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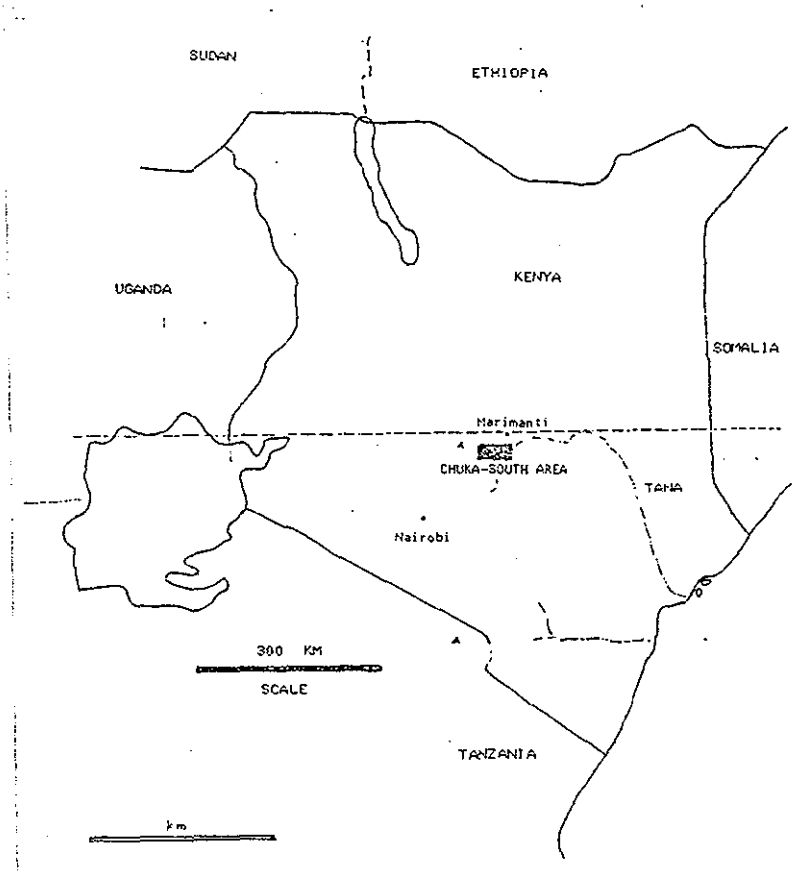
1 INTRODUCTION

The Chuka-south area, the study area, is situated on the eastern slopes of Mt. Kenya (Eastern Province, Kenya), see figure 1.
It was selected because of the environmental variation, climatical it varies from humid to semi-arid, geological from volcanic to metamorphic and physiographical from Mountain Footslopes to Uplands.

In 1985 and 1986 the TPIP (Training Project in Pedology) of the Agriculture University Wageningen in the Netherlands has conducted soil surveys and related surveys in the Chuka-south area, as a following up of previous projects in Kisii and Kilifi. In close cooperation with the Kenya Soil Survey a 1:100,000 soil map has been prepared. The work will be finished with an overall land evaluation of the area.

A part of this work is the preparation of a Vegetation/Landuse map, scale 1:100,000, necessary for an sound landevaluation.
The presented map and the descriptions of landscape, vegetation and landuse are based on interpretations of 1968 air photographs (1:50,000), corrected to the present situation. Four months of field work was spend to describe the interpretation units.

FIGURE 1: LOCATION CHUKA-SOUTH AREA



2 GEOLOGY, PHYSIOGRAPHY AND CLIMATOLOGY

As an introduction to the next chapters a generalised image is given of the environmental factors of the area. For more details see the report Geology of the Chuka-south area by Veldkamp and Visser and the several soil reports by various authors.

2.1 Geology

A major division can be made between the relatively young Kenya volcanics which dominate the western part of the Chuka-south area and the precambrian Basement System which dominates the eastern part of the area. Going from the past to the present:
In precambrian times (more than 500 million years ago) the metamorphic Mozambique belt was formed. It covers much of Eastern and Southern Africa. The Basement System which dominates large areas of Kenya is part of it. It is formed by layers of sediments, later completely metamorphised. The majority of it consists of various types of gneisses, south of Ishiara predominantly biotite and hornblende gneisses, in other parts Hornblende gneisses predominate. In these gneisses narrow amphibolite belts occur. The plagioclase (a feldspar) in the weathering gneisses and amphibolites is the source of Ca in the secondary lime which accumulates especially near rivers.
Locally in the cental and northern parts of the area, the gneisses have been further metamorphised into granulites.

Two major types of intrusives are found in the Basement System rocks: a range of granitic intrusives is found in the eastern part of the area. Mumoni is part of one range , Kijege and Kierere are of an other range (all SW-NE). Outside the area they continue. The nucleus of these intrusives is pure granite, but the peels are granitoid gneisses. They are formed several kilometers below surface and finally appeared after weathering of softer layers. The surrounding gneisses are softer and more sensitive for erosion. In this way the granite bodies remained and rose above the surroundings as "Inselbergs". In the northern part of the area several other intrusives dominate the landscape. They differ largely of the Mumoni and Kijege range in consisting of predominatly (ultramafic) hornblende gabbros and granulites.
The overal strike in the area is south west- north east. This can be easily seen in the direction of the Tana river, especially the southern part of it, where it flows straight trough a belt of relative soft hornblende gneisses and avoids the surrounding granitoid gneisses.
In the western part of the area some small granitic Hills can be found, remnants of Inselbergs like the eastern ones which are largely covered by volcanic deposits.

Quite recently major changes took place, preceded by the formation of the Rift Valley. Mt. Kenya , a volcano , was formed and 3.5-2 million years ago flows of Phonolite and especially Lahars (mud streams, a mixture of water, pyroclastics phonolite and other eroded rocks) covered the western part of the area. Often these flows were very fluid and could reach distances of up to 50 km. They covered the area, exept the peaks of the granitic Intrusives. At the end of the flows no real altitude difference existed between the volcanic flows and the Basement System area. Due to a difference in erosivity, nowadays differences of more than 100 m can be found.

Roughly at the same time as the activity of Mt. Kenya , craters of the Nyambeni range (north of the Chuka area) were active and basalt flows from there covered much land north of our area. A few basalt flows streamed through rivers like the Mutonga till the Tana river (the lowest part of the area). Nowadays remnants of these flows can be seen as plateaus. The surrounding Basement System rocks eroded faster than the basalt (inversion).

This volcanic activity changed the drainage pattern of the area considerably. One of the most conspicious aspects of the eastern part of the area are there fore the numerous river terraces (not all of them very easily detectable). The Tana terraces are rich in Pyroclastics, the terraces of the Thuchi and Ruguti rivers contain mixtures of as well Basement material as Phonolites.

Colluvium from the volcanic area and the numerous Mountains and Hills rejuvenates locally the landscape. This has had large effects, especially after the clearing of forests.

2.2 Physiography

In this description all landform classification names are used as defined by the Kenya Soil Survey in their internal communication nr 13, 1978.

Starting at the highest point of the area (2100 m), the slopes of Mt. Kenya form a landscape which is called Mountain Footridges This landscape consists of more or less parallel ridges with a slope down towards the east. These ridges are seperated by valleys, differing in depth and width. Four of them were big enough to map, they have their origin in the alpine zone on Mt. Kenya.
In the southern part of the area these Mountain Footridges change at ± 1300 m altitude into a Plateau with a slope of a few percent to the east and very undulating topography. The same major valleys dissect this Plateau , they are however much smaller than upwards. Several other valleys are formed in this landscape and cause a much more dissected landscape. In the east the Plateau is bounded by a scarp of up to 100 m high.
North of the Plateau the Mountain Footridges change into (volcanic) Uplands (1200 m) with an undulating to rolling topography and with an average slope of more than 10% directed to the east.

Here the boundary to the (Basement System) Uplands is quite gradual and is on several places interrupted by the a smooth transition to the Hills and Mountains of the (basic) Intrusives. (1100m altitude). They are of approximately the same altitude as the western part of the (volcanic) Uplands, but rise more than 100 m above the (Basement) Uplands. Their topography is in general hilly or mountaineous (slopes > 16%).

The Uplands in the Basement System are gently undulating to rolling and are dissected by several relative small valleys (compared to upwards). Many small seasonal streams dissect the land , relative deep (several meters). Many riverterraces with a flat to gently undulating topography are found near the rivers. These rivers streamed in the volcanic landscapes more or less parallel to each other. Here in the Uplands they flow to one central point north of the Kianyongo Hills where they join and flow in the Mutonga and finally in the Tana river.
Hills are quite common, most of them rise a few hundred meters above the surroundings and have quite extended footslopes.

The Tana valley is surrounded by the Mountain range of Kijege and Mumoni which rise up to 1500 m and some other Hills. Several kilometers wide, with an undulating topography the valley dominates the extreme eastern part of the area. Riverterraces are quite common along the Tana, some of them are flat (north), in the south they have a slope of several percents (but much less than the other Uplands) and are dissected. Several wadis (very wide rivers which flow only a few days a year) dissect the Uplands east of the Tana. The river bed is sandy and flat.

2.3 Climate

In general the climate in the Chuka-south area ranges from mountaneous humid to semi-arid. Figure 2 shows the average annual rainfall in the area. The correlation between the amount of rainfall and altitude is very high. As a rule of the thumb one can say that the amount of rainfall in millimeters is the same as the altitude in meters. The dominating eastern wind is responsible for this and causes for a rising amount of rainfall to the west and spots of wet areas on the Mountains in the east.

Figure 3 shows the annual rainfall distribution for three characteristic places, Embu forestry station (1905 m) for the highest part of the area, Chuka (1470 m) for most of the western part of the area. Tharaka (914 m) is characteristic for the eastern area.

In general two rainy seasons are present , one long (march, april and may) and one short (october and november). The amount of rainfall in each does not differ. High, in the extreme western part of the area, also rain is possible in the period of june till september. In january and february no rain falls.

These figures show only the mean annual rainfall. Especially in the semi-arid eastern part of the Chuka-south area considerable variation in annual rainfall is found. Figure 4 shows the amount of rainfall in several years in Marimanti (15 km north of Chiokarige in a comparable environment).
Rainfall measurements show (figure 5) that a considerable part of the rain falls in one day . In two or three showers more than 70% of the total amount of rain falls!. These showers fall very locally (due to the topography) and it often happens that one particular area does not receive such a shower at all. In this way it is a dry year for that area.
Not only the amount of rainfall is important, also the evaporation, which depends on the temperature and humidity. The higher the altitude the lower is the temperature and even more important, the lower is the amount of sunshine (due to clouds).

