeared or is disappearing from the area? 01. Yes 02. No

37. State any species that has disappeared or is disappearing; it's habitat and explain reason why they are disappearing?

Species Name	**Species habitat**	**Reasons**

Key: Habitats (Bush, Forest, Farm, Swamp, Grassland, River line, ……)

38. State any new plant species that have emerged in the area and explain the cause of their emergency.

Species Name	Species habitat	Cause of emerging

Key: Habitats (Bush, Forest, Farm, Swamp, Grassland, River line, ……)

Wildlife Biodiversity

39. State the wildlife types found in your area in the past and today.

Types Animal Species	Species Names	
	Past	Today
Reptiles		
Mammals		
Rodents		
Birds		

40. State the wild life species that disappeared in the area

Wild life Name	Species habitat	Reasons for disappearing

Key: Habitats (Bush, Forest, Farm, Swamp, Grassland, River line, …)

41. Name any wildlife species that moved in the area recently

Wild life name	Species habitat	Possible reasons for emergency

42. Rate the level of human / wildlife conflict in the area.

01. Very high 02. Moderate 03. Low 04. None

43. What is the nature of human / wildlife conflict

Wild life Name	Nature of conflicts

Water Resources

44. Where is the main source of water **Today**?

During dry season:	01. Lake / pond	02. River / Stream	03. Spring
	04. Bore hole	05. Piped water	
	06. Roof catchment	07. Well	
During wet season:	01. Lake / pond	02. River / Stream	03. Spring
	04. Bore hole	05. Piped water	
	06. Roof catchment	07. Well	

45. How would you rate the quality of water in terms of the following pollution, cleanliness, and taste?

a) **Pollution**	01. Very polluted	02. Fairly polluted	03. Not polluted
b) **Cleanliness**	01. Very clean	02. Fairly clean	03. Dirty
c) **Taste**	01. Very good	02. Fairly good	03. Bad

46. Do you consider the water safe for drinking? 01. Yes 02. No

47. How far is the main watering point from the household?

During the wet season _____ meters/ kilometers

During the dry season _____ meters/ kilometers

Fuel sources

48. State your main sources of fuel **10 years ago** and **today**. Rank your **current** sources of fuel in order of importance based on frequency of usage.

Sources of fuel	**10 years ago (✔)**	**Today (✔)**	**Rank**
Dry wood			
Charcoal			
Paraffin			
Gas			
Electricity			
Maize Stalks			
Swamp dry vegetation			
Others Specify			

49. Where did you get fuel 10-15 years ago? _____

50. Where do you obtain fuel today? _____

51. Explain the difference between (63 and 64) _____
_____

52. How much time do you take to gather fuel wood (time for walking to and fro and gathering)? 01. 10 min 02. 30 min 03. 60 min 04. 120 min +

53. Are there any natural forests in this area? 01. Yes 02. No

54. If yes, do you have access to these forests? 01. Yes 02. No

55. What has been the trend of forest cover in the area?
01. Increased 02. Decreased 03. No change

56. What do you think is the reason for the observed trend in forest cover?

57. Apart from timber/fuel what other important **products** do you obtain from the **bush/Forest/uncultivated**?

Product	**Obtained Today (✔)**	**General Use /Purpose**	**Level of use Today**	**Level of availability**	**Give reasons for rare use/availability and not using**
Honey					
Wild fruit					
Wild animal (Bush meat)					
Grass					
Medicinal Plants					
Fibres					
Dye					
Craft Material					
—					
—					

Level of use / availability

Regularly
Rarely
Not used / found

Thank you very much for participating in the survey

For Enumerator Use Only

1. Do you think the answers from respondent were sincere and truthful?

   01. Very true 0 2. Fairly true 03. Not true

2. Summarize your view of respondent answers in the space provided below.
3. Counter check the questionnaire to ensure that all the questions have been answered
4. Record end time.

Comments from the enumerator

Appendix 2 Land use land cover analysis

RIFT VALLEY PROVINCE

BARINGO	
landuse/cover	**Area (ha)**
agriculture	12886
barren land	54686
bushland	722422
forest	13726
plantation	1058
swamp	15496
water body	16905
woodland	27318

KEIYO	
landuse/cover	**Area (ha)**
Agriculture	51727
Bushland	49332
Forest	25029
Plantation	202
Woodland	17746

KOIBATEK	
landuse/cover	**Area(ha)**
agriculture	89994
bushland	79637
forest	44281
plantation	7875
water body	3024
woodland	6215

LAIKIPIA	
landuse/cover	**Area (ha)**
Agriculture	74433
barren land	3662
Bushland	221096
Forest	33382
Plantation	556308
Swamp	6431
Town	1397
Woodland	49203

MARAKWET	
landuse/cover	**Area (ha)**
agriculture	64294
bushland	32265
forest	55798
swamp	1418
woodland	5028

NAKURU	
landuse/cover	**Area (ha)**
Agriculture	326452
barren land	16718
Bushland	182946
Forest	105694
Plantation	60382
Swamp	8333
Town	3362
water body	5944
Woodland	14708

SAMBURU	
landuse/cover	**Area (ha)**
barren land	350935
bushland	1478346
forest	97848
grassland	20093
plantation	28461
woodland	122880

NANDI	
landuse/cover	**Area (ha)**
Agriculture	222783
Bushland	10468
Forest	38599
Plantation	15779
Woodland	683

WEST POKOT	
landuse/cover	Area (ha)
Agriculture	60925
barren land	141406
Bushland	631338
Forest	26299
Swamp	589
Woodland	40271

NYANZA PROVINCE

BONDO	
landuse/cover	Area (ha)
agriculture	72000
swamp	5296
water body	19330

HOMABAY	
Landuse/cover	Area (ha)
agriculture	104184
bushland	6060
water body	2148
woodland	2948

KISUMU	
landuse/cover	Area (ha)
agriculture	66372
bushland	872
plantation	9096
swamp	4635
town	2073
water body	9422

KURIA	
Landuse/cover	Area (ha)
agriculture	53673
woodland	34

MIGORI	
landuse/cover	Area (ha)
agriculture	179177
bushland	3487
swamp	4676
water body	7818
woodland	2186

SIAYA	
Landuse/cover	Area (ha)
agriculture	143334
bushland	956
Swamp	7459

SUBA	
landuse/cover	Area (ha)
agriculture	55012
bushland	22257
forest	3062
grassland	3630
water body	19048

NYANDO	
Landuse/cover	Area (ha)
agriculture	84168
bushland	10461
Forest	586
plantation	6778
Swamp	12596
water body	1962

RACHUONYO	
landuse/cover	Area(ha)
Agriculture	1480419
Bushland	80760
Forest	78893
Grassland	3630
Plantation	31649
Swamp	54533
Town	2073
water body	74695
Woodland	5851

WESTERN PROVINCE

BUSIA	
landuse/cover	Area (ha)
agriculture	79630
bushland	5868
swamp	19707
water body	2455

BUTERE/MUMIAS	
landuse/cover	Area (ha)
Agriculture	94507

BUNGOMA	
landuse/cover	Area (ha)
agriculture	206932

MT. ELGON	
landuse/cover	Area (ha)
Agriculture	35193
Bushland	14595
Forest	36646

CENTRAL PROVINCE

KIRINYAGA	
landuse/cover	**Area (ha)**
agriculture	94584
barren land	6161
bushland	5563
forest	29923
plantation	10127
woodland	478

MURANGA	
landuse/cover	**Area (ha)**
Agriculture	73164
Forest	18366
Town	392
Woodland	1092

THIKA	
landuse/cover	**Area (ha)**
agriculture	76624
forest	20588
plantation	97205
town	1016
woodland	24

MARAGUA	
landuse/cover	**Area (ha)**
Agriculture	66224
Forest	5613
Plantation	14412

EASTERN PROVINCE

KITUI	
landuse/cover	**Area (ha)**
agriculture	373650
barren land	5309
bushland	1512983
forest	5937
grassland	1051
woodland	127704

MBEERE	
landuse/cover	**Area (ha)**
Agriculture	154775
Bushland	45541
Plantation	335
water (artificial)	3079
Woodland	4214

MWINGI	
landuse/cover	**Area (ha)**
agriculture	644330
bushland	302700
woodland	53242

MERU NORTH	
landuse/cover	**Area (ha)**
Agriculture	162521
barren land	2074
Bushland	210142
Forest	12100
Grassland	312
Woodland	5381

EMBU	
landuse/cover	**Area (ha)**
agriculture	49501
barren land	2736
bushland	543
forest	19456
woodland	332

ISIOLO	
landuse/cover	**Area (ha)**
Agriculture	4922
barren land	189279
Bushland	1954133
Grassland	222709
Swamp	66425
Town	344
Woodland	73670

MAKUENI	
landuse/cover	**Area (ha)**
agriculture	515421
barren land	1634
bushland	169323
forest	10507
plantation	43430
town	19
woodland	53784

MERU CENTRAL	
landuse/cover	**Area (ha)**
Agriculture	129796
barren land	49512
Bushland	27675
Forest	45729
Plantation	41477
Town	364
Woodland	2291

THARAKA	
landuse/cover	**Area (ha)**
agriculture	128482
bushland	16292
woodland	9951

MACHAKOS	
landuse/cover	**Area (ha)**
Agriculture	355761
barren land	7170
Bushland	71551
Forest	2234
Grassland	802
Plantation	166683
Town	786
water (artificial)	11517
Woodland	2934

Appendix 3. Soils sampled.

Sample	Laboratory No.	Details
1	1211/08	Meru National Park, Meru Swamp composite sample 1
2	1212/08	Meru National Park, Meru Swamp composite sample 2
3	1213/08	Meru bushland compost sample 1
4	1214/08	Meru bushland compost sample 2
5	1215/08	Meru grassland compost sample 1
6	1216/08	Meru National Park Meru grassland composite sample 2
7	1217/08	Meru Forest compost sample 1
8	1218/08	Meru Forest compost sample 2
9	1219/08	Meru agriculture compost sample 1
10	1220/08	Meru agriculture compost sample 2
11	1221/08	Embu Forest composite sample
12	1222/08	Mbeere/Embu forest sample 2
13	1223/08	Mbeere bushland compost sample P, Q.
14	1224/08	Bushland Mbeere Q1, mixed with Q2
15	1225/08	Mbeere agriculture sample 1 P5, Q2
16	1226/08	Mbeere woodland sample 1
17	1227/08	Embu agriculture composite sample
18	1228/08	Mbeere (mavyani) grazing area
19	1229/08	Mbeere (Kamburu) sample 1, P2, Q1, bushland
20	1230/08	P1, Q2, Mbeere (Kamburu dam) sample mix with Q1, composite bushland sample
21	1231/08	Mbeere woodland sample 2
22	1232/08	Kitui Sample 1 forest woodland 16/5
23	1233/08	Kitui sample 2 woodland P5
24	1234/08	Kitui sample 1 woodland composite sample 1
25	1235/08	Kitui bushland composite sample 1, P1, Q1 and Q2 (Ikutha, Kitui)
26	1236/08	Sample 2 agriculture Kitui Transect P6,Q1 and Q2
27	1237/08	B4 Bushland
28	1238/08	Kitui Kanziku, agriculture sample 1
29	1239/08	Kitui bushland sample 2, P4, Q1 and Q2, Kitui transect
30	1240/08	Baringo saimo
31	1241/08	Baringo saimo
32	1242/08	Baringo oseen
33	1243/08	Baringo, bushland
34	1244/08	Agriculture Baringo, sesila village
35	1245/08	Baringo Kabutie
36	1246/08	B13, Baringo
37	1247/08	B14, Baringo North

38	1248/08	Baringo, Kambi samaki
39	1249/08	Mwingi woodland sample 2, P1, Q1
40	1250/08	Mwingi bushland sample 2, P1,Q2
41	1251/08	Mwingi composite sample 2 agriculture P2, Q1, mix with Q1
42	1252/08	P2, Q1 and Q2 mixed Nuu hills Mwingi woodlands
43	1253/08	P1, Q2 Mwingi agriculture compost sample
44	1254/08	Mwingi Bushland sample 1, P5, Q1 and Q2 mixed
45	1255/08	Rachuonyo Kadel
46	1256/08	Rachuonyo
47	1257/08	Rachuonyo Kadel
48	1258/08	Rachuonyo Kadel
49	1259/08	Busia
50	1260/08	Busia
51	1261/08	Busia
52	1262/08	Bondo agriculture Uyoma
53	1263/08	Bondo agriculture Uyoma
54	1264/08	Homabay extra
55	1265/08	Homabay extra
56	1266/08	Homabay extra (2)
57	1267/08	Homa bay agriculture, Kanyidogo
58	1268/08	Homa bay Kanyidoyo agriculture
59	1269/08	Homa bay agriculture Miranga
60	1270/08	Homa bay Miranga agriculture
61	1271/08	Homa bay W. Kanyanwa bushland
62	1272/08	Homa bay W. Kanyanwa bushland
63	1273/08	Usenge Siaya
64	1274/08	Boro Siaya Swamp Boro
65	1275/08	Uranga S.W. Alego
66	1276/08	Uranga S.W. Alego
67	1277/08	Nyando, Genrae, agriculture
68	1278/08	Nyando
69	1279/08	S. Central Kadongo
70	1280/08	Limuru Busia/Nyamasaria

Appendix 4 summaries of vegetation data by transects

SUBA-HOMA BAY TRANSECT: Average number (count), percent cover and relative density (Rd) per species, for plants sampled in the Suba – Homa Bay transect

	LAND COVER/USE																	
	Agric(mix crop)			Agric(mono crop)			Bushland			Forest			Grassland			Woodland		
BOTNAME	count	%cover	Rd	count	%cover	Rd	count	%cover	Rd	count	%cover	Rd	count	%cover	Rd	count	%cover	Rd
Abrus precatorius								8.5							0			
Acacia abyssinica													2.0	40.0	0.45			
Acacia brevispica							4.0	20.0	0.89				2.5	3.0	1.12			
Acacia seyal	2.0	10.0	0.45				8.3	23.3	5.58	2.0	1.5	0.89						
Acacia tortilis								15.0										
Albizia coriaria																	1.0	
Amaranthus gangeticus		16.2																
Aristida adscensionis		15.0						5.0						2.5				
Balanites aegyptiaca							1.0	15.0	0.22									
Bidens pilosa		7.8												2.0				
Bidens pipinnata					5.0													
Boscia angustifolia					3.5													
Bothriochloa insculpta		2.0						20.0						5.5			16.0	
Brachiaria eruciformis		5.0						5.0						28.8			15.0	
Brachiaria umberata								50.0										
Capparis tomentosa								5.0										
Carissa edulis							2.5	15.0	1.12							3.0	5.0	0.67
Catha edulis					8.0													
Cenchrus metes														15.0				
Chloris pycnothrix														15.0				
Cissus rotundifolia					1.0			8.0						10.0			2.5	
Chloris gayana		15.0						10.0										
Coelorhachis afraurita								5.0						5.0				
Coelothachis afraunta														7.5				
Combretum adenogonium																3.0	17.5	1.34
Commelina benghalensis		9.9			9.0													
Commelina trilocularis								4.5										
Commiphora africana																1.0	20.0	0.22

	LAND COVER/USE											
	Agric(mix crop)	**Agric(mono crop)**	**Bushland**			**Forest**			**Grassland**	**Woodland**		
Combretum molle											17.5	
Corchorus olitorius	15.0											
Crotalaria	5.0	2.0							3.5			
Crotalaria agatiflora	7.5											
Crotalaria axillaris				1.3					2.0			
Croton alie				5.0								
Cymbopogon caesius		3.5		12.5								
Cynodon dactylon	18.6	22.5							10.0			
Cynodon nlenfuensis	3.0			17.7					5.0			
Cypress						4.8	16.7	6.47				
Digitaria abyssinica	2.0	7.5							5.0			
Digitaria milanjiana				5.0								
Dodonaea angustifolia				20.0								
Dombeya	7.5											
Dombeya burgessiae				7.5								
Dovyalis abyssinica				2.0								
Echnocloa haploclada	3.0	2.0		10.0								
Eragrostis racemora									30.0			
Eragrostis tenuifolia		10.0		20.0							10.0	
Erogrostis tenuifolia				2.0					10.0		32.5	
Eucalyptus globulus						1.7	4.0	1.12				
Euclea divinorum			8.0	12.5	3.57					8.0	9.0	3.57
Eustachys paspaloides	2.0	20.0										
Ficus natalensis	1.0			1.0								
Grewia bicolor			11.5	4.3	5.13					18.5	15.8	8.26
Grewia molis			4.0	10.0	0.89							
Grewia similis			9.3	15.0	6.25						9.0	
Groundnut	16.7											
Harrisonia abyssinica			11.7	22.7	7.81					5.0	15.0	1.12
Heteropogon contortus				2.0					5.0		15.0	
Hoslundia oppo											3.0	
Huslundia opposita		5.0										

	LAND COVER/USE														
	Agric(mix crop)			Agric(mono crop)			Bushland			Forest			Grassland	Woodland		
Hyparrhenia dissoluta													60.0			
Hyparrhenia filipendula		15.0			2.5			34.0					31.4			
Hyparrhenia rufa		2.0			15.0			38.0					3.0		15.0	
Hyparrhenia variabilis													3.0			
Indigofera are														13.0	7.5	5.8
Indigoffera arrecta													20.0			
Jasminum schimpery								2.0								
Kigelia africana										2.0	5.5	1.79				
Lantana camara	8.0	10.0	1.79					7.5							21.2	
Lantana trifolia					2.0			15.0					5.0			
Leonotis		5.0														
Leonotis lepetifolia		7.5														
Leonotis molissima		5.0														
Leonotis nepetifolia								5.0								
Leucas grandis		5.0			20.0			5.0							5.0	
Lippia javanica					20.0			11.5							4.0	
Mimosa pigra							6.0	10.0	1.34						20.0	
Mucuna gigantiea								5.0					2.0			
Mytenus								17.5								
Mytenus heterophylla							7.5	25.0	3.35							
Mytenus senegalensis							10.0	25.0	2.23							
Ocimum kilimandscharicum					5.0											
Ocimum suave								5.0								
Oxalis Latifolia		10.0														
Panicum infestum					5.0			12.5								
Paspalum scrobiculalum								10.0								
Pennisetum stramineum													3.5			
Phaseolus vulgaris		20.0			5.0											
Pine										5.3	11.9	9.38				
Polyscias fulva					2.0											
Portulaca quadrifida													5.0			
Psidia guajava				1.0	25.0	0.22								7.0	11.0	3.13

	LAND COVER/USE											
	Agric(mix crop)	Agric(mono crop)	Bushland			Forest	Grassland			Woodland		
Psidium punctulata				20.0								
Rhus natalensis			21.0	20.0	9.38		3.0	10.0	0.67	6.0	8.5	2.68
Rhynchelytrum repens villosum		5.0										
Sapium ellipticum				2.0				7.5				
Sesbania sesban				12.5								
Setaria incrassata								62.5				
Setaria sphacelata	2.0			11.3				6.5				
Solanum incanum								10.0				
Solanum terminale	6.0											
Sorghum bicolor	65.0											
Spathodea companulata	5.0											
Sporobolus discosporus		10.0										
Sporobolus pyramidalis		2.0		30.0				6.7				
Sporobolus stapfianus	3.5											
Stipa dregene				55.0				25.0				
Striga hermontheca	5.0											
Striga asiataica		2.0										
Sucutia myrtina				10.0								
Teclea nobilis			2.5	7.5	1.12							
Teclea trichocarpa				3.5								
Tephrosia Emeroides	4.0											
Themeda triandra	2.0	4.0		9.9				27.8			50.0	
Tinea aethiopica				15.0								
Tithonia	2.0											
Trumphetta rhomboidea		6.5		5.0								
Unknown SU1								15.0				
Unknown SU2	4.0											
Unknown SU3	5.0			3.0								
Unknown SU4	1.0	1.7									2.0	
Unknown SU5				3.0								
Vapis mobilis											20.0	
Varleria ventricosa				10.0								

	LAND COVER/USE					
	Agric(mix crop)	**Agric(mono crop)**	**Bushland**	**Forest**	**Grassland**	**Woodland**
Vernonia karaguensis		5.0				
Vigna unguiculata	35.0					
Wondering jew	4.5				15.0	
Zea mays	43.1	46.7				
Zehneria anomala			12.5			

BUSIA-BONDO-SIAYA TRANSECT: Average number (count), percent cover and relative density (rd) per species, for plants sampled in the Busia-Bondo-Siaya transect