FIGURE 2: AVERAGE ANNUAL RAINFALL IN CHUKA-SOUTH AREA

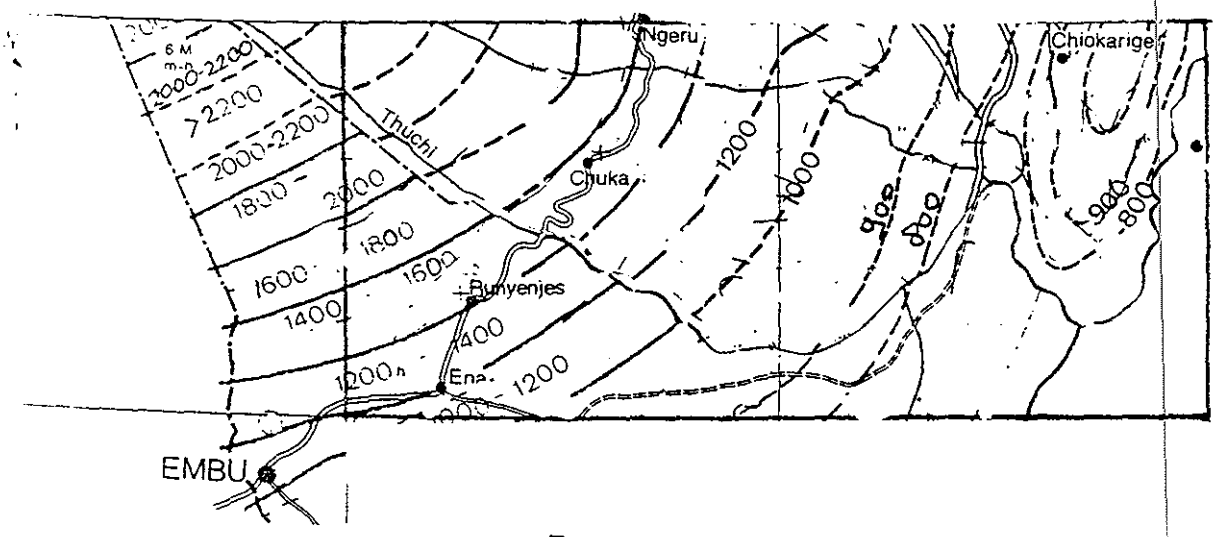


FIGURE 3A: CLIMATE EXTREME UPPER PART OF THE AREA

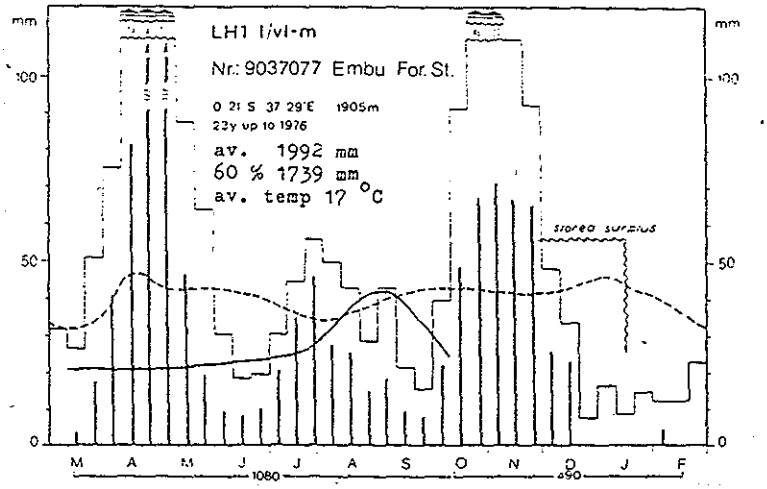


FIGURE 3B: CLIMATE IN WESTERN PART OF THE AREA

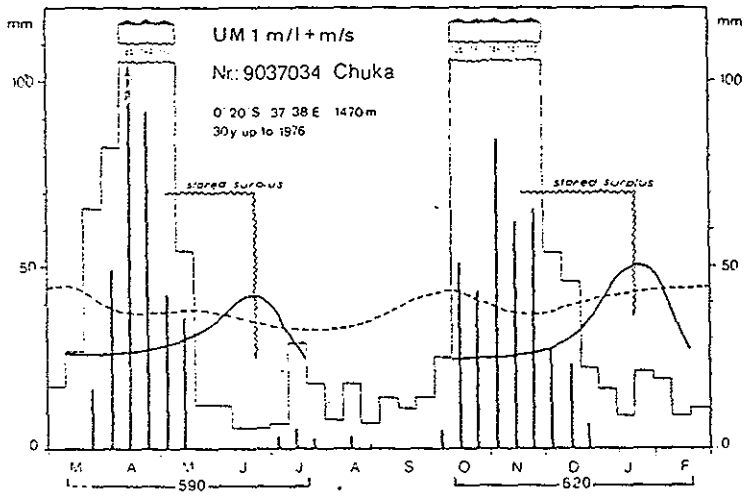
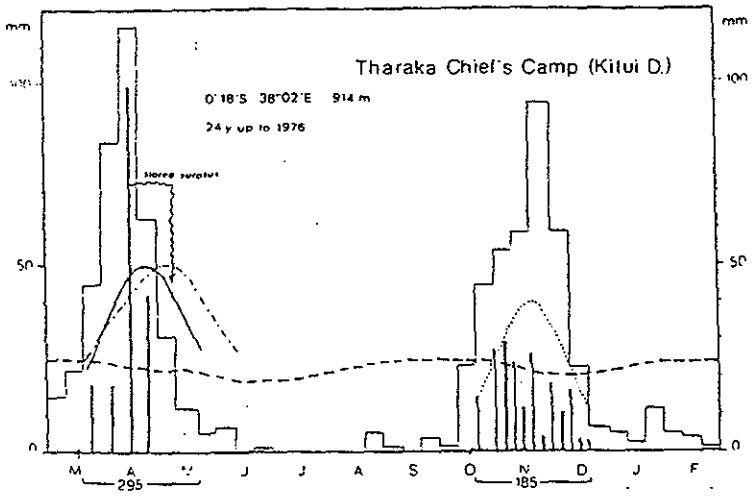


FIGURE 3C: CLIMATE IN EASTERN PART OF THE AREA



Average rainfall per decade | rainfall surpassed in 6 out of 10 years

Approx. pot. evapotranspiration of a permanent crop

Approx. pot. evapotranspiration of late mat. maize

1080 Rainfall per indicated growing period, surpassed in 6 out of 10 years

FIGURE 4: RAINFALL VARIATION IN EASTERN PART OF THE AREA

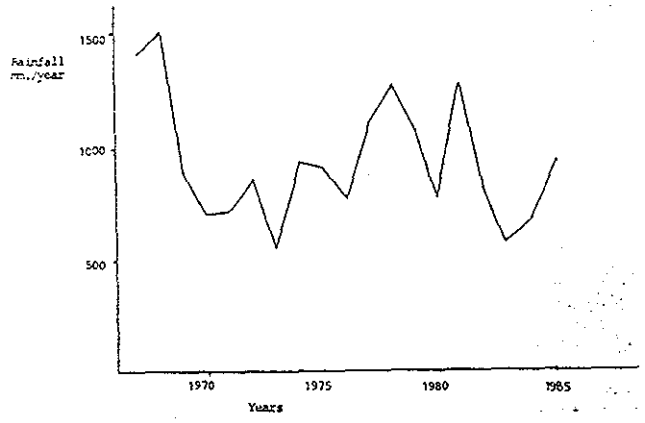
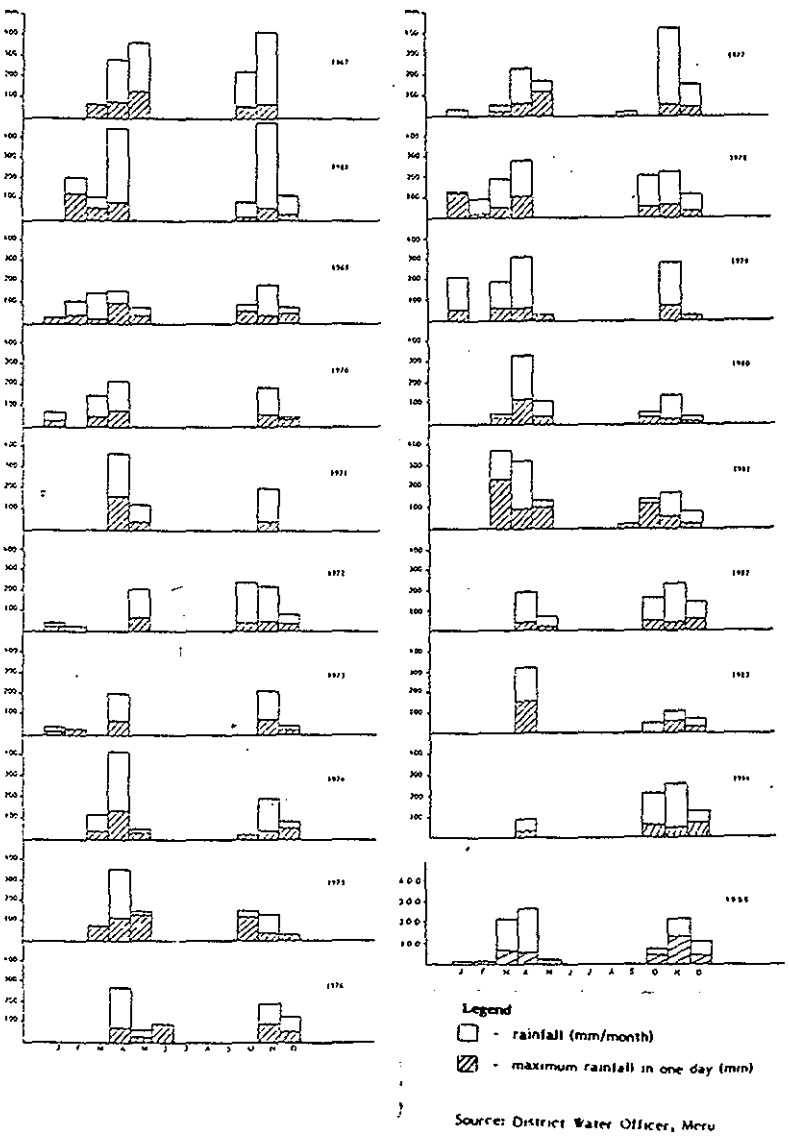


FIGURE 5: TOTAL RAINFALL COMPARED WITH DAILY RAINFALL IN EASTERN PART OF THE AREA



3 WORKING METHODS

3.1 Introduction

In order to be able to map an area of this extend an efficient and convenient method is needed. We have chosen for the landscape guided (=physiographic) method as developed by the ITC (International Institute for Aerial Survey and Earth Sciences) (Zonneveld 1982).
This method is based on the use of air photographs to delineate landunits on physiographic basis and on a lower level on vegetation and landuse differences.
During the fieldwork these units are sampled in a so called stratified random way: sampling activity is divided between all airphoto interpretated (API) units, with in principle an equal attention to each unit.