	LAND COVER/USE											
	Bushland			Swamp			Agric(mix crop)			Agric(mono crop)		
BOTNAME	count	%cover	rd	count	%cover	rd	count	%cover	rd	count	%cover	rd
Acacia seyal	1.0	20.0	0.0									
Acalypha fruticosa							11.0	9.0	1.1			
Agelaea pentagyna	1.0	3.0	0.1									
Amaranthus gangeticus							1.0	3.5	0.1			
Argeratina adenophora	7.0	15.0	0.7									
Aristida adcensionis							6.0	10.0	0.3			
Aristida stenostachys	11.0	30.0	1.1									
Asystasia schimperi scanderis				2.0	5.0	0.1						
Bidens pilosa							6.8	6.0	2.0			
Boletus edulis							2.0	0.5	0.1			
Bothriochloa insculpta							3.0	3.0	0.3			
Brachiaria eruciformis							3.5	7.0	0.3			
Brachiaria subquadripara										7.0	10.0	0.3
Brachiaria umbellata	14.0	10.0	1.4									
Caesalpinia trothae	2.0	4.0	0.1									
Calpurnia aurea							7.0	15.0	0.3			
Capparis tomentosa							5.0	5.0	0.2			
Cassia accidentalis							4.0	2.0	0.4			
Cassia edulis	11.0	18.3	1.5				1.0	5.0	0.1	3.0	2.0	0.1
Cissus rotundifolia	2.0	1.0	0.1				2.5	6.0	0.2			
Chloris gayana							9.0	10.0	0.9			
Commelina Africana										6.0	10.0	0.6
Commelina benghalensis							10.0	14.4	1.9			
Commerlina trilocularis							1.0	1.0	0.1			
Craibia brownii							6.5	4.0	0.6			
Crotalaria							4.5	1.3	0.9			
Crotalaria axillaris	3.0	5.0	0.3	6.0	7.5	0.6	2.0	1.0	0.1			
Cynodon dactylon	22.5	70.0	2.2	8.0	30.0	0.3	6.7	10.4	3.6			
Cynodon nlenfuensis				10.0	30.0	0.5				3.0	5.0	0.1
Cyperus papyrus	3.0	5.0	0.1	13.0	44.0	3.2	3.0	1.0	0.3			

	LAND COVER/USE											
	Bushland			Swamp			Agric(mix crop)			Agric(mono crop)		
Cyphostema kilimandscharica				6.0	10.0	0.3						
Dactyloctenium				7.0	70.0	0.3						
Dactyloctenium aristatum							2.0	5.0	0.2			
Dactyloctenium bogdanii										13.0	60.0	0.6
Dactyloctynium avistatum							4.0	10.0	0.8			
Dactylonium aristatum				7.0	17.5	0.7						
Dactylotinum aristatum							7.0	60.0	0.3			
Digitaria							5.7	8.7	0.8			
Digitaria gazensis							11.3	62.5	2.2	13.5	50.0	1.3
Digitaria gymnotheca	10.5	7.5	1.0									
Digitaria milanjiana							4.0	11.3	0.8			
Digitaria rivae				8.0	15.0	0.4						
Digitaria scalarum	15.0	10.0	1.5				2.0	5.0	0.2			
Digitaria velutina	6.0	10.0	0.6				12.0	25.0	1.2	9.0	15.0	0.9
Digiteric gynnotheca				13.5	67.5	1.3						
Diplachne chudate										7.0	10.0	0.7
Dodonaea angustifolia				6.0	15.0	0.3						
Dombeya burgessiae							3.0	8.0	0.1			
Elionurus muticus	1.0	2.0	0.1									
Embelia schimperi	2.0	11.0	0.2									
Eragrostis tenuifolia	3.0	10.0	0.3				11.5	9.2	2.0	1.0	1.0	0.1
Eragrostis racemosa							10.0	5.0	1.0			
Euclea divinorum	4.0	11.0	0.8									
Eustachys paspaloides							9.0	10.0	0.9	7.5	11.0	0.7
Grewia bicolor	2.0	12.5	0.2							9.0	20.0	0.4
Grewia similis	2.0	10.0	0.1				2.5	11.5	0.2			
Harizona abyssinica	15.0	9.0	1.5									
Hibiscus callyphylus							5.5	10.5	1.1			
Hoslundia opposita							1.0	1.0	0.0			
Hyparrhenia anamese	14.0	35.0	1.4									
Hyparrhenia rufa							5.0	15.0	0.2			
Ipomoaea kituensis							6.0	5.0	0.6			
Jasminum dichotomum										2.0	4.0	0.1

	LAND COVER/USE											
	Bushland			Swamp			Agric(mix crop)			Agric(mono crop)		
Jasminum fluminense	7.0	3.5	0.7									
Juniperus procera				5.0	70.0	0.5						
Lantana camara	9.5	39.2	2.8				6.1	16.0	2.4	15.0	15.0	0.7
Lantana trifolia	4.0	3.0	0.2									
Leonotis lepetifolia							4.0	8.0	0.4			
Leucas calostachya							8.0	3.0	0.4	3.0	5.0	0.3
Leucas glabrata							7.0	9.0	0.7			
Leucas grandis							3.3	6.8	0.6	4.0	5.0	0.2
Manihot esculenta							11.5	37.5	2.3			
Markhamia lute										7.0	3.0	0.3
Mimosa pigra	12.8	16.8	2.5	6.5	15.0	1.3	8.0	35.0	0.8			
Mucuna gigantea							6.0	2.0	0.3			
Mytenus heterophylla							6.0	2.0	0.3			
Obudo (luo)							1.0	2.0	0.0			
Ocimum suave							5.4	7.4	1.3	1.0	5.0	0.0
Panicum infestum							4.0	10.0	0.4			
Panicum Penifolium	4.0	1.0	0.2									
Paspalum paniculatum	20.0	70.0	2.0									
Phaseolus vulgaris							7.0	21.0	1.7			
Physalis peruviana							5.0	5.0	0.2			
Portulaca quadrifida	4.0	2.0	0.4				4.0	10.0	0.2			
Psidium guajava	4.0	20.0	0.4									
Psydrax parviflora							5.5	5.5	0.5			
Rhus natalensis	2.0	15.0	0.2				4.5	8.5	0.4	3.0	5.0	0.1
Rhus vulgaris							2.0	2.0	0.2			
Sesbania sesban				2.0	10.0	0.1						
Setaria acromelaena							3.0	1.5	0.3			
Sochus schweinfurthii							2.0	2.0	0.2			
Solanum incanum	1.0	1.0	0.1				5.1	9.4	2.5	6.0	4.0	0.3
Solanum nigrum							2.7	3.7	0.4			
Sonchus schweinfurthii										4.0	5.0	0.2
Sorghum vulgarie							12.5	15.0	1.2			
Sporobolus discosporus							12.0	20.0	1.2			

	LAND COVER/USE											
	Bushland			**Swamp**			**Agric(mix crop)**			**Agric(mono crop)**		
Sporobolus pyramidalis							1.5	3.5	0.1			
Talinum portulacifolium							2.0	2.0	0.1			
Unknown B1							3.0	5.0	0.1			
Unknown 1							4.5	5.0	0.4			
Unknown B2							2.0	0.5	0.1			
Unknown SU2										1.0	2.0	0.0
Urera Sansibarica				10.0	20.0	0.5						
Urocloa mosambiensis	1.0	2.0	0.1									
Vanguaria infausta	7.0	3.0	0.3									
Vatovae pseudolablab				3.0	6.5	0.3						
Vigna radiate							5.5	3.0	0.5			
Vigna unguiculata							9.7	46.7	2.8			
Zea mays							8.5	39.2	5.4	9.0	60.0	0.4

SUBA-HOMA BAY: Average number (count), percent cover and relative density (rd) per species, for plants sampledin the Suba – Homa Bay transect

	LAND COVER/USE																	
	Bushland			Forest			Grassland			Woodland			Agric(mix crop)			Agric(mono crop)		
BOTNAME	count	%cover	rd	count	%cover	rd	count	%cover	rd	count	%cover	rd	count	%cover	rd	count	%COVER	rd
Abrus precatorius	2.0	8.5	0.1															
Acacia abyssinica							2.0	40.0	0.1									
Acacia brevispica	10.3	20.0	1.0				2.5	3.0	0.2									
Acacia seyal	8.3	23.3	0.8	2.0	1.5	0.1							2.0	10.0	0.1			
Acacia tortilis	3.0	15.0	0.1															
Albizia coriaria										1.0	1.0	0.0						
Amaranthus gangeticus													5.1	16.2	1.9			
Aristida adcensionis	2.0	5.0	0.1				6.0	2.5	0.4				8.0	15.0	0.5			
Balanites aegyptiaca	1.0	15.0	0.0															
Bidens pilosa							3.0	2.0	0.1				5.2	7.8	1.0			
Bidens pipinnata																5.0	5.0	0.3
Boscia angustifolia																2.0	3.5	0.1
Bothriochloa insculpta	5.0	20.0	0.3				3.5	5.5	0.5	7.0	16.0	0.9	4.0	2.0	0.1			
Brachiaria eruciformis	2.0	5.0	0.1				8.3	28.8	2.2	5.0	15.0	0.3	4.0	5.0	0.4			
Brachiaria umbrellata	4.0	50.0	0.3															
Capparis tomentosa	8.0	5.0	0.3															
Carissa edulis	6.3	15.0	0.6							2.3	5.0	0.2						
Catha edulis																4.0	8.0	0.1
Cenchrus metes							3.5	15.0	0.2									
Chloris pycnothrix							4.5	15.0	0.3									
Cissus rotundifolia	5.5	8.0	0.4				9.0	10.0	0.3	5.0	2.5	0.3				1.0	1.0	0.0
Chloris gayana	2.0	10.0	0.1										6.5	15.0	0.4			
Coelothachis afraunta	3.0	5.0	0.2				7.0	12.5	0.5									
Combretum adegonium										3.0	17.5	0.2						
Commelina benghalensis													6.9	9.9	1.0	9.5	9.0	1.3
Commelina trilocularis	4.0	4.5	0.3															
Commiphora africana										1.0	20.0	0.0						
Combretum molle										4.5	17.5	0.3						
Corchorus olitorius													13.0	15.0	0.9			
Crotalaria							5.0	3.5	0.3				4.0	5.0	0.3	1.0	2.0	0.0
Crotalaria agatiflora													8.0	7.5	0.5			