3.2 Air Photo Interpretation

Air photographs on a scale of 1:50,000 were the basis for the interpretation map. A major problem was that these photos showed the situation in 1968. Major changes could be expected in a time span of nearly 20 years. More recent (1982) air photographs of a scale of 1:12,500 were available for only a very limited part of the area. We have used them occasionally to observe major changes which were observed in the field. A satellite (Landsat MSS) image, scale 1:250,00, was used for a rough impression of the extent of various landscapes.

The 1968 1:50,000 air photographs were interpretated with as first division major landscape differences (based on general landform differences in the terminology of the Kenya Soil Survey). On a lower level differences in individual landforms and vegetation/landuse were used to differentiate API units. Some landscapes could not be divided in any detail (the Mountain Rain forest). There more attention had to be given during the fieldwork to find correlations between air photograph characteristics and vegetation differences. However for the majority of the area no such problems were encountered. In this way an API map of scale 1:100,000 was prepared and used to prepare the fieldwork (sample places and routes).

3.3 Field sampling

3.3.1 General

By car and motorcycle parts of the area were visited and subsequent API units were sampled. Especially those units were visited which were adjacent to each other (the clustered aspect of the method). This was not only efficient but also showed the transition between the various units very well and gave an impression of the validity of the boundaries.
The samples were taken guided by the appearance of the vegetation, in general not too close near a road or an other disturbed area (unless that was the object). In general only a sample was taken when the area could be detected on the air photographs.
During the fieldwork the difference of the vegetation and landuse between 1968 and present (1985) became a problem. Especially in the eastern part of the area units could consist of high bushland which were previously bare farmland (and vice versa). In these cases sampling was not that much related to the specific place as it was else where. Sometimes this was avoided and a non changed area was sampled. However in general this did not cause any problem and the specific sample place was precisely noted on the air photograph. In this way all units were sampled (at least 2 samples in each unit), some very inaccesible parts (the tops of the mountains in the eastern part of the area) could only be observed by glasses.

3.3.2 Samples: environment and soil

A total of 180 samples have been made, distributed over 30 API units. Each of them consists of a relevee of the vegetation, an augering and general remarks of the landscape and landuse. See appendix nr IV for a sample form which has been used to registrate all data. As said before each sample was noted on the air photographs and on the API map.

3.3.3 Vegetation relevees

Vegetation relevees were of different sizes, dependant on the kind of vegetation structure. Table 1 shows the sizes which have been used for relevees in different physiognomic vegetation types. Some relevees were made with a different size for tree- and grass layer, especially in landscape 5 where a sparse and heterogenous tree layer covers less than 10%. In order to registrate that layer a relevee of more than 1000 m^2 has to be made, the grass layer can be described in a size of 20 m^2.

TABLE 1: SIZES OF VEGETATION RELEVEES IN DIFFERENT VEGETATION FORMS

VEGETATION STRUCTURE	RELEVEE AREA M^2
Woodland & Bushland	400
Shrubland & Thicket	150-200
Arable land	400
Grassland	25
Wooded Grassland	1000

Vegetation structure
We usually started with describing the vegetation structure, see figures 8 A-V. In a scale of 0-3cm, 3-12.5cm, 12.5-25cm,25-50cm, 50cm-1m, 1-2m, 2-4m, 4-8m, 8-16m, 16-32m and 32-64m the external and internal coverage was noted. With both data the real coverage can be calculated:

$$\text{real coverage (\%)} = \frac{\text{external coverage (\%)} \times \text{internal coverage(\%)}}{100}$$

External coverage: is the coverage of the vertical projection of the plant
Internal coverage: is the part of that projection which covers the ground
Real coverage: is the total part covered by the plant.

In table 2 the decimal coverage estimation scale is given.

TABLE 2: DECIMAL RANGE FOR COVER ESTIMATION

NOTATION coverage external	internal	RANGE OF COVERAGE
-		< 2%
00	0	2 - 5 %
01	1	5 - 15%
02	2	15 - 25%
03	3	25 - 35%
04	4	35 - 45%
05	5	45 - 55%
06	6	55 - 65%
07	7	65 - 75%
08	8	75 - 85%
09	9	85 - 95%
10	10	95 -100%

External coverage in first column, internal in the second

Floristic composition
In each relevee all plant species were noted and an estimation was made of the external- and internal coverage of the individual plantspecies with the decimal scale is shown in table 2. Also notes were made of the abundancy of the plants , see table 3.

TABLE 3: RANGE FOR ABUNDANCY ESTIMATION

NOTATION	ABUNDANCY
1	1 per 1000 m^2
2	1 per 100 m^2
3	1 per 10 m^2
4	1 per 1 m^2
5	10 per 1 m^2
6	1 per 1 dm^2
7	10 per 1 dm^2

Naming plant species

A major disadvantage of the floristic method is the difficulty with naming the plantspecies. In a diverse area as the Chuka - south area more than 2000 plantspecies can be expected (not all needed for a floristic classification). We have used several methods in order to over come this problem.

All unknown species encountered in a relevee were collected in a quick herbarium and were given a nickname and a collection number.

We tried to reveal the local name from passers-by, who also taught us how to recognise the plants. This collecting took much time especially in the eastern part of the area, where the plants were often dessicated and only vegetative.

The local names could provide us the scientific names. In other cases the quick herbarium was determined by ourselves and by the East African Herbarium in Nairobi.

3.4 Field sample processing

...ysiognomic classification

...ch confusion exists in the numerous classifications, a term ...ke savanna is so often used in so many different ways that the ...rd does not have much meaning anymore. We have chosen for the ...mple physiognomic clasification as given by White 1983, see ...ble 4 for a description of the 10 units. This classification ... used in the legenda and the various descriptions only to give ... first impression. More detailed vegetation structure ...ssifications as given by the Kenya Soil Survey are only given ... complete the image , for pratical use they are much too ...licated. In case of cultivated land not the physiognomic ...ssification is used but the term Farmland and the degree of ...ltivation.

...BLE 4: PHYSIOGNOMIC CLASSIFICATION ACCORDING TO WHITE (1983)

...RMATIONS ...REGIONAL ...TENT

... *Forest.* A continuous stand of trees at least ... m tall, their crowns ...erlocking.

... *Woodland.* An open stand of trees at least ... m tall with a canopy ... of 40 per cent or ... The field layer ... usually dominated ... grasses.

... *...land.* An open ... of bushes usually ... 3 and 7 m tall ... canopy cover of ... cent or more.

... *Thicket.* A closed ... of bushes and ... usually be-...ween 3 and 7 m tall.

... *...land.* An open ... stand of ... up to 2 m ...

5. *Grassland.* Land covered with grasses and other herbs, either without woody plants or the latter not covering more than 10 per cent of the ground.

6. *Wooded grassland.* Land covered with grasses and other herbs, with woody plants covering between 10 and 40 per cent of the ground.

7. *Desert.* Arid landscapes with a sparse plant cover, except in depressions where water accumulates. The sandy, stony or rocky substrate contributes more to the appearance of the landscape than does the vegetation.

8. *Afroalpine vegetation.* Physiognomically mixed vegetation occurring on high mountains where night frosts are liable to occur throughout the year.

TRANSITIONAL FORMATIONS OF LOCAL EXTENT:

9. *Scrub forest.* Intermediate between forest and bushland or thicket.

10. *Transition woodland.* Intermediate between forest and woodland.

11. *Scrub woodland.* Stunted woodland less than 8 m tall or vegetation intermediate between woodland and bushland.

EDAPHIC FORMATIONS:

12. *Mangrove.* Open or closed stands of trees or bushes occurring on shores between high- and low-water mark. Most mangrove species have pneumatophores or are viviparous.

13. *Herbaceous fresh-water swamp and aquatic vegetation.*

13. *Halophytic vegetation* (saline and brackish swamp).

FORMATION OF DISTINCT PHYSIOGNOMY BUT RESTRICTED DISTRIBUTION:

15. *Bamboo*

UNNATURAL VEGETATION:

16. *Anthropic landscapes.*

...istic classification

... final legend of the map is based on the floristic ...ification. Mapping units consist of (mostly) complexes of ...tation types which are characterised by sociological types. ...is survey the relevee data were processed according to the ...-Blanquet tabulation method. A matrix with rows (plant ...) and colums (relevees) is formed. These rows and colums ... rearranged till a matrix of clusters of plots (vegetation ...) and plant species (sociological groups) is obtained, see ...ndix II.

3.5 Final map preparation

After the field work was done the entire area was reinterpretated on the 1:50,000 air photographs. Some major differences were made compared to the first interpretation. Especially in landscape 6 many units were changed. The previous interpretation was too much based on differences in bush fallow stages. The final interpretation consists of larger units with many complexes of different vegetation types. Several boundaries between units were changed , partly because of a better understanding of the area and the photographs.

However one has to realise that air photographs of 1968 are the basis of this map and that not all units could be adapted to the present situation (takes too much time).

The final map was preparated by reducing the interpretations by the means of a sketchmaster to a 1:100,000 map.

The final legend is based on the importance of the different vegetation types in the complex. A characteristic and a dominant plant species is used to name the mapping unit. The physiognomic classification as well as the physiographic classification is given for each mapping unit. General geology is given for the whole landscape and for each mapping unit only when changes in geology occur.

4 VEGETATION AND LANDUSE

4.1 The seven main landscapes

A total of seven landscapes were distinguished in the Chuka-south area based on differences in vegetation, landuse and physiography. The landscapes are named after two plantspecies; the first one is a characteristic, the second a dominant species.

Landscape 1 : Ocotea usambarensis - Strombosia scheffleri

Mountain Rain Forest on Mountain Footridges, developed on Mt. Kenya volcanics.
Only the lowest four kilometer of forest is exploitated (fuelwood, timber).

Landscape 2 : Croton megalocarpus - Coffea arabica

Very intensively cultivated land on Mountain Footridges, developed on Mt.Kenya volcanics.