	LAND COVER/USE																	
	Bushland			Forest			Grassland			Woodland			Agric(mix crop)			Agric(mono crop)		
Crotalaria axillaris	2.7	1.3	0.3				3.5	2.0	0.2									
Croton alie	3.0	5.0	0.2															
Cymbopogon caesius	5.5	12.5	0.7													1.5	3.5	0.1
Cynodon dactylon							5.0	10.0	0.3				7.0	18.6	2.6	6.0	22.5	0.8
Cynodon nlenfuensis	6.5	17.7	1.3				2.0	5.0	0.1				4.5	3.0	0.3			
Cypress				4.8	16.7	1.0												
Digitaria abyssinica							2.0	5.0	0.1				1.0	2.0	0.1	3.0	7.5	0.2
Digitaria milanjiana	4.0	5.0	0.3															
Dodonaea angustifolia	4.0	20.0	0.1															
Dombeya burgessiae	4.5	7.5	0.3										3.0	7.5	0.2			
Dovyalis abyssinica	3.0	2.0	0.1															
Echnocloa haploclada	4.0	10.0	0.1										6.0	3.0	0.4	1.0	2.0	0.1
Eragrostis racemora							3.0	30.0	0.2									
Eragrostis tenuifolia	4.0	22.0	0.3				4.5	10.0	0.6	14.0	42.5	1.0				4.0	10.0	0.3
Eucalyptus globulus				1.5	3.8	0.2												
Euclea divinorumnorum	8.0	12.5	0.5							8.0	9.0	0.5						
Eustachys paspaloides													1.0	2.0	0.0	7.0	20.0	0.5
Ficus natalensis	1.0	1.0	0.0										3.0	1.0	0.1			
Grewia bicolor	7.0	4.3	0.9							11.3	15.8	1.5						
Grewia molis	4.0	10.0	0.1															
Grewia similis	9.3	15.0	0.9							3.5	9.0	0.2						
Groundnut													6.7	16.7	1.3			
Harrisonia abyssinica	11.7	22.7	1.2							5.0	15.0	0.2						
Heteropogon contortus	4.0	2.0	0.1				2.0	5.0	0.1	6.0	15.0	0.4						
Huslundia opposita										6.0	3.0	0.2				5.0	5.0	0.2
Hyparrhenia dissoluta							15.0	60.0	1.0									
Hyparrhenia filipendula	6.2	34.0	1.0				5.7	31.4	1.3				7.0	15.0	0.5	1.5	2.5	0.1
Hyparrhenia rufa	6.5	38.0	2.2				9.0	3.0	0.6	12.0	15.0	0.8	1.0	2.0	0.1	6.0	15.0	0.4
Hyparrhenia variabilis							4.0	3.0	0.3									
Indigoffera arrecta							12.0	20.0	0.4	10.5	7.5	0.7						
Jasminum schimpery	3.0	2.0	0.1															
Kigelia africana				2.0	5.5	0.3												
Lantana camara	9.5	7.5	0.6							5.3	21.2	1.1	8.0	10.0	0.3			

	LAND COVER/USE																				
	Bushland			Forest			Grassland			Woodland			Agric(mix crop)			Agric(mono crop)		
Lantana trifolia	10.0	15.0	0.7				4.0	5.0	0.3							3.0	2.0	0.2
Leonotis													4.5	10.0	0.3			
Leonotis molissima													6.0	5.0	0.2			
Leonotis nepetifolia	2.0	5.0	0.1										5.5	7.5	0.4			
Leucas grandis	2.0	5.0	0.1							4.0	5.0	0.1	4.3	5.0	0.4	10.0	20.0	0.7
Lippia javanica	3.3	11.5	0.4							4.0	4.0	0.1				10.0	20.0	0.7
Mimosa pigra	6.0	10.0	0.2							6.5	20.0	0.4						
Mucuna gigantea	3.0	5.0	0.1				5.0	2.0	0.2									
Mytenus	10.0	17.5	0.7															
Mytenus heterophylla	7.5	25.0	0.5															
Mytenus senegalensis	10.0	25.0	0.3															
Ocimum kilimandscharicum																6.0	5.0	0.4
Ocimum suave	6.0	5.0	0.2															
Oxalis Latifolia													7.0	10.0	0.2			
Panicum infestum	5.0	12.5	0.3													4.0	5.0	0.3
Paspalum scrobiculatum	6.0	10.0	0.4															
Pennisetum stramineum							2.0	3.5	0.1									
Phaseolus vulgaris													10.2	20.0	2.0	6.0	5.0	0.4
Pine				5.3	11.9	1.4												
Polycia fulva																1.0	2.0	0.1
Portulaca quadrifida							8.0	5.0	0.5									
Psidia guajava										4.0	11.0	0.5				15.0	25.0	0.5
Psidia punctulata	6.0	20.0	0.2															
Rhus natalensis	12.8	20.0	1.7				3.0	10.0	0.1	4.0	8.5	0.5						
Rhynchelytrum repens (villosum)																2.0	5.0	0.1
Sapium ellipticum	1.0	2.0	0.0				7.5	7.5	0.5									
Sesbania sesban	6.0	12.5	0.4															
Setaria incrassata							10.0	62.5	0.7									
Setaria sphacelata	4.0	11.3	0.5				4.0	6.5	0.3				1.0	2.0	0.0			
Solanum incanum							7.5	10.0	0.5									
Solanum terminale													3.0	6.0	0.1			
Sorghum bicolor													7.6	28.0	2.5			
Spathodea companulata													5.0	5.0	0.2			

	LAND COVER/USE																	
	Bushland			Forest			Grassland			Woodland			Agric(mix crop)			Agric(mono crop)		
Sporobolus discosporus																4.0	10.0	0.3
Sporobolus pyramidalis	6.0	30.0	0.4				3.0	6.7	0.3							1.0	2.0	0.1
Sporobolus stapfianus													1.5	3.5	0.1			
Stipa dregene	11.0	55.0	0.7				4.0	25.0	0.5									
Striga hermontheca													6.0	5.0	0.4			
Striga asiafica																2.0	2.0	0.1
Sucutia myrtina	4.0	10.0	0.3															
Teclea nobilis	2.5	7.5	0.2															
Teclea trichocarpa	2.0	3.5	0.1															
Tephrosia Emeroides													5.0	4.0	0.3			
Themeda triandra	4.4	9.9	1.8				5.7	27.8	1.1	11.0	50.0	0.7	3.0	2.0	0.4	2.0	4.0	0.1
Tinea aethiopica	4.0	15.0	0.1															
Tithonia													1.0	2.0	0.0			
Triumfetta rhomboidea	3.0	5.0	0.1													5.5	6.5	0.4
Unknown SU1							11.0	15.0	0.7									
Unknown SU2													4.0	2.0	0.3			
Unknown SU3	5.0	3.0	0.3										6.0	5.0	0.4			
Unknown SU4										3.0	2.0	0.1	2.0	1.0	0.1	2.0	1.7	0.2
Unknown SU5	5.0	3.0	0.2															
Vapis mobilis										6.0	20.0	0.4						
Varleria ventricosa	8.0	10.0	0.3															
Vernonia karaguensis																3.3	5.0	0.3
Vigna unguiculata													10.0	35.0	1.3			
Wondering jew							11.0	15.0	0.7				2.8	4.5	0.4			
Zea mays													9.7	43.1	5.8	9.0	46.7	1.8
Zehneria anomala	3.0	12.5	0.2															

RACHUONYO-NYANDO: Average number (count), percent cover and relative density (rd) per species, for plants sampled in the Rachuonyo-Nyando transect

	LAND COVER/USE											
	Bushland			Swamp			Agric(mix crop)			Agric(mono crop)		
BOTNAME	count	%cover	rd	count	%cover	rd	count	%cover	rd	count	%cover	rd
Abrus precatorius	3.0	5.0	0.4									
Acacia brevispica										3.0	5.0	0.4
Albizia coriaria				7.0	10.0	1.0						
Amaranthus gangeticus							7.0	15.0	2.0			
Andropogon africanus							3.8	3.5	2.1			
Bidens pilosa										2.0	5.0	0.6
Brachiaria deflexa				2.0	10.0	0.3	5.3	7.5	3.0			
Capsicum frutescens										3.0	1.0	0.4
Cassia bicapsularis										6.0	5.0	0.9
Chenopodium opulifolium										5.0	10.0	1.4
Cloris gayana	3.0	10.0	0.4									
Clotalaria auxillaris										2.0	2.0	0.6
Combretum adenogonium							4.0	10.0	1.1			
Commelina benghelensis							8.5	8.0	2.4			
Crotalaria agatiflora							6.5	15.0	1.8			
Crotalaria axillaris	3.0	9.5	0.9									
Crotalaria brevidens										2.5	10.0	0.7
Curcubita pepo										3.0	20.0	0.4
Cynodon dactylon	4.5	10.0	2.6	4.0	60.0	0.6				3.2	6.7	2.7
Dactyloctenium aegyptium	3.0	5.0	0.9									
Dactylotinum australe	3.0	5.0	0.9									
Digitaria abyssinica	6.0	10.0	0.9				2.5	5.0	0.7	6.0	7.0	7.4
Digitaria anusa	10.0	60.0	1.4									
Echnocloa colona	8.0	10.0	2.3									
Eragrostis exasperata	8.0	10.0	2.3				2.0	5.0	0.6			
Euclea divinorumnorum							2.7	8.3	1.1			
Harrizonia abyssinica										1.0	5.0	0.1
Heinsenia diervilrodes							10.0	17.5	2.8			
Indigofera areiiecta										10.0	5.0	1.4
Jasminum fluminense	3.5	6.0	1.0									

	LAND COVER/USE											
	Bushland			Swamp			Agric(mix crop)			Agric(mono crop)		
Lantana camara	6.0	80.0	0.9	3.5	6.0	1.0	7.0	30.0	2.0			
Leonotis nepetifolia						0.0	11.0	20.0	2.4			
Leucas calostachya	3.0	5.0	0.4			0.0						
Leucas glabrata						0.0	3.0	8.0	0.4			
Lippia javanica				3.0	5.0	0.9				1.0	5.0	0.3
Manihot esculenta							8.0	35.0	4.5			
Ocimum kilimandscharium							2.5	7.0	0.7			
Ocimum suave							1.5	2.5	0.4			
Panicum maximum										1.0	2.0	0.3
Phaseolus vulgaris							4.0	20.0	1.1			
Polyscias fulva										1.0	2.0	0.1
Portulaca quadrifida										4.5	2.0	1.3
Rhus natalensis	8.5	17.5	2.4				3.0	10.0	0.9			
Rhus vulgaris							3.0	2.0	0.4			
Saccharum officinarum										7.0	80.0	2.0
Senna didymobotrya				6.5	27.5	1.8	4.0	20.0	0.6			
Sochus schweinfurthii							2.0	1.0	0.6	4.0	3.5	1.1
Solanum incanum	3.3	2.0	1.8									
Sorghum bicolor	7.0	30.0	2.0									
Teclea nobilis							7.7	23.3	3.3			
Terminalia brownii	10.0	40.0	1.4									
Tithonia							3.5	12.5	1.0			
Unknown SU1	7.0	70.0	2.0				1.0	2.0	0.1			
Unknown SU2	3.0	10.0	0.9	2.5	3.5	0.7			0.0			
Unknown SU3							4.0	10.0	1.1			
Unknown SU4							6.0	2.0	0.9	1.0	2.0	0.1
Vigna unguiculata	8.5	30.0	2.4						0.0			
Vulpia bromoides	2.0	10.0	0.6				4.5	6.0	2.6			
Zea mays	6.0	40.0	1.7				6.3	41.4	6.2			0.0