Landscape 3 : Dombeya rotundifolia - Mangifera indica

Intensively cultivated land on Plateau and (volcanic) Uplands, developed on Mt.Kenya volcanics.

Landscape 4 : Combretum zeyheri - Combretum binderianum

Extensively cultivated Bushland and Woodland on Plateau and (volcanic) Uplands, developed on Mt. Kenya volcanics.

Landscape 5 : Hyparrhenia sp. - Heteropogon contortus

Very extensively cultivated Wooded Grassland on Hills and Mountains developped on (basic) Intrusives in Basement System.

Landscape 6 : Acacia senegal - Commiphora africana

Complex of extensively and intensively cultivated Thicket, Bushland, and Woodland in Uplands, developed on Basement System.

Landscape 7 : USP 10 - Ochna ovata

Scrub forest on Mountains, developed on Intrusives in Basement System (granites and granitoides)

4.2 Agriculture and other Landuses in the survey area

It is not the aim of this report to deal with agriculture and other landuses in any detail. This chapter gives only an overview of agriculture and other landuses in the various landscapes as background for the vegetation and landuse description of the specific landunits.
Detailed specialised studies involving farms, farmers, farming systems and farming economy in the survey area is carried out by fellow-project participants.
In chapter 4.3 (E,F and S) agriculture is dealt with in LS II, III and IV, by agriculture the most influenced landscapes.

4.2.1 Agriculture, general

Apart from the cashcrops tea and coffee in LS II and cotton in LS III,IV and VI, farming in the survey area is characterised by low capital input, land (family) labour and small acre (1-6) farms. Most important tool is the hoe.
For tea and coffee fertilizers and pesticides are mostly used. Also they are small scale affair (1-3 acre).
A list of agricultural crops is presented in table 5 together with the occurence in the several LS with a scale of abundancy (1....5).

4.2.2 Annual Crops

Most important annual crop is maize (Zea mays) which is planted in Ls II and III. In years with everage rainfall it is optimal in Ls III. In dry years the harvest might fail there. Sometimes it is grown near the homestead in Ls VI under irrigated conditions.
In Ls II the following starch crops are important: arrowroots (Colocasia antiquorum), which is grown only in valley bottoms, cassave (Manihot esculente), sweet potatoes (Ipomoea batatas) and potatoes (Solanum tuberosum). The most important vegetable is sukuma-wiki (Brassica oleracea var.) which means: "To push within 7 days".
Of the Papilionaceous crops, beans (phaseolus vulgaris), cowpies (Vigna unguiculata), pigeon pies (Cajanus cajan) and greengrams (Vigna aureus) are most important. Beans grow abundantly in Ls II. Kitheri, a mixture of with maize, beans and vegetables serves as peoples' most important food in Ls II. In Ls III cowpies and especially pigeon pies are common. They better yield in marginal rainfall areas than beans. Greengrams is grown in the driest landscape, Ls VI.
In Ls VI the cereals sorghum and millet are most common. They are very drought resistant and out yield maize under rainfed conditions. A fermented porridge is made of sorghum and millet. For millet and sorghum cultivation both baboons and birds are a big problem, they plunder the gardens and unless people chase them. People spend several months a year to protect the gardens and chase these animals away (by throwing stones with special made lassos).

The cultivation system in Ls VI is complex. Subsequent to (a period of years of-) cultivation, land remains fallow for several years, so that a secondary bush may develop. After the fallow period, the land is cultivated again (see description of Ls 6 for more details)

TABLE 5: CROPS IN THE CHUKA-SOUTH AREA

ANNUAL CROPS

NAME	BOTANIC NAME	FAMILY	LANDSCAPE	
Maize	Zea mays	Gramineae	II4 III5	
Cassava	Manihot esculente	Euphorbiaceae	II3 III3	
Yam	Dioscorea spp.	Dioscoreaceae	II1	
Potatoes	Solanum tuberosum	Solanaceae	II3	
Sweet potatoes	Ipomoea batatas	Convulvulaceae	II2	
Beans	Phaseolus vulgaris	Papilionaceae	II5	
Cowpies	Vigna unguiculata	,,	III4	
Pigeon pies	Cajanus cajan	,,	III5	
Greengrams	Vigna aureus	,,	VI4	
Blackgrams	,, mungo	,,	VI1	
Napier grass	Pennisetum purpureum	Gramineae	II4	animal fodder
Sugarcane	Saccharum spp.	,,	II2	
Sunflower	Helianthus annuus	Compositae	III3	animal fodder
Tobacco	Nicotiana tabacum	Solanaceae	III3	
Cotton	Gossypium hirsutum	Malvaceae	III3	IV2 VI3
Millet	Pennisetum typhoides	Gramineae	VI5	
Sorghum	Sorghum spp.	,,	III3	VI3
Sukuma-wiki	Brassica oleracea	Brassicaceae	II4	
Tomato	Lycopersicon esculentum	Solanaceae	II2	
Onion	Allium sepa var.	Liliaceae	II2	
Carrot	Daucus carota	Umbellifera	II2	

PERENNIAL CROPS

Cotton	Gossypium sp.	Malvaceae	IV4, VI4	
Castor	Ricinus communis	Euphorbiaceae	II3	III2
Arrowroots	Colocasia antiquorum		II2	
Passionfruit	Passiflora spp.	Passifloraceae	II1	
Kenaf	Hibiscus cannabinus	Malvaceae	II2	
Sisal	Agave sisale	Agavaceae	III3	IV3

TREECROPS

Tea	Camellia sinensis	Theaceae	II4	
Coffee	Coffea arabica	Rubiaceae	II5	
Mango	Mangifera indica	Anacardiaceae	II3	III4
Bananas	Musa spp.	Musaceae	II3	III2
Orange/lemon	Citrus spp.	Rutaceae	II3	III3
Papaya	Carica papaya	Caricaceae	II3	
Avocado	Persea americanum	Lauraceae	II2	
Calabash	Gescentia cujete	Cucurbiaceae	III2	
Miraa	Catha edulis	Celastraceae	I1	III1

4.2.3 Perennial Crops

Cotton (Gossypium sp.) is the most important cashcrop in the drier parts of the area, with in contrast to coffee and tea farming low yields.

4.2.4 Tree Crops

Most important cashcrop is coffee (coffea arabica) covering more than 1/4 of the area in Ls II. To prevent competition, intercropping with coffee is forbidden.

Tea (Camellia sinensis) occurs at high altitudes of Ls II. Nowadays a tea farmer is relative prosperous, because of a good price for one kg tea (6 sh. per kg and about 5.000 kg yield per acre). Nowadays in the tea gardens no shadow trees are left, because of intensive cultivation practices (eg. fertilizers).

Mango (Mangifera indica) occurs everywhere in Ls II and III, although it is not an important cashcrop. The fruits are gathered haphazardly, sometimes sold at the local market.

Banana trees (Musa spp.) are planted in valleys of Ls II and III on pure stands or with beans in the understorey. They are an important foodcrop.

4.2.5 Livestock

Livestock is an important part of the farming system in the Chuka-south area and is often intensively connected with other agriculture activities. The same diversity found in agriculture is also found in livestock keeping. Table 6 shows some differences in livestock keeping in the 7 landscapes.

Descending the slopes of Mt.Kenya the importance of intensive, often zero grazing with improved dairy cattle decreases in favour of extensive grazing by cattle and goats (and to a lesser extent sheep). Quite recently zero grazing has been propagated, especially with improved dairy breeds. The majority of the forage is Napier grass (Pennisetum purpureum) which is grown in pure stands and on the border of the gardens. Only in the upper part of Ls 2, improved dairy cattle grazes in small pastures. Unimproved local zebu, goats (East Africa goats) and (Masai fat tailed) sheep graze along the roads and on fallow spots. In Ls 4, 5 and 6 extensive grazing is important and is no longer confined to small areas, but has it's influence every where. Else where a description and ecological analysis of the extensive grazing system is given (Scholte 1986).

TABLE 6: ASPECTS OF LIVESTOCK KEEPING IN THE 7 LANDSCAPES

	Ls 1	Ls 2	Ls 3	Ls 4	Ls 5	Ls 6	Ls 7
Zero grazing	--	++	+	-	--	--	--
Improved breeds	+	+	-	-	--	--	--
Importance of cattle	+	++	+	+	++	++	--
Importance of goats	--	-	-	+	+	++	-
Importance of sheep	--	-	+	+	+	+	-

++ : (relative) very important
+ : (relative) important
- : (relative) unimportant
-- : not important

4.2.6 Forestry

Different types of forestry are practised in the Chuka-south area: In Mt.Kenya forest logging by forestry service is practised, mainly for timber. Some wood is collected near the boundaries for fuelwood, sometimes to make charcoal of it.
In the intensively cultivated land a kind of agro-forestry is practised with as most important trees Grevillea robusta and Mangifera indica. They form an important landuse system with the foodcrops (especially maize and beans) and provide the people shade and some fuelwood (the majority of the energy is supplied by charcoal which is bought).
In the less intensively cultivated areas people gather their fuelwood in the "bush" and often earn some money (often the only) with the preparation of charcoal. The bags with charcoal are conspicuous along the major roads in the eastern part of the area (very well connected to the markets in the higher areas).
The forests on mountains in the extreme eatern part of the area are protected areas against erosion.

4.2.7 Beekeeping

More important than it seems is bee keeping. Although no honey reaches the market, it is highly appreciated, because it is the source of local beer. Especially in the eastern areas all trees near the homesteads are occupied by bee hives. Only a very limited amount of beer is traded, the majority is privately used.

4.3 Sociological groups and plant communities

About 180 field samples (vegetation relevees) were taken and processed according to the described method (3.4). This resulted in the formation of 30 sociological groups (see table 7) and 22 plant communities.

The sociological groups consists of species, similar in occurence in the several plant communities. This is based on the relevees and personal experience. Each sociological group consists of 3 or more plant species.
Some exceptions were made with species, which have been placed in two different sociological groups (Combretum zeyheri, Terminalia brownii, Commiphora africana and Ocimum basilicum). This is done because these species occur in two or more landscapes in totally different vegetation types.

TABLE 7: LIST OF THE SOCIOLOGICAL GROUPS

1	PODOCARPUS MILANJIANUS
2	OCOTEA USAMBARENSIS
3	STROMBOSIA SCHEFFLERI
4	PRUNUS AFRICANA
5	CAMELLIA SINENSIS*
6	TAGETES MINUTA
7	COFFEA ARABICA*
8	CROTON MEGALOCARPUS
9	OXYGONUM SINUATUM
10	GREVILLEA ROBUSTA*
11	DOMBEYA ROTUNDIFOLIA
12	VERNONIA AEMULANS
13	COMBRETUM MOLLE
14	INDIGOFERA BINDERI
15	GARDENIA JOVIS-TONANTIS
16	COMBRETUM ZEYHERI
17	THEMEDA TRIANDRA
18	TEPHROSIA POLYPHYLLA
19	ACANTHOSPERMUM HISPIDUM
20	COMMIPHORA AFRICANA
21	ACACIA TORTILIS
22	CAPPARIS SEPIARIA
23	STERCULIA RHYNCHOCARPA
24	ACACIA NILOTICA
25	OCHNA OVATA
26	CASSIA LONGIRACEMOSA
27	PENNISETUM TYPHOIDES*
28	LAWSONIA INERMIS
29	COMBRETUM SP.
30	USP 10

* cultivated plants or not indigenous trees

The formation of the plant communities is related to geological and climatical conditions and to human influence.
10 Plant communities were found on the volcanic deposits of Mount Kenya , 10 on the Basement System Rocks and 2 on Intrusives.

TABLE 8: LIST OF THE PLANT COMMUNITIES

(On Mt. Kenya volcanics)			
A	PODOCARPUS MILANJIANUS	-	GALINIERA COFFEOIDES
B	OCOTEA USAMBARENSIS	-	STROMBOSIA SCHEFFLERI
C	PRUNUS AFRICANA	-	CELTIS AFRICANA
D	PTERIDIUM AQUILINUM	-	CAMELLIA SINENSIS*
E1	DIGITARIA SCALARUM	-	COFFEA ARABICA*
E2	NEWTONIA BUCHANI	-	CROTON MEGALOCARPUS
F	DOMBEYA ROTUNDIFOLIA	-	MANGIFERA INDICA*
G	VERNONIA AEMULANS	-	LANTANA CAMARA
H	COMBRETUM MOLLE	-	COMBRETUM BINDERIANUM
J	TERMINALIA BROWNII	-	COMBRETUM ZEYHERI
K	THEMEDA TRIANDRA	-	USP 2
(On Basement System Rocks)			
L	TEPHROSIA UNIFLORA	-	TEPHROSIA VILLOSA
M	PUPALIA LAPPACEA	-	ARISTIDA ADSCENSIONIS
N	COMMIPHORA AFRICANA	-	ACACIA TORTILIS
O	ACACIA BREVISPICA	-	ACACIA TORTILIS
P	DELONIX ELATA	-	STERCULIA RHYNCHOCARPA
Q	ACACIA NILOTICA	-	TERMINALIA BROWNII
R	HYPHAENE THEBAICA	-	CASSIA LONGIRACEMOSA
S	PENNISETUM TYPHOIDES*	-	SORGHUM BICOLOR*
T	LAWSONIA INERMIS	-	SPHAERANTHUS SP.
U	COMBRETUM SP.	-	COMMIPHORA AFRICANA
(On Intrusives)			
I	HYPARRHENIA SP.	-	HETROPOGON CONTORTUS
V	OCHNA OVATA	-	USP 10

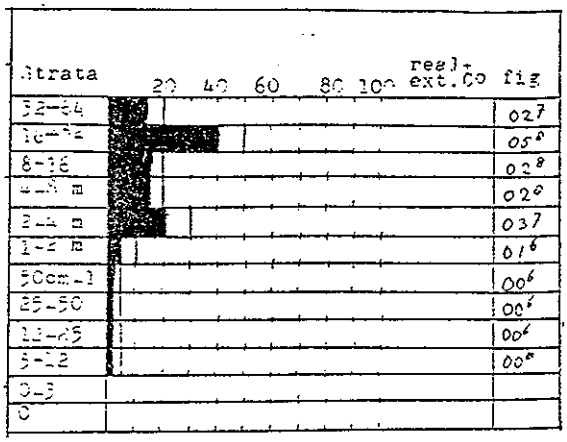
The plant communities are described in detail as follows:

A : PODOCARPUS MILANJIANUS - GALINIERA COFFEOIDES
The most important species in the Podocarpus milanjianus montane rain forest are:

	NAME:	FAMILY:
trees:	Podocarpus milanjianus	Podocarpaceae
	Ochna holstii	Ochnaceae
	Suregada procera	Euphorbiaceae
	Aningeria adolfi-friederici	Sapotaceae
	Olea hochstetteri	Oleaceae
	Ocotea usambarensis	Lauraceae
shrubs:	Galiniera coffeoides	Rubiaceae
	Pauridiantha holstii	,,

This montane rainforest occurs in the coldest, wettest part in the extreme northwest of the survey area at an altitude above 1950m. This is in landscape 1, unit 1.1.

Figure 6A: The characteristic structure diagram of the Podocarpus milanjianus montane rainforest



The trees of the evergreen upper stratum are 28-38m tall (Ocotea usambarensis, Aningeria adolfi-friederici and Olea hochstetteri). Their crowns, which are not in lateral contact are raised well above the middle stratum and are wide spreading. The abundant Podocarpus milanjianus is the tree of the middle stratum at 16-28m. Its crown is conical. The evergreen leaves are broader than the leaves of the European conifers and physiognomically the tree is intermediate between conifers and foliaged trees. The shrub stratum of 2-6m is dominated by Rubiaceae shrubs and especially by Galiniera coffeoides. The herb layer is sparse and consists largely of forest grasses and ferns.
Epiphytic ferns are common especially on the stem of old Ocotea trees. Colonization of epiphytic ferns seems to be succesful late in the live of the tree. Lianas are not very abundant here.
In East Africa Podocarpus milanjianus is confined to the wettest montane forests. The tree occupies less area than its drier counterparts Podocarpus gracilior and Juniperus procera.

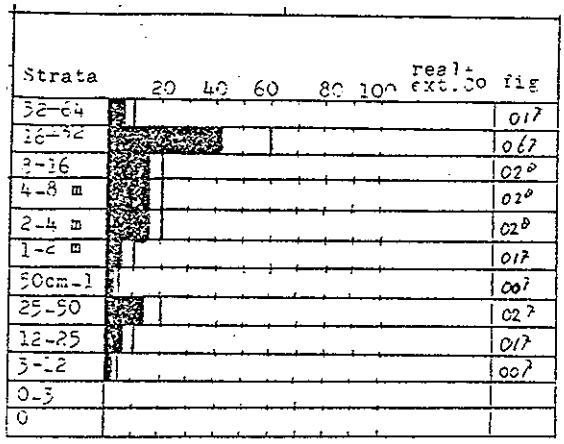
B : OCOTEA USAMBARENSIS - STROMBOSIA SCHEFFLERI

The most important trees in the Ocotea usambarensis submontane rainforest are :

	NAME:	FAMILY:
trees:	Ocotea usambarensis	Lauraceae
	Strombosia scheffleri	Olacaceae
	Xymalos monospora	Monimiaceae
	Tabernaemontana holstii	Apocynaceae
	Fagaropsis angolense	Rutaceae
	Olea hochstetteri	Oleaceae
	Vitex keniensis	Verbenaceae
	Cassipourea malosana	Rhizophoraceae
shrubs:	Galiniera coffeoides	Rubiaceae

The Ocotea usambarensis submontane rain forest is bordering A going downwards in landscape 1, where it forms unit 1.2. It has a subtropical climate.

Figure 6B: The characteristic structure diagram of the Ocotea usambarensis submontane rainforest



The trees of the upper stratum are 25-37m tall and they cover externally 70% of which Ocotea usambarensis covers 35%. Other layers are not distinguishable, because there are no mature trees in the stratum of 6-25m. The shrub layer, 2-6m tall, is dominated by Galiniera coffeoides. The understorey is normally open and consists of broad-leaved forest grasses, several fern species and rejuvenation of trees. It is striking to see many juvenile trees which are adult only at higher altitudes (Podocarpus milanjianus and Ochna holstii).
Especially old Ocotea trees harbour many epiphytic ferns (no orchids). Compared to the Podocarpus milanjianus montane rainforest lianas are more abundant in this submontane rainforest. They can reach the 20m.
In the big valleys tree ferns (Cyathea manniani) and wild bananas (Ensete ventricosum) are more common. In the smaller valleys the tree composition is the same as the composition of the mountain footridges. The vegetation in or just at the border of the

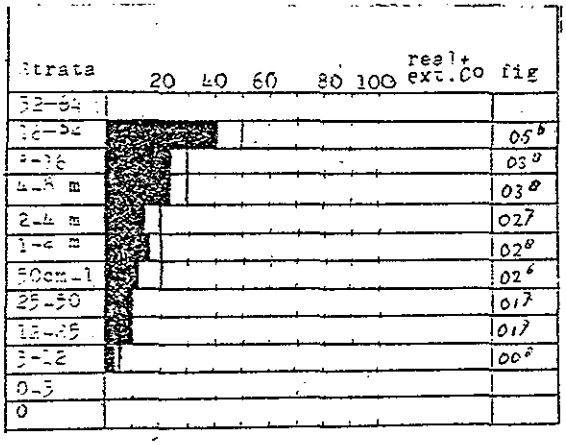
streams is quite different, with a lot of ferns and without trees. Locally the vegetation there has been destroyed by elephants and harbours secondary and ruderal species.
In East Africa Ocotea usambarensis, the "camphor" tree, is the biggest tree (in width the baobab is wider). The tree occurs only in the wettest montane and submontane forests

C : PRUNUS AFRICANA - CELTIS AFRICANA
The most important trees in the Prunus africana wet forest are :

	NAME	FAMILY
trees:	Prunus africana	Rosaceae
	Celtis africana	Ulmaceae
	Anthocleista grandiflora	Moraceae
	Zanthoxylum macrocalyx	Rutaceae
	Polyscias kikuyuensis	Araliaceae
	Myrianthus holstii	Moraceae
	Newtonia buchanani	Mimosaceae
	Albizia gummifera	Mimosaceae
	Ficus sp.	Moraceae

The Prunus africana wet forest occurs at the edge of Mt Kenya forest in landscape 1, where it forms unit 1.3. This forest is more influenced by human than the previous two rain forest communities.

Figure 6C: The characteristic structure diagram of the Prunus africana wet forest.