KITUI: Average number (count), percent cover and relative density (rd) per species, for plants sampled in the Kitui transect

		LAND COVER/USE														
		Bushland			Forest			Mix crop			Mono crop			Woodland		
Botanical name	**Local/Common**	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd
Acacia mellifera	Muthia	2.0	15.0	0.3												
Acacia senegal	King'olola													1.0	5.0	0.1
Acacia tortilis	Mwaa	4.0	6.0	0.5										1.0	6.0	0.1
Acalypha fruticosa	Mukulua													3.0	3.0	0.4
Adansonia digitata	Muamba													1.8	4.8	0.9
	Mwamba	1.0	5.0	0.3	1.0	4.0	0.1							1.0	3.0	0.1
Albizia anthelmintica	Kyoa	3.0	3.0	0.4	2.5	4.5	0.7							5.0	3.0	1.3
Balanites aegyptica	Mulului	1.0	5.0	0.1												
Barleria acanthoides	Thangila	4.0	3.0	1.1										12.0	25.0	1.6
Boscia angustifolia/b.coriacea	Kiluli	1.0	15.0	0.1										1.0	5.0	0.1
Caesalpinia volkensii	Muvuu				1.0	2.0	0.1							5.0	10.0	0.7
	Muvuu				1.0	5.0	0.1									
Cajanus cajan	Nzuu							5.8	11.6	3.9	5.5	5.0	1.5			
Commiphora riparia/c.mildebrandtii	Itula	3.5	5.0	0.9												
Commelina benghalensis	Mukengesya				37.5	84.0	19.9									
Commiphora baluensis	Ikuu	11.3	7.7	4.5	2.3	5.0	0.9									
	Yiulu	2.0	5.5	0.5												
Commiphora riparia/c.mildebrandtii	Itula	1.0	2.0	0.1												
Cyanthula cylindrica/polycephala	Kyamata													8.2	36.2	6.5
Dalbergia lactea	Kibwabui													1.0	2.0	0.1
Delonix elata	Mwaange	1.0	2.0	0.1												
Dombeya kirkii	Mutoo													1.0	3.0	0.1
Euphobia candelabrum	Kyaa													3.0	10.0	0.4
Grewia bicolar	Kilawa				2.0	20.0	0.3									
	Mulawa	1.2	7.0	0.8										2.0	8.5	0.5
Grewia tembesis	Mutuva	3.0	3.0	0.4												
Hibiscus micranthus	Muliambila													2.0	2.0	0.3

		LAND COVER/USE														
		Bushland			Forest			Mix crop			Mono crop			Woodland		
	Mongoe tree							1.0	40.0	0.1						
Melia volkensii	Mukau							2.5	13.5	0.7						
Pistacia aethiopica	Musaai	7.0	11.8	3.7	1.0	5.0	0.1							8.8	35.0	7.0
Tamarindus indica	Uthumula													1.0	8.0	0.1
Terminalia brownii	Muuku													5.0	20.0	0.7
Zea mays	Mbemba							5.0	4.5	1.3						
	Green grams/Ndengu							10.8	12.5	5.7						
	Inyinginyi													1.0	5.0	0.1
	Itolongwe													1.0	15.0	0.1
	Kienjenje							1.0	10.0	0.1						
	Kinaatha	1.0	10.0	0.1												
	Kinukwi	50.0	75.0	6.6												
	Kisilungu	1.0	2.0	0.1												
	Kithumula										1.0	5.0	0.1			
	Komo	2.7	2.3	2.1	3.0	20.0	0.4							17.5	47.5	4.7
	Millet/Mwe							3.5	8.0	0.9						
	Monde				4.0	20.0	0.5							2.0	3.0	0.3
	Mukokola				4.0	80.0	0.5									
	Mutaa	23.3	31.7	9.3												
	Mutotomoko							5.0	10.0	0.7						
	Nut grass															
	Pawpaw							2.0	5.0	0.3						
	Thoroko/cow peas							3.3	4.0	1.3						
	Tobacco															
	Uungu							1.0	55.0	0.1						
	Walange	2.0	5.0	0.3												
	Yongwa													3.0	3.0	0.4

MBEERE: Average number (count), percent cover and relative density (rd) per species, for plants sampled in the Mbeere transect.

BOTANICAL NAME		LAND COVER/USE																		
		Bushland			forest			grazing area			Mix Crop			Mono crop			Wodland		
	LOCAL/COMMON	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	Rd	Count	Cover	rd
Acacia mellifera	Muthia	5.8	9.6	3.2															
Acacia nilotica	Musemei	2.0	2.0	0.1															
Acacia senegal	(blank)																1.0	3.0	
Acacia tortilis		5.3	10.5	1.3															
Balanites aegyptiaca	Mulului	1.0	1.0																
Caesalpinia volkensii	Muvuu	1.5	7.8	0.2															
Cajanus cajan	Pegion pea										3.0	8.0	0.2						
Cassia	Mukirichia										3.0	8.0	0.1						
Celtis africana	Mubebu				1.6	7.2	0.3												
Cenchrus ciliaris	(blank)	23.8	37.5	3.8															
Combretum molle	Murama																6.9	20.8	3.3
Commiphera africana	Mukuya																1.0	3.0	
Commiphora baluensis	Ikuu	5.7	8.4	1.6															
Commiphora sp	Itula	2.0	2.0	0.1															
Cordia africana	Muringa				1.4	4.4	0.6												
Croton macrostachyus	Mutundu				1.6	3.0	0.1												
Croton megalocarpus	Mukinduri				3.0	30.5	0.2												
Cynodon dactylon								65.0	87.5	5.1									
Diospyros mespiliformis	Mukoro																1.5	12.5	0.1
Dombeya burgesiae	Mukeu				15.6	37.9	4.3												
Dombeya kirkii	Mutoo													2.0	3.0	0.1	1.0	4.5	0.2
D/ombeya sp	Monde	12.6	20.4	5.0															
Ehretia cymosa	Murembu				1.0	3.0	0.1												
Erythrina abyssinica	Muuti	5.6	17.1	3.1				1.0	2.0										
Eucalyptus sp	(blank)				20.0	68.1	6.3												
Euclea divinorum	Kiraa kia njogu																2.5	43.8	0.4
Fagaropsis hildebrandtii	Muraa wa mburi																1.3	1.7	0.2
Ficus sycomorus	Mukuu				1.0	3.0													
Fiscus sycomorus	Mukuyu																1.0	4.0	
Flacourtia indica	Muraga																2.0	3.0	0.1

		LAND COVER/USE																
		Bushland			forest			grazing area			Mix Crop			Mono crop			Wodland		
Flueggea virosa	Mukururu	4.0	3.0	0.2				3.0	2.0	0.1								
Grewia tembensis	Mutuva	1.2	5.8	0.2														
Hibiscus micranthus	Muliambila	1.0	1.5	0.1														
Indigofera swaziensis	Ruora															3.5	22.5	0.3
Indigofera tanganyikensis	Rung'oyo															1.5	2.0	0.1
Juniperus procera	Mukuu	3.7	4.0	0.9	5.0	2.0	0.2											
Lannea fruiticosa	Kitharara															1.0	5.0	
Lantana camara		1.5	2.5	0.1												6.0	60.0	0.2
Leucaena sp	(blank)										3.0	2.0	0.1					
Markhamia lutea	(blank)															1.0	5.0	
Mangifera indica	Mangoes										1.8	19.8	0.4	1.0	5.0	0.0		
Manihot glaziovii	Cassava										1.0	35.0						
Markhamia lutea	Muu				1.5	13.5	0.1											
Ochna inermis	Muchegechege															1.0	3.0	
Ochna sp	Mutandi	1.0	5.0															
Ocotea usambarensis	Muura							1.0	4.5	0.1								
Opilia abyssinica	Mwanjati															4.5	27.5	0.4
Ormocarpum sp	Muthingii	3.0	1.0	0.1														
Ozoroa mucronata	Murahi	1.0	2.0													1.6	3.2	0.3
Pentas parvifolia	Maayo															2.0	10.0	0.1
Piliostigma thonningii	Mukuura	1.0	10.0															
Plectranthus barbatus	Kyooa	3.0	1.0	0.1														
Raphia farinifera	Mware										1.0	5.0						
Rhus sp	Mutheeru															17.0	45.0	0.7
Solanecio manni	Mooa	1.0	2.0															
Solanum incum	Mutongu	1.0	4.0	0.1														
Solanum incunum	(blank)	8.0	17.5	0.6														
Strychnos henningsii	Mutambi															1.8	6.8	0.3
Strychnos spinosa	Mwange	1.0	5.0															
Terminalia sp	Muuku	1.8	3.8	0.3														
Themeda triandra		32.3	72.9	9.0														
Vangueria infausta	Mukomara															1.0	30.0	
Vernonia amygdalina	Gitoru															16.0	45.0	0.6

		LAND COVER/USE																
		Bushland			forest			grazing area			Mix Crop			Mono crop			Wodland		
Ximenia americana	Mutura	3.0	4.0	0.1														
Zanthoxylum chalybeum	Mukenenga															1.0	5.0	
Zea mays	maize										4.8	15.6	1.5	2.0	5.0	0.1		
	Black cambretum	4.0	7.0	0.2														
	Mukokora	1.0	20.0															
	Mukumbi	1.0	3.0															
	Mukusya	5.0	40.0	0.2														
	Muthii	1.0	1.0															
	Muthingii	1.0	1.0															
	Mutololo	1.0	3.0															
	Mutuuduga				1.3	3.7	0.2											
	Mukinduru				8.0	25.0	0.3											
	Mwooya	2.5	2.0	0.2														
	Mutheru															3.0	40.0	0.1
	Mutheu	2.0	2.0	0.1														
	Muching'aara															1.0	1.0	0.0
	Avocado										1.0	15.0						
	Bananas										4.3	21.7	0.5					
	Beans										11.0	48.8	1.7	20.0	90.0	0.8		
	Black berry				1.0	15.0												
	Black cambretum										1.0	3.0					7.2	17.4 1.4
	Black jack				4.5	16.0	0.4				2.5	2.5	0.4					
	Blackjack										2.0	0.1	0.1					
	Brittle grass	4.5	24.5	0.4														
	Cassava										1.0	40.0						
	Cedar				8.7	10.7	1.0											
	cow pea										9.0	20.0	0.4					
	cowpeas										6.7	11.3	0.8					
	Euphobia																1.5	4.5 0.1
	Fern																1.0	3.0
	Fig tree				1.0	15.0												
	Gata weru																1.0	0.1
	Gikiriri																18.0	53.8 2.9

	LAND COVER/USE																	
	Bushland			**forest**			**grazing area**			**Mix Crop**			**Mono crop**			**Wodland**		
Githigongo																1.0	25.0	
Gitorongwe																1.0	3.0	
Gitoru																10.0	30.0	0.4
green grams										8.5	82.5	0.7						
Indigofera	2.0	2.0	0.1				5.0	1.0	0.2									
Itungati	3.0	3.5	0.2															
Kaaragania ndudu																5.5	10.0	0.4
Kanyaga weru																4.0	17.3	0.5
Kigaa kia ng'ombe	1.0	2.0																
Kirangare																1.0	5.0	
kirathagi																7.0	10.0	0.3
Kirera mbuku				1.0	1.0													
Kiumbu																1.0	10.0	
Kivaa																1.0	3.0	
Kivarwa																1.0	2.0	
Kyusya	1.0	1.0																
M,ukusyi	2.0	3.0	0.1															
makau										2.0	15.0	0.2						
Mbota				3.0	10.0	0.1												
Mbugu										5.0	8.0	0.2						
Mbwea	3.0	60.0	0.1															
Meru oak																3.0	10.0	0.1
Mitendera																14.5	50.0	1.1
Monde	13.5	25.0	1.1															
motootoo										1.0	5.0							
Mpingo																1.0	3.5	0.1
Muang'ara																1.0	10.0	
Muchiere																1.0	5.0	
Muchiji	1.0	2.0																
Muhara																3.0	50.0	0.1
Mukalwa	1.5	2.5	0.1															
Mukau										2.0	11.5	0.2						
Mukima				1.0	2.0					1.0	3.0	0.1						

	LAND COVER/USE																	
	Bushland			forest			grazing area			Mix Crop			Mono crop			Wodland		
Mukirichia													5.0	15.0	0.2			
Mukokora	2.0	40.0	0.1															
Mukombo				1.0	5.0													
Mukomboa ngima				1.0	1.0													
Mukomothi																1.0	8.0	0.1
Mukorwe				2.3	6.3	0.3												
Mukumbi	2.0	5.0	0.1															
Mukuswe	1.5	18.5	0.1															
Mung'ata	4.5	5.0	0.4															
Mung'uthe	1.0	1.0	0.1															
Muraa	3.0	20.0	0.4															
Murathangi	4.0	1.0	0.2															
Muriaria										7.0	3.0	0.3						
Murinda nguruwe				1.0	3.0											6.5	6.5	0.5
Muringa				1.0	1.0													
Muroroma							1.0	5.0										
Muruma andu																13.3	81.7	1.6
Mururuku																1.0	3.0	
Musari																10.0	50.0	0.4
Muswiswi	6.5	10.8	1.0															
Mutaa	6.7	26.7	0.8															
Mutamaliu																3.0	10.0	0.1
Mutharwa	2.7	1.7	0.3															
Muthatha				5.0	1.0	0.2												
Mutherema	4.0	8.5	0.3															
Mutheria ndundu				1.0	3.0													
Muthigira																1.0	15.0	0.0
Muthigiri	1.0	1.5	0.1				1.0	3.0								1.3	6.8	0.3
Muthingii	1.0	2.0																
Mutithi	15.0	25.0	0.6													2.0	5.0	0.1
Mutololo	3.0	2.0	0.2															
Mutongu				4.0	20.0	0.2												
Mutootoo																2.0	5.0	0.1

	LAND COVER/USE																
	Bushland			**forest**			**grazing area**			**Mix Crop**			**Mono crop**			**Wodland**	
Mutungurutha																3.0	40.0 0.1
Mutuva	4.0	15.0	0.2														
Muui	1.0	3.0	0.1														
Muuruthi																3.3	26.7 0.4
Muveva mai																1.0	10.0
Muvila	1.0	4.0															
Muvirairu																1.0	10.0
muvururu							1.0	1.0									
Muvuuri				2.0	10.0	0.1											
Muyee																4.5	5.5 0.4
Mwonde	1.5	4.0	0.1														
Nandi oak				4.0	5.0	1.0											
Ndathangi																6.5	35.0 0.5
Njegeni				1.0	1.0												
No herbs																	37.8
Ntharangi	20.0	30.0	0.8														
Numa							5.0	3.0	0.2								
Nut grass				8.0	25.0	0.6											
Panicum maximum										2.5	27.0	0.2					
pawpaw										2.0	3.8	0.3					
Red repens	50.0	40.0	2.0														
Runywe	16.3	27.7	2.6														
Ruuku				7.0	50.0	0.3											
Sisal	7.0	30.0	0.3														
Sweetpotatoe										3.5	35.0	0.3					
Uthui	4.0	7.0	0.2														
Whisthing pine				8.7	15.0	1.0											
White cambretum	5.0	8.0	0.2										1.0	3.0		2.7	16.7 0.6
Wild lillies																5.0	82.5 0.4

MERU: Average number (count), percent cover and relative density (rd) per species, for plants sampled in the Meru transect.

		LAND COVER/USE																	
	LOCAL /	Bushland			Forest			Grassland			Mix Crop			Mono Crop			Swamp		
BOTANICAL NAME	COMMON NAME	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	Rd
Acacia africana	(blank)																4.5	35.0	0.1
Acacia drepanolobium	(blank)	15.0	5.0	0.2															
Acacia senagal	(blank)	2.0	10.0	0.0															
Acacia tortilis	Mugaa	1.0	0.5	0.0				2.5	3.0	0.1									
Acokanthera schimperi	Mwara Muthwa				1.0	3.0	0.0												
Aristida	(blank)							1.7	53.3	0.1									
Bottle brush	(blank)							5.0	40.0	0.1									
Bracharia deflexa	Ruuku				30.5	55.0	1.0												
Brachiaria reptans	(blank)																100.0	95.0	1.6
Bridelia micrantha	Mutemana				9.0	10.3	0.4												
Calsalphinia volkensii	Muyuthi																		
Catha edulis	Miraa										3.0	10.0	0.0						
	Muraa										2.2	20.0	0.2						
Combretum collinum	Muraa/white combretum							3.0	8.0	0.0									
Cordia abyssinica	Mutuati																		
Cordia africana	Muringa										1.0	5.0	0.0						
	Muu				9.0	55.0	0.1												
Cynodon dactylon	(blank)																150.0	70.0	2.4
Cynodon dactylon	Ntima										200.0	95.0	3.1						
Friesodielsia oboyata	Q2P7 unknown 1	1.0	1.0	0.0															
Justicia flava	Thandoe				37.5	36.3	2.4												
Markhamia lutea	Muu										1.0	1.0	0.0						
Merkhamia lutea	Muu				3.0	24.5	0.2												
Osyris lanceolata	(blank)																		
Ponicum maximum	Murugia										2.0	3.0	0.0						
Rhapia australis	Muruguyu	1.5	12.0	0.0															
Rhus vulgaris	Murema Muthwa							2.0	5.0	0.0									
	Muremamuthwa							1.0	1.0	0.0									
Solanum incunum	Mutongu							1.5	7.5	0.0									

		LAND COVER/USE																	
	LOCAL /	Bushland			Forest			Grassland			Mix Crop			Mono Crop			Swamp		
BOTANICAL NAME	COMMON NAME	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	Rd
Tamarindus indica	Mkwajo	1.0	50.0	0.0															
Themeda triandra	(blank)	52.5	85.0	1.7				171.8	88.8	21.6							17.0	75.0	0.3
Tothonia	Kimaua													12.0	41.0	0.4			
Vangueria madagascariensis	Muiru				2.0	5.0	0.0												
Zea mays	Mpempe										12.0	25.0	0.2						
Zeamays	Mpempe										4.5	7.0	0.1						
	Aristida																41.3	37.3	1.9
	Avocado										5.0	15.0	0.2						
	Banana tree										53.3	66.7	2.5						
	Beans/Mung'au										22.0	48.5	0.7						
	Black Combretum	2.0	2.0	0.0															
	Bottle brush	100.0	50.0	1.6															
	Gikuri										4.0	2.0	0.1						
	Karangare				2.0	1.0	0.0												
	Kienyi																		
	Kiere				1.0	22.5	0.0												
	Kirigi				8.0	50.0	0.1												
	Mpempe										2.0	3.0	0.0						
	Muchene																		
	Muilu										1.0	1.0	0.0						
	Mukima										3.8	12.5	0.2						
	Mukomore				5.0	40.0	0.1												
	Mukuno Muvuno				1.0	2.0	0.0												
	Mukuu				1.0	20.0	0.0												
	Murema muthua	13.3	27.5	0.8															
	Murenda													1.0	1.0	0.0			
	Muriama				1.0	10.0	0.0												
	Murunga				6.0	30.0	0.1												
	Mutemana				13.0	5.0	0.2												
	Muteretu				8.0	60.0	0.1												
	Muthande				1.0	5.0	0.0												

BOTANICAL NAME	LOCAL / COMMON NAME	LAND COVER/USE Bushland			Forest			Grassland			Mix Crop			Mono Crop			Swamp		
		Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	Rd
	Muthangalia				4.0	1.5	0.1												
	Muti muilu				7.0	5.0	0.1												
	Mutongu				4.0	30.5	0.1												
	Mutoro				3.0	50.0	0.0												
	Mutu				6.0	10.0	0.1												
	Mutuati				1.0	15.0	0.0												
	Mutuu				5.0	1.0	0.1												
	Muuruga				7.0	40.0	0.1												
	Mwara Muthwa				1.0	3.0	0.0												
	Ndago																3.0	20.0	0.0
	Nkengeyia													15.5	22.5	0.5			
	Nut grass	35.0	55.0	1.1															
	Nut grass/Ngatu										280.0	60.0	4.4						
	Nutgrass/Ngatu										155.0	75.0	4.9						
	P9Q1 unkown 1 shtub	2.0	20.0	0.0															
	Poison grub	1.0	13.3	0.0															
	Sector grass	1.0	10.0	0.0															
	Star edulis																3.0	20.0	0.0
	Star grass																	2.0	
	Sweet Potatoe										3.5	65.0	0.1						
	Thandoe				41.0	45.0	1.3												
	unknown herb 3	3.0	40.0	0.0															
	Unkonwn 1 Q2P10																150.0	90.0	2.4
	Utu Kuumo				10.8	42.5	1.4												
	Water lilis																1.0	10.0	0.0
	White berry bush	1.0	5.0	0.0															
	White Combretum	3.0	2.5	0.1				6.5	9.0	0.2									

MWINGI: Average number (count), percent cover and relative density (rd) per species, for plants sampled in the Mwingi transect.