The trees of the upper stratum are 25-32m tall, less high than the previous rainforest communities with less tree species.
Other layers are difficult to distinguish, because the total cover is very high, due to domestic cut for timber and firewood. The, 1-4m tall, shrub layer and the herb layer are also dense and make the forest nearly impenetrable. Strangling epiphytic trees

(Ficus sp.) and lianas are abundant.
The leaves of the trees are semi-hygromorph evergreen. Newtonia buchanani is the only (semi)deciduous tree.
In Africa a transitional (rain)forest is a forest at an altitude where lowland (Newtonia buchanani and Albizia gummifera), montane (Prunus africana and Myrianthus holstii) and "in between" tree species (Celtis africana) occur together. In an undisturbed state the climax of this wet forest is a transition rainforest.

D : PTERIDIUM AQUILINUM - CAMELLIA SINENSIS*
The most important plant species in the Camellia sinensis (tea) communities are :

	NAME:	FAMILY:
trees:	Grevillea robusta*	Proteaceae
	Croton megalocarpus	Euphorbiaceae
	Croton macrostachyus	,,
	Newtonia buchanani	Mimosaceae
	Eucalyptus camaldulensis*	Myrtaceae
shrubs:	Camellia sinensis* (tea)	Theaceae
herbs :	Spermacoce princei	Rubiaceae
	Sida cuneifolia	Malvaceae
	Richardia braziliensis	Rubiaceae
	Tagetes minuta	Compositae
	Bidens pilosa	,,
	Ageratum conyzoides	,,
	Crassocephalum crepidioides	,,
ferns:	Pteridium aquilinum	Pteridophytes

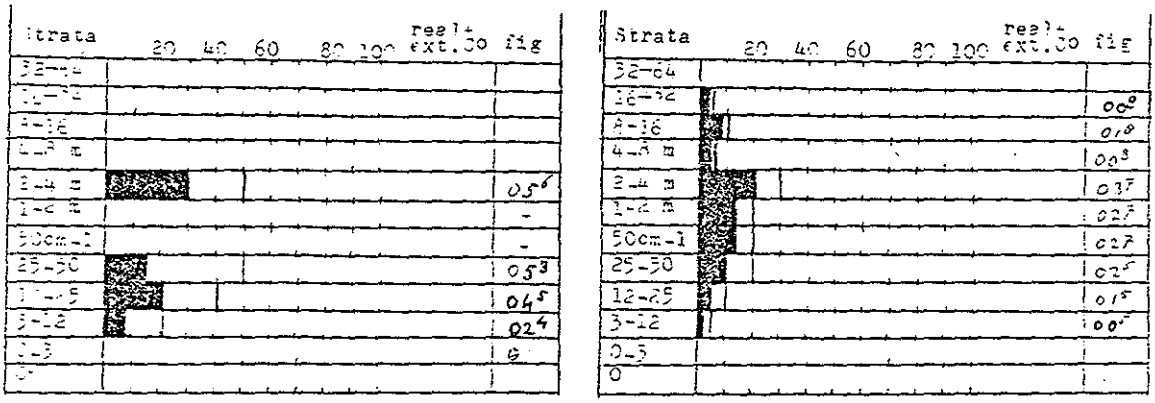
The Camellia sinensis (tea) communities are found in landscape II from Mt Kenya forest downwards to about 1530m, which Jaetzold (Jaetzold & Schmidt, 1983) defined as the Tea-Diary Zone and partly the Coffee-Tea Zone. The requirements of tea cultivation are met here. Fine quality tea requires to grow at high altitude and to receive a a high amount of rainfall (>1500mm).
Trees, 10-35m tall, are abundant in the Camellia sinensis communities. Externally they cover 10-15%. They were planted 25 years ago and are for a great deal exotic (Eucalyptus camaldulensis, Pinus radiata, P. elliotii, P. patula and Grevillea robusta). The indigenous trees (Newtonia buchanani, Anthocleista grandiflora and Myranthus holstii) are remnants from the time that there was still a forest.
Tea, if it is growing properly, allows no weeds, because of its litter and high coverage. Nevertheless there are specific weeds confined to unsuccesful tea plots and borders of tea plots. These weeds form sociological group 5.

E1 : DIGITARIA SCALARUM - COFFEA ARABICA*
E2 : NEWTONIA BUCHANANI - CROTON MEGALOCARPUS
The most important species in the Coffea arabica (coffee) /foodcrops communities are:

	NAME:	FAMILY:
trees:	Croton megalocarpus	Euphorbiaceae
	,, macrostachyus	,,
	Cordia abyssinica	Boraginaceae
	Newtonia buchanani	Mimosaceae
	Grevillea robusta*	Proteaceae
shrubs:	Coffea arabica* (coffee)	Rubiaceae
	Musa sp.* (banana)	Musaceae
herbs:	Galinsoga parviflora	Compositae
	Bidens pilosa	,,
	Tithonia diversifolia	,,
	Ageratum conyzoides	,,
	Phaseolus vulgaris* (beans)	Papilionaceae
	Triumphetta rhomboidea	Tiliaceae
grasses and cypers:		
	Zea mays* (maize)	Gramineae
	Digitaria scalarum	,,
	Cyperus esculentus	Cyperaceae
	,, rotundus	,,

The Coffea arabica/foodcrop communities are found from Mount Kenya forest downwards to about 1200m, exclusive the Camellia sinensis (tea) communities. This is where Jaetzold defined the Main and the Marginal Coffee-Zone and partly the Coffee-Tea Zone. Because of its complexity community E is divided into E1 and E2. E1 represents relevees made of the agricultural parcels with the major foodcrops and the cash crop coffee. It also represents relevees made of fallow land and road-sides.
E2 represents relevees which are made only of the tree layer over a larger area. These trees include tree-crops such as orange, lemon, banana and mango trees, the not indigenous tree Grevillea robusta and indigenous trees such as Croton megalocarpus, Markhamia hildebrandtii and the conspicuous Newtonia buchanani. Newtonia buchanani, known as the "mukui", can reach 40m and is confined to the bigger valleys (unit 2.4). In the Coffea arabica /foodcrops communities the scattered trees and fruit-trees cover externally 20%.
The important cashcrop coffee, a 3-5m tall shrub, is planted in 1-2 acre parcels. These parcels occupy about 30-40% of the Coffea arabica /foodcrops communities. Coffee is not intercropped, except by napier grass, which is grown for cows and for erosion prevention on the slopes. In the coffee plots there is a special weedy vegetation. These weeds form sociological group 7. Two cypers and one grass (Cyperus esculentus, C. rotundus and Digitaria scalarum) are the most troublesome weeds.
Foodcrops are common because of the high population density. Most important are maize and beans. They are often intercropped.

Figure 6 E1&2: two characteristic structure diagrams of the Coffea arabica/ foodcrops communities.



The two structure diagrams present a clear picture of the communities. The first (left) gives a structure diagram of a coffee plantation with two distinguishable layers, the coffee shrubs and a weedy vegetation. The second diagram is characteristic for communities E1 and E2 together with trees, tree-crops (4-8m), coffee, the major foodcrops and weeds.

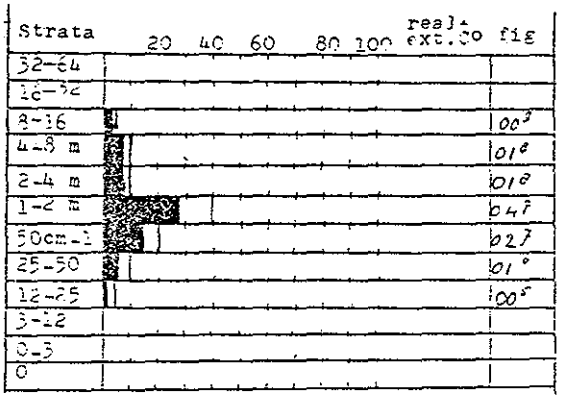
F : DOMBEYA ROTUNDIFOLIA - MANGIFERA INDICA*

The most important species occuring in the Mangifera indica* (mango) communities are:

	NAME:	FAMILY:
trees:	Dombeya rotundifolia	Sterculiaceae
	Mangifera indica* (mango)	Anacardiaceae
	Faurea saligna	Proteceae
	Erythrina abyssinica	Papilionaceae
(shrubby) herbs		
	Cajanus cajan* (pigeon peas)	Papilionaceae
	Nicotiana tabacum* (tobacco)	Solanaceae
	Helianthus annuus* (sunflower)	Compositae
	Senecio discifolius	,,
	Agave sisalana* (sisal)	Agavaceae
grasses:	Zea mays* (maize)	Gramineae
	Rhynchelytrum repens	,,

The Mangifera indica* (mango) communities occupy landscape III between 1100 and 1200m. Mango trees, maize and pigeon peas (Cajanus cajan) grow optimally here, compared to the rest of the survey area.
The rainfall is fairly reliable, but too low for the cultivation of coffee (1100-1200mm).
Maize is more favourable than the indigenous cereals because with satis-factory rainfall it has a higher yielding potential and it is not damaged by birds. Maize is often intercropped with pigeon peas (Cajanus cajan) and cow peas (Vigna unguiculata).
Mango trees are common and cover externally nearly 5%. The fruits are for own consumption or for the local market. Tobacco and especially cotton are the cash crops, but they cover less than the foodcrops.

Figure 6F: The characteristic structure diagram of the Mangifera indica communities.



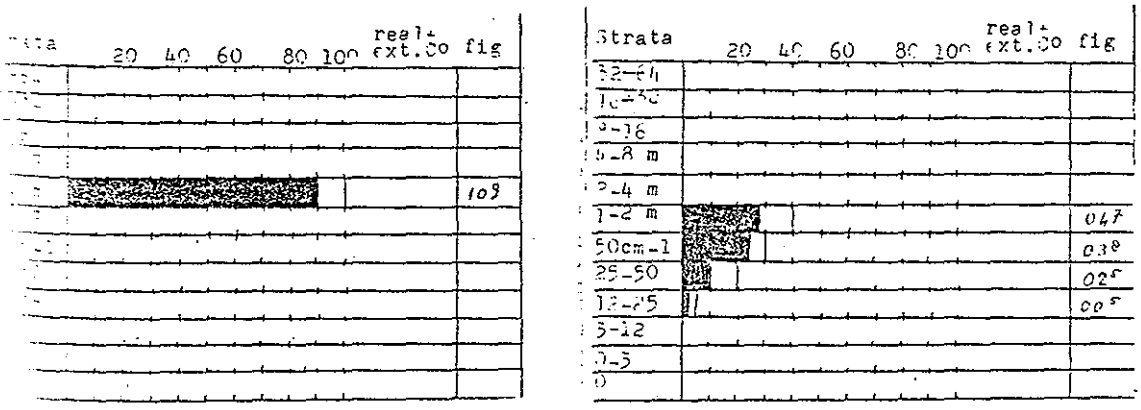
The structure diagram F does not differ much from the structure diagram E2, because in both communities there are scattered higher trees, scattered smaller tree-crops and between 0,5 and 2m a lot of foodcrops.
There is not much left of the original vegetation, besides the remnants of trees up to 16m (Erythrina abyssinica, Dombeya rotundifolia and Combretum species. It is striking that the leaves are big leather-like and that they fall down at the end of the dry season.