		LAND COVER/USE											
		Bushland			Mix Crop			Mono crop			Woodland		
BOTANICAL NAME	**LOCAL/COMMON**	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd
Acacia Nilotica	Kisemei										2.0	8.0	0.4
Acacia tortilis	Muaa	4.0	20.0	1.7							5.0	19.5	2.2
Acalypha Fruticosa	Mukulua										3.0	30.0	0.7
Adansonia Digitata	Mwamba				1.0	2.0	0.2				1.0	16.7	0.7
Albizia anthelmintica	Kyoa										2.0	3.0	0.9
Caesalpinia volkensii	Muvuu	3.0	55.0	1.3							2.0	15.0	0.4
Cajanas Cajan	Nzuu				10.4	12.4	11.3	33.5	37.5	14.6			
capparis tomentosa	Itamba Mboo										1.5	45.0	0.7
Cassia Abbreviata	Kiatha Ndathe										2.0	15.0	0.4
	Kyathandathe										4.0	40.0	0.9
Commiphora Baluensis	Ikuu	5.0	17.0	2.2									
	Mukuu										17.0	40.0	3.7
Cyanthula Cylindrica/Polycephala	Kyamata	1.5	1.0	0.7									
Delonix elata	Mwaange	2.0	5.0	0.4									
Grewia Bicolar	Mulawa										2.0	30.0	0.4
Grewia similis	Mutuva	1.0	2.5	0.4									
Mangifera Indica	Mangoes				15.0	50.0	6.5						
Melia Volkensii	Gikeu	4.0	15.0	0.9									
Meru oak	Muuru (Kimeeru)							1.0	2.0	0.2			
Premna Resina	Mukaakaa										4.5	52.5	2.0
Sclerocarya birrea	Kamula (Muura-Kitharaka)	2.0	2.0	0.4									
	Muua	1.0	10.0	0.2									
Sterculia rhynchocarpa/S.africana	Kyusya	1.7	10.0	1.1									
Tarmarindus Indica	Muthithi-Kimeeru				1.0	15.0	0.2						
Terminalia Brownii	Muuku										2.0	23.3	1.3
Zea mays	Mbemba				5.3	3.7	3.5						
	Bridgles				6.0	6.0	1.3						
	Cassava				3.5	10.0	1.5						
	Gikuni										2.0	10.0	0.4
	Guava tree				1.0	10.0	0.2						

BOTANICAL NAME	LOCAL/COMMON	LAND COVER/USE											
		Bushland			Mix Crop			Mono crop			Woodland		
		Count	Cover	rd	Count	Cover	rd	Count	Cover	rd	Count	Cover	rd
	Ithiia Utuku	6.0	45.0	1.3									
	Kalundi										1.0	2.0	0.2
	Kalundi (Nundi)										4.0	5.0	0.9
	Kilembu	1.0	1.0	0.2									
	Kinunga nai										1.0	7.0	0.2
	Kisibu										3.0	7.0	0.7
	Komo	5.0	17.5	2.2							2.0	10.0	0.4
	Lemon Tree												
	Monde										5.0	25.0	1.1
	Mua							1.0	10.0	0.2			
	Mukwata Ng'ondu											80.0	
	Mulema	6.0	47.5	2.6									
	Mung'ei (Kimeeru)				20.0	40.0	4.3						
	Mutaa	4.0	2.0	0.9							10.0	50.0	2.2
	Mutatha	1.0	1.0	0.2									
	Muthigiti-Kimeeru				1.0	5.0	0.2						
	Mutoo				1.0	2.0	0.2						
	Mutunga	1.0	28.0	0.2									
	Muvuu										2.0	10.0	0.4
	Mwithangwe										1.5	5.5	0.7
	Mwithongwe										18.0	30.0	3.9
	Nut grass/Ngatu				3.0	5.0	0.7						
	Onions				1.0	1.0	0.2						
	Orange tree												
	Paw paw				2.0	3.0	0.4						
	Runywee										25.0	40.0	5.4
	Sorghum							4.0	15.0	0.9			
	Thoroko/cowpeas				10.0	7.5	4.3						
	Tuti										4.0	35.0	0.9

Appendix 5. Summaries of insect data by transects

Species of insects found in the Nyanza/western and Baringo transects of PATTEC study sites

Location	Land Use/ Land cover	Insect Name	Common Name	No. Insects
Sindo-Suba	Grassland	Papilio spp.	Large Butter flies	3
		Vespula spp.	Wasps	2
		Apion pullus	Cow Bea weevil	5
		Lygaeus spp.	Plant Bugs	2
		Chrysopa peria	Lace wing	1
		Iris oratoria	Mantids	1
		Brevycoryne brassicae	Aphids	10
	Agriculture	Chorthippus scalaries	Green Hopper	2
		Pieris spp	Milk butterfly	4
		Pieris spp.	Yellow/ Black butterflies	3
		Limenitis Camilla	Yellow Butterfly	2
		Gryllus campestris	Field Cricket	1
		Apis mellifera	Honey Bees	5
		Empir tessellate	White Butterflies	2
		Chrysolina spp.	Robber fly	1
		Lucilia Caesar	Green Blow flies	7
		Pieris spp.	Leaf Beetles	4
		Chilo spp.	Larvae of stem borer	3
		Maculinea arion	Small Blue Butterflies	2
		Apis mellifera	Honey Bees	8
		Vanessa cardui	Milk Butterfly	2
		Musca domestica	House flies	6
		Chorthippus spp.	Blue flies	10
		Chrysolina polita	Flower Beetle	2
		Hippodamia spp	Lady Bird	5
		Aeshua cyanea	Dragon flies	2
		Camponotus Vagus	Brown G/ Hopper	1
		Calliphoria Vomitoria	Black Ants	3
		Vespula Vulgaris	Wasps	7
		Lucilia Caesar	Green flies	6
		Necrodes littoralis	Rove Beetles	2
		Acanthomia horida	spiny Bugs	6
		Bacillus rossius	Stink Insects	3
		Callosamia	Long horned grass hopper	1
		Syrphus ribesii	Ground Beetles	4
		Anopheles	Mosquitoes	6
		Myrmica rubsa	Ants	10
		Gryllus campestris	Cricket	1
		Eriosoma spp.	Aphids	2
		Chrysopa pallens	Lace wings	1
		Tettigoniadae spp	Flies/ Hover	8
	Bushland	Musca domestica	House fly	6
		Pieris spp.	White Butterflies	2

Location	Land Use/ Land cover	Insect Name	Common Name	No. Insects
		Scarabaeus spp	Bees	5
		Lucilia Caesar	Blow fly green	3
		Epilachna spp	Dung Beetle	2
		Tetrix undulata	Brown grass hopper	1
		Apis mellifera	Lady bird	1
Ruma N.P	Bushland	Pieris napi	Butter flies	1
		Bombus terrestries	Bumble bee	1
		Myrmilla capitata	Wild wasps	4
		Camponotus vagus	Fleshflies	1
		Musca domestica	Black Ant.	5
		Chllidura aptera	Earwig	4
		Lucilia Caesar	Green metali flies	6
		Caliphora Vomitoria	metallic blue flies	10
		Sarcophaga spp	Houseflies	1
	Grassland	Rhipicephilus appendiculatus	Tsetse flies	8
		Tabanus spp	Brown Ear tick	3
		Anopheles	Mosquito	3
		Pieris	Yellow butterflies	1
		Glossina spp	Horse flies	5
Homabay South - Kabuoch	Woodland	Pieris Spp.	Yellow Butterfly	2
		Tiphia femorata	Wasps	1
		Rivetina bactica	mantids	1
		Phylus spp.	True bugs	5
		Papilio	Large butter	2
		Rhacocleis germanica	Wood cricket	1
Miranga	Agriculture	Apis mellifera	Honey bees	4
		Musca domestica	House flies	3
		Acanthosoma spp	Flesh flies	3
		Gryllomorpha spp	Shield Bug.	1
		Lucilia caesar	Metalic Green	1
		Calliphoria vomitoria	Metalic blue	8
		Sarcophaga	Field cricket	5
		Aedes spp.	Field Cockroaches	1
		Loboptera decipiens	Mosquitoes	4
Busia	Agriculture	Meliera Omissa	Fruit flies	2
		Papilio spp.	P/ Mantio	1
		Mantis religiosa	Large Butter flies	1
		Aeshua grandis	Dragon brown	2
		Apis mellifera	Honey Bee	3
		Epilacua spp.	Lady Bird	1
		Volucella spp	Bee flies	4
Funyula	Agriculture	Myrmica rubsa	Brown Ants	5
		Apis Mellifera	H/ Bees	5
		Aromia moschata	long horned Beetles	4
		Calliphoria vomitoria	Metalic Blue	1
		Pieris spp	White Buttea	1
		Anax imperator	Blue Dragon	2
		Ischnura elegans	Damsel flies	3
		Lucilia Caesar	Metalic Green	6

Location	Land Use/ Land cover	Insect Name	Common Name	No. Insects
Siaya	Agriculture	Lasius niger	Ants	1
		Anopheles spp	Lacewing	1
		Aphis fabae	Mosquito	4
		Nokochrysa fulriceps	Aphids	9
		Libellula depressa	Dragonfly	1
		Acrotylus incubricus	Grass hopper	3
		Myrmica rubsa	Ants/ Brown	8
		Chorthippus parallelus	H/ Bees	6
		Scolia flavifrons	Green Hopper	2
		Apis Mellifera	Wasps	1
		Nezara viridula	Shield Bug	1
		Apis mellifera	Bee	8
		Carpocoris spp	Bugs	1
		Monomorium spp.	Brown ants	3
		Locusta spp.	Grass hopper	2
	Bushland	Culex spp.	Mosquitoes	3
		Epilachua spp.	Lady bird	2
		Musca domestica	Houseflies	6
		Messor Barbara	Ants	15
		Celastrina spp.	Small blue butterflies	3
		Hippodamia spp.	Lady bird beetle	1
		Chorthippus scalars	Spider	2
		Formica rufa	Grass hopper	8
		Dysdera crocota	Ants	1
		R.A	Ticks	1
		Gryllus campestris	red Dragon flies	2
		Sympetrum spp	Field Crichets	3
	swamp	Camponotus Vagus	Black Ant.	3
		Aeshua cyanea	Dragon	2
		Psyllobora punctata	Lady Bird	1
		Chrysolina polita	Leaf Beetle	4
		Colias croceus	Yellow Butterflies	2
		Hylaeus signatus	Bees	4
		Pieris spp.	White B/ flies	2
		Astata boops	Black wasps	3
		Coryna	Pollen beetle	1
BONDO	Bushland	Aromia moschata	long horned Beetles	1
		Anax imperator	Blue Dragon	3
		Pieris spp	White Buttea	1
		Calliphoria vomitoria	Metalic Blue	6
		Ischnura elegans	Damsel flies	8
		Leucozona spp.	Flower flies	1
		Phyllopertha horticola	Dung Bettles	4
		Lucilia Caesar	Metalic Green	1
	Swamp	Pieris spp	Yellow butterflies	2
		Musca domestica	Houseflies	6
		Pieris spp	Mosquitoes	3
		R.A Rhipicephilus appendiculatus	Flesh flies	5