G : VERNONIA AEMULANS - LANTANA CAMARA
The most common species in the ruderal Lantana camara communities are :

	NAME:	FAMILY:
shrubs:	Lantana camara	Verbenaceae
	Euphorbia tirucalli	Euphorbiaceae
herbs:	Aspilia mossambicensis	Compositae
	Hermannia exappendiculata	Sterculiaceae
	Hibiscus cannabinus	Malvaceae
	Waltheria indica	Sterculiaceae
	Leucas mollis	Labiatae
	Vernonia aemulans	Compositae
	Indigofera arrecta	Papilionaceae
grasses:	Rhynchelytrum repens	Gramineae

The ruderal Lantana camara communities are not formed by comformance to structure but to floristic composition and ruderal character. These ruderal communities are found in landscape IV where the Combreteous savanna has been influenced by people and in landscape III where an agricultural parcel has been left fallow.
In these situations Lantana camara, the most troublesome (shrub) weed in Africa, can arise and becomes completely dominant. It forms a 3m tall, impenetrable thicket.

Figure 6 G1&2: two structure diagrams of the ruderal Lantana camara communities.



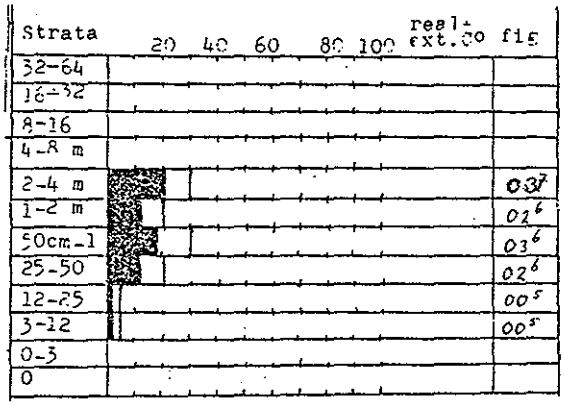
The figure left shows the structure of a Lantana camara dominance. The figure right is an exemple of the occurence of tall ruderal herbs such as Leucas mollis, Hermannia exappendiculata, Monechma debile and Aspilia mossambicensis.

H : COMBRETUM MOLLE - COMBRETUM BINDERIANUM
The most common species in the Combreteous bushland are:

	NAME:	FAMILY:
trees/	Combretum zeyheri	Combretaceae
shrubs:	,, molle	,,
	,, binderianum	,,
	Allophylus africanus	Sapindaceae
	Vitex payos	Verbenaceae
	Bridelia scleroneura	Euphorbiaceae
	Acacia seyal	Mimosaceae
dwarf shrubs:		
	Harrisonia abyssinica	Simaroubaceae
	Clerodendrum myricoides	Verbenaceae
	Indigofera binderi	Papilionaceae
herb:	Vernonia aemulans	Compositae
grasses:	Heteropogon contortus	Gramineae

This bushland occupies Ls IV at an altitude of 1050-1100m. It is a major East African bushland and it is characterized by various broad-leaved Combretum species (C. zeyheri, C. molle and C. binderianum) and Terminalia brownii, belonging to the same family. Hence it is called the Combretum bushland.

Figure 6H: The characteristic structure diagram of the Combreteous bushland



The trees/shrubs do not exceed 6m and their external cover is 30%. They have broad leather-like leaves which fall only late in the dry season. In the lower shrub layer, 0.5-1.5m tall, there are some dwarf shrubs. The grass /herb layer consists of the perennial grass Heteropogon contortus and the Compositeous Vernonia aemulans. Rapidly growing herbs and bulbous monocotyledons (Gladiolus sp. and Haemanthus sp.) flower at the onset of the rains before the leafy cover thickens.
Heteropogon contortus which dominates this landscape (at least the northern part of it) is a species which is favoured by regularly burning.

Reason for this resistence against fire is the fact that its seed becomes buried in the top half inch of the soil. Also the trees tolerate burning which is illustrated by the dark fire spots on their bark.

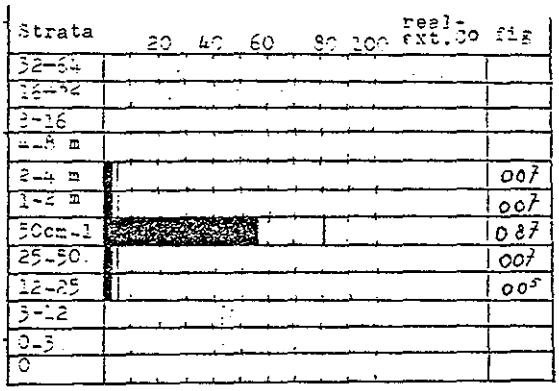
I : HYPARRHENIA SP. - HETEROPOGON CONTORTUS

The most characteristic species in the Heteropogon contortus Wooded grassland are:

	NAME:	FAMILY:
shrubs:	Heeria reticulata	Anacardiaceae
	Gardenia jovis-tonantis	Rubiaceae
	Harrisonia abyssinica	Simaroubaceae
	Clerodendrum myricoides	Verbenaceae
	Indigofera binderi	Papilionaceae
herbs	Barleria grandicalyx	Acanthaceae
	Cassia mimosoides	Caesalpiniaceae
grasses:	Enteropogon macrostachys	Gramineae
	Heteropogon contortus	,,
	Hyparrhenia spp.	,,

The Heteropogon contortus Wooded grassland is found at two places. The grassland occupies landscape V, hills of 950-1050m elevation (100-250m above the surrounding area of Ls VI).
It is also found at some open places in Kijege forest and on the tops of Mutharanga forest, Munguni forest and Njuguni forest above 950-1050m.

Figure 6I: The characteristic structure diagram of the Heteropogon Wooded grassland



The most characteristic aspects are the 0.75-2m very dense tall perennial grass layer and the scattered, always present, 2-4m tall shrubs of Gardenia jovis-tonantis and Heeria reticulata, covering externally 10%. These shrubs must be very fire-tolerant because the high production of the tall grasses makes the temperature of the fires occuring each year extremely high.

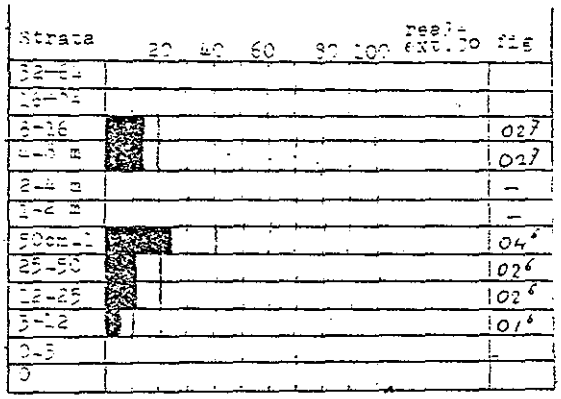
J : TERMINALIA BROWNII - COMBRETUM ZEYHERI

The most characteristic species in the Combretum zeyheri woodland are:

	NAME:	FAMILY:
trees:	Combretum zeyheri	Combretaceae
	Terminalia brownii	,,
	Bridelia taitense	Euphorbiaceae
herbs:	Hypoestes hildebrandtii	Acanthaceae
	Myosotis vestergrenii	Boraginaceae
	Cissus rotundifolia	Vitaceae
	Triumphetta flavescens	Tiliaceae
	Melhania velutina	Sterculiaceae
	Spermacoce sp.	Rubiaceae
	Canthium phyllanthoideum	,,
	Ocimum basilicum	Labiatae
grasses:	Tetrapogon cenchriiformis	Gramineae
	Aristida adscensionis	,,

The Combretum zeyheri woodland is found on two plateaus. These plateaus belonging to LS IV are situated as islands 50m elevated above the drier LS VI.

Figure 6J: The characteristic structure diagram of the Combretum zeyheri woodland at the end of the wet season.



Combretum zeyheri and Terminalia brownii in the semi-evergreen tree-layer are 7-14m tall. Externally they cover 40%. In the understorey there is a large seasonal variety. In the rainy season it is very dense, with herbs and annual and perennial grasses. In the dry season most grasses and herbs are consumed, desiccated or burned. Lianas and a shrub layer are absent.
The structure of the Combretum zeyheri woodland resembles that of the Combretum bushlands in landscape IV. The plant species, except Combretum zeyheri, are species which are found in the Acacia-Commiphora landscape VI.

This woodland is old, because of the well-developed trees. The absence of shrubs and lianas is caused by fires. In this woodland Combretum zeyheri, a fire-tolerant species, also shows dark spots on the bark.
At the end of the rainy season the Terminalia brownii trees flower and produce a smell resembling goats.

K : THEMEDA TRIANDRA - USP 2
The most characteristic species in this Grassland communitie are:

	NAME:	FAMILY:
herbs:	Dyschoriste depressa	Acanthaceae
	Rhynchosia nyasica	Papilionaceae
	,, malacophylla	,,
	Sida ovata	Malvaceae
	Polygala liniiflora	Polygalaceae
	Ocimum basilicum	Labiatae
	USP 3 #	
grasses:	USP 2 #	Gramineae
	Themeda triandra	,,

(USP)= unidentified species

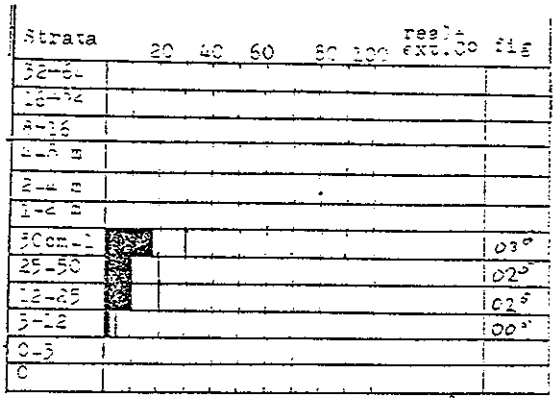
This community is found in landscape IV on vertisols. There is no tree layer and the herb layer is characterised by two Rhynchosia species, an unidentified grass (USP 2) and Themeda triandra. In the survey area these last two grasses are only found on vertisols

L : TEPHROSIA UNIFLORA - TEPHROSIA VILLOSA
The most important species in the Tephrosia fallow shrubby herblands communities are :

	NAME:	FAMILY:
herbs:	Tephrosia uniflora	Papilionaceae
	,, polyphylla	,,
	,, villosa	,,
	,, pumila	,,
	Acanthospermum hispidum	Acanthospermum
	Ocimum basilicum	Labiatae
	Boerhavia erecta	Nyctaginaceae
	Endostemon tereticaulis	Labiatae

The Tephrosia fallow communities occur scattered in landscape VI. It is a herb vegetation in the beginning stage of regeneration following a period of millet or sorghum cultivation.