Location	Land Use/ Land cover	Insect Name	Common Name	No. Insects
		Sarcophagi spp.	Ticks	2
	Agriculture	Aeshna cyanea	Dragon common hawker	1
		Pyrrhosoma	Red Damsel fly	4
		Sympetrum flaveolum	Brown Dragon	2
		Lycaena spp	Green /hopper	2
		Psophus stridullus	BrownG;/Hopper	3
		Chorthippus spp	Blue butterflies	1
		Sarcophaga spp	Flesh fly.	2
		Gyrinus natator	Whirligig	3
		Aquarius najas	Water striders	6
		Glossina spp	Tsetse flies	4
		Libellula depressa	Dragon fly	3
		Myrmica rubra	Ant.	1
		Lycaena virgaurege	Butterfly	4
		Scutigerella spp.	Centipede	1
		Kalotermes vagus	Termites	6
		Camponotus Vagus	Black Ants	5
		Anophles spp	Mosquitoes	2
		Tibicen plebejus	Cicada	1
		Aiolopus spp	Green hopper	3
		Pisaura mirabilis	Gray spider	1
		Calliphoria vomitoria	Metalic blue	8
		Lucilia Caesar	metallic green	9
		Pieris spp	Black Ant	3
		Ikalotermes spp	House fly	5
		Camponotus vagus	Yellow Butter	1
		Musca domestica	Termites	10
		Orthetrum spp	Termites mould	15
		Camponotus spp	Dragon fly	2
		Brenthis ino	Yellow Butterfly	3
		Pieris napi	White red butterflies	1
		Messor Barbara	Brown Ants	5
		Evarcha arcuata	piders	1
		Formica rufa	Wood Ant/ Brown	3
		Pieris spp	Yellow Butterfly	1
		Papilio spp	Large Butterflies	1
		Reticulitermes	Termites	6
		Tabanus bovinus	Horse flies	1
		Aeshna grandis	Dragon flies	1
		Hylaeus signatus	Bee	5
		Melecta luctuosta	Wild Bee	1
		Messos Barbara	Winged Ant	3
		Vespula Vulgaris	Social wasps	1
		Cychrus caraboides	Ground Beetle	1
		Sarcophagi carnaria	Flesh fly	3
		Pieris rapae	yellow Butter	1
		Methochinae spp.	Wild wasps	1
		Tetrix undulate	Hoppers	2
		Camponotus vagus	Ants.	6

Location	Land Use/ Land cover	Insect Name	Common Name	No. Insects
		Phlaeothrips spp	Thrips	8
		Empis tesellata	Robber flies	1
		Pieris spp	Dragon flies	1
		Orthetrum cancellatum	Dragon flies blues	1
		Tetrix depressa	Y/ Butterflies	1
		Anax imperator	G/ Hoppers	1
BARINGO	Bushland	Aeshna cyanea	Dragon common hawler	4
		Pyrrhosoma	Red Damsel fly	2
		Sarcophagus spp	Flesh fly.	1
		Lucilia Caesar	Metalic green flies	3
		Gyrinus natator	Whirligig	8
		Aquarius najas	Water strides	4
		Glossina spp	Tsetse flies	6
		Tibicen spp	cicada	3
		Libellula depressa	Dragon fly	2
		Myrmica rubra	Ant.	5
		Lycaena virgaurege	Butterfly	2
		Scutigerella spp	Centipede	1
		Kalotermes vagus	Termite	10
		Camponotus Vagus	Black Ants	5
		Anophles spp	Mosquitoes	8
		Tibicen plebejus	Cicada	1
		Aiolopus spp.	Green hopper	1
		Pisaura mirabilis	Gray spider	2
		Orthetrum spp	Termites mould	8
		Camponotus spp	Dragon fly	2
		Pieris napi	White red butterflies	1
		Messor Barbara	Brown Ants	2
		Evarcha arcuata	Spiders	1
	Agriculture	Formica rufa	Wood Ant/ Brown	10
		Calliphoria vomitoria	Metalic blue	6
		Lucilia Caesar	metallic green	7
		Camponotus vagus	Black Ant	1
		Musca domestica	House fly	4
		Pieris spp.	Yellow Butterfl	2
		Ikalotermes spp	Termites	12
		Pieris spp	Yellow Butterfly	1
		Papilio spp	Large Butter	1
		Reticulitermes	Termites	8
		Tabanus bovinus	Horse flies	1
		Aeshna grandis	Dragonfly	3
		Hylaeus signatus	Bee	8
		Melecta luctuosta	Wild Bee	1
		Messos Barbara	Winged Ant	4
		Vespula Vulgaris	Social wasps	6
		Cychrus caraboides	Ground Beetle	1
		Pieris rapae	yellow Butter	2
		Methocha spp	Wild wasps	1
		Tetrix undulate	Hoppers	2

Location	Land Use/ Land cover	Insect Name	Common Name	No. Insects
		Camponotus vagus	Ants.	6
		Phlaeothrips spp	Thrips	10
		Empis tesellata	Robber flies	1
		Anax imperator	Dragon flies	1
		Tetrix depressa	G/ Hoppers	3
		Pieris spp	Y/ Butterflies	2
		Libellula depressa	Dragonfly.	2
		Sympetrum spp.	Dragon fly	1
		Chorthippus spp	Grasshopper	3
		Euchorthippus spp.	Grass hopper	4
		Vestitus	Crickets.	1
		Phylledremia spp.	Cockroach	2
		Libellula spp.	Dragon	1
		Apis Mellifera	Honey bee	6
		Messor spp	Ants	8
		Callifornia vomitoria	Blowfly	1
		Bombus spp.	Bumble bee	1
		Ruspolia nitudula	Grass hopper	6

Species of insects found in eastern transects of Meru - Mwea PATTEC sites

Location	Land use	Scientific name	Number
Siakago	Sparse agriculture	Paracinema tricolor	3
		Herpes mellifera	5
		Cylas sp	1
		Cheilomenes sp	1
		Cletus fuscescens	1
		Chrotogonus sp	1
		Melanagromyza phaseoli	3
		Ptossina sp	1
		Apion pullus	5
		Aphis craccivora	50
Njukiri	Artificial forest	Assasin bug	10
		Diciostaurus sp	6
		Gryllus sp	8
		Platella germanicae	5
		Asbecesta cyanipennis	2
		Alydus calcaratus	2
		Apion pullus	3
Kianjiru	Sparse agriculture	Herpes mellifera	3
		Coryna sp	2
		Melanagromyza phaseoli	5
		Alcidodes sp	1
		Cheilomenes sulphurea	2
		Cheilomenes lunata	4
		Lycaena virgaureae	3
		Maculinea arion	5
	Woodland	Lycaena virgaureae	2
		Maculinea arion	3
		Papilio sp	1
		Sympetrum	1
Kiang'ombe	Woodland	Dysdecus sp	2
		Sympetrum sp	5
		Epilachina sp	6
		Dissosteira sp	1
		Beris sp	2
Makima	Bushland	Inachis sp	3
		Lycaena virgaureae	2
		Cheilomenes sp	1
		Dysdecus sp	4
		Herpes mellifera	6
		Cletus fuscescens	1
		Paracinema tricola	4
		Dissosteira sp	3
		Pholidoptera	1
		Melieria omissa	1
Kivaa	Bushland	Maculinea arion	4
		Melieria omissa	1

Location	Land use	Scientific name	Number
		Euroleon nostras	4
		Herpes mellifera	3
Mutuati	Forest	Necrobia sp	5
		Maniola jurtina	5
		Inachis sp	4
		Pieris brassicae	5
		Lygaeus sp	10
		Conchylidae	25
		Callosomia sp	9
		Acrotylus sp	3
		Tipula sp	3
		Blatella germanicae	10
		Dissosteira maroccunus	2
Nguyuyu	Dense bushland	Melanargia galathea	10
		Lycaena virgaureae	5
		Dissosteira sp	10
		Pyrgomorpha sp	10
		Paracinema tricor	5
		Locusta migratoria	5
		Aeshina grandis	5
		Punctata sp	2
		Herpes mellifera	5
		Chrysolina sp	10
		Helopeltis sp	5
		Coryna sp	4
		anophotiermes sp	4
		Acanthosoma sp	2
Meru national park	Swamp	Aeshina grandis	5
		Locusta migrotoria	10
		Pyrgomorpha sp	4
		Oberea sp	1
		Punctata sp	2
		Aphthona bimaculata	2
		Tragiscoschema sp	5
	Grassland	Locustae migratoria	>30
		Pygomorpha sp	20
		Aeshina grandis	2
Kabachi	Agriculture	Acanthosoma sp	3
		Maculinea arion	2
		Herpes mellifera	4
		Vespula sp	2
		Dissosteira sp	4
		Pyrgomorpha sp	5
		Necrobia sp	2
		Cantharis sp	4
		Dolycoris baccarum	2
		Epilachna chrysomelina	2
Athi	bushland	Anthocoris cardamis	5
		Pieris rapae	5

Location	Land use	Scientific name	Number
		Colias croceus	5
		Melanargia galathea	7
		Dissosteira maroccanus	7
		pezotetrix giornai	2
		euroleon	4
		Apion pullus	10
Kanziko	Sparse agriculture	Lycaena virgaureae	3
		Pieris brassicae	5
		Glossina sp	6
		Maculinea arion	4
		Utethesia pulchella	2
		Coryna sp	8
		Mirperus jaculus	10
		locusta migratoria	2
		Notostiva elongata	5
Ndile	Woodland	Lycaena virgaureae	18
		Dociostaurus maroccarus	4
		Anthocaris cardamines	10
		Pieris napi	15
		Colias eroceus	20
Nzoiyani	Woodland forest	Dysdecus sp	5
		Pieris rape	3
		Aporia crataegi	5
		Apion pullus	2
		Dissosteira sp	3
Nuu hills	woodland	Coryna sp	15
		Herpes mellifera	10
		Glossina sp	20
		Pezotetrix giornai	3
Masyungwa	Bushland	Pieris rapae	3
		pieris napi	2
		Dysdecus sp	4
		Rhinocoris sp	1
		Misembrina meridiana	4
		Platycleis albopunctata	2
		Cychrus caraboides	1
		Blatella germanica	5
Mivukoni	Sparse agriculture	Cheilomenes sp	5
		Epilachina canina	10
		Acanthosoma sp	8
Migwani	Agriculture	Cheilomenes sp	5
		Cletus fuscescen	3