Figure 6L: The characteristic structure diagram of the Tephrosia fallow communities.



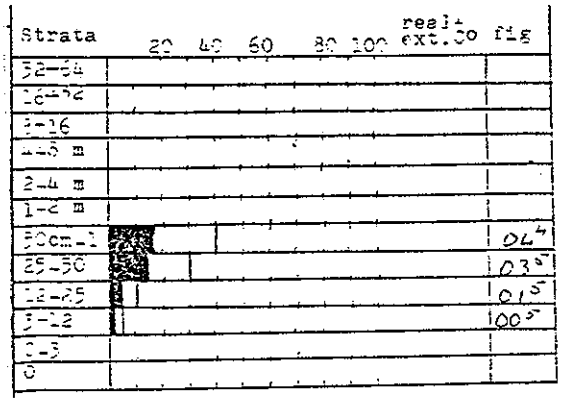
Papilionaceous Tephrosia species are dominating in the 25-75cm tall herb layer. Aromatic Labiateous species (Ocimum basilicum and Edostemon tereticaulis) and weeds (Acanthospermum hispidum) are also common.

M : PUPALIA LAPPACEA - ARISTIDA ADSCENSIONIS
The most important species in the Aristida adscensionis fallow Grassland are:

	NAME:	FAMILY:
herbs:	Boerhavia erecta	Nyctaginaceae
	Pupalia lappacea	Amaranthaceae
	Commelina sp.	Commelinaceae
grasses:	Aristida adscensionis	Gramineae

The Aristida adscensionis fallow grassland has nearly the same structure as the Tephrosia fallow communities.

Figure M: The characteristic structure diagram of the Aristida adscensionis fallow grassland.



It occurs in landscape VI, scattered and covering bigger areas. Instead of Tephrosia species, it is dominated by the perennial grass Aristida adscensionis which is not very digestible for cattle.
The domination of this grass together with poverty of the soil prevents a quick bush development.

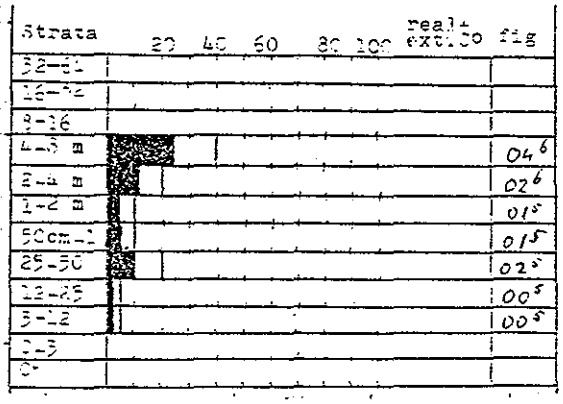
N : ACACIA TORTILIS - COMMIPHORA AFRICANA
The most characteristic species in the Acacia-Commiphora bushland are :

	NAME:	FAMILY:
trees:	Acacia tortilis	Mimosaceae
	Commiphora africana	Burseraceae
shrubs:	Acacia senegal	Mimosaceae
	Lannea triphylla	Anacardiaceae
	Combretum aculeatum	Combretaceae
	Grewia villosa	Tiliaceae
	Boscia coriacea	Capparidaceae
	Maerua spp.	,,

(shrubby) herbs		
	Ocimum basilicum	Labiatae
	Barleria eranthemoides	Acanthaceae
	,, acanthoides	,,
	Capitanya otostegioides	Labiatae
	Triumphetta flavescens	Tiliaceae
	Paederia pospischilii	Rubiaceae
grasses:	Aristida adcenscionis	Gramineae
	Eragrostis cilianencis	,,
	Tetrapogon cenchriiformis	,,
	Tragus beterionanus	,,

The Acacia-Commiphora bushland, which is one of the most extensive dry vegetation types of East Africa, occupies vast areas in landscape VI. In the bush-fallow system it is a bushland in later stages of regeneration, following a period of cultivation and its first stages of regeneration (fallow communities L and M).

Figure 6N: The characteristic structure diagram of the Acacia-Commiphora bushland



The tree layer, 5-9m tall, consists of the deciduous Commiphora africana and Acacia tortilis. The shrub layer, 3-5m tall, consists of the deciduous Acacia senegal, Grewia villosa and Combretum aculeatum and evergreen Capparidaceae species (Boscia coriacea, Capparis spp. and Maerua spp.). The cover of the annual grass/herb layer depends on the season and on the stage of degradation/erosion caused by a too short rotation scheme and overgrazing. Even in the rainy season the ground can be bare except some thorny Acanthaceae species (Blepharis linariifolia and Barleria acanthoides)

0 : ACACIA BREVISPICA - ACACIA TORTILIS

The most important species in the Acacia communities are :

	NAME:	FAMILY:
tree :	Acacia tortilis	Mimosaceae
shrubs:	,, brevispica	,,
	Acacia senegal	Mimosaceae
	,, mellifera	,,
	Cassia singueana	Caesalpiniaceae
	Ochna ovata	Ochnaceae
	Bauhinia tomentosa	Caesalpiniaceae
	Adenium obesum	Apocynaceae
	Euphorbia nyikae	Euphorbiaceae
	Grewia bicolor	Tiliaceae
(shrubby) herbs		
	Canthium phyllanthoideum	Rubiaceae
	Dyschoriste thunbergiflora	Acanthaceae
	Cyphostemma maranguense	Vitaceae
	Chascanum hildebrandtii	Verbenaceae
grasses:	Tragus berterionanus	Gramineae

The Acacia communities have the domination of Acacia species in common.

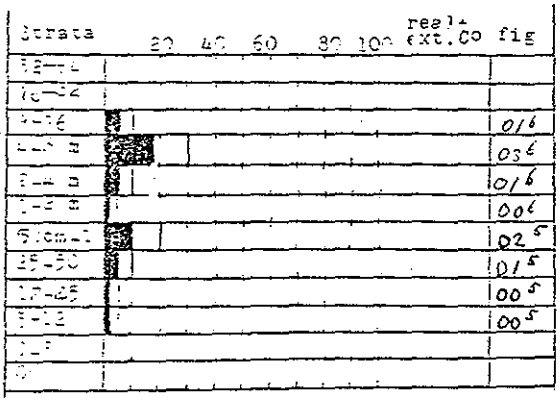
-The first Acacia community occurs at the footslopes between LS IV and LS VI (Unit 6.1). Acacia brevispica forms with Grewia bicolor, Ochna ovata and Cassia singueana a 3-6m tall thicket (see figure 0 1).
-The second Acacia community is a Acacia mellifera-Acacia senegal thicket in degraded/eroded areas in LS VI. When it is cleared this thicket is very susceptible to erosion, because it has no grass /herb layer and the soil lacks organic material.
-The third Acacia dominated community forms unit 6.3 near Igambangombe. It is a woodland with 10m tall Acacia tortilis trees covering externally 30%. In the understorey , 0.25-1m tall, shrubs are common (Canthium phyllanthoideum and Triumphetta flavescens).

P : ALBIZIA ANTHELMINTICA - STERCULIA RHYNCHOCARPA
The most important species in the wooded Sterculia rhynchocarpa bushland are :

	NAME:	FAMILY:
trees:	Delonix elata	Caesalpiniaceae
	Sterculia rhynchocarpa	Sterculiaceae
	Albizia anthelmintica	Mimosaceae
	Terminalia brownii	Combretaceae
	Acacia tortilis	Mimosaceae
	Commiphora africana	Burseraceae
shrubs:	Acacia mellifera	Mimosaceae
	Capparis sepiaria	Capparidaceae
	Combretum aculeatum	Combretaceae
herbs:	Dicliptera sp.	Acanthaceae
	Barleria eranthemoides	,,
	Triumphetta flavescens	Tiliaceae
	Cissus quadrangularis	Vitaceae
	,, rotundifolia	,,
grasses:	Tetrapogon cenchriiformis	Gramineae

The Sterculia rhynchocarpa wooded bushland resembles in structure and in flora the Acacia-Commiphora bushland. Only this wooded bushland has scattered trees with well defined trunks which carry the crown above the Acacia-Commiphora canopy. They include Delonix elata, Sterculia rhynchocarpa, Albizia anthelmintica, Terminalia brownii and Adansonia digitata, the baobab. They attain a height of 10m. Only the baobab can reach 20m.

Figure 6P: The characteristic structure diagram of the Sterculia rhynchocarpa developed bushland at the end of the wet season.



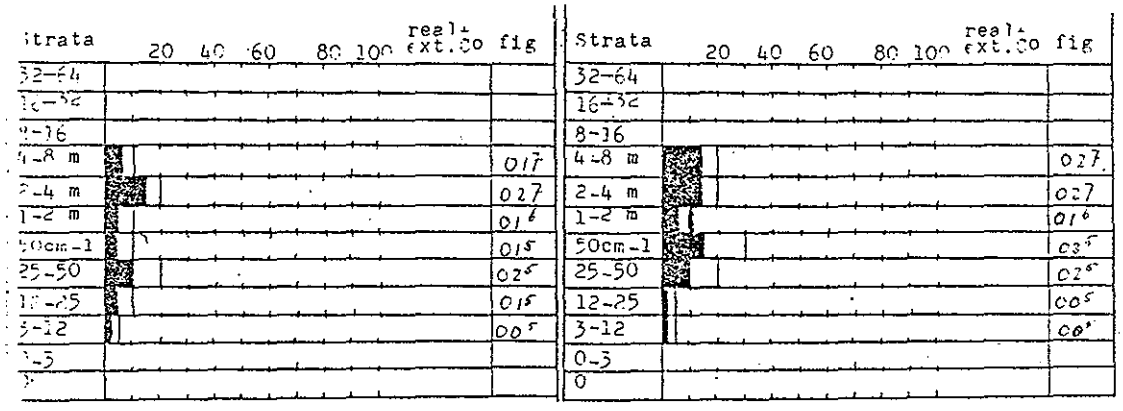
Most of these tree species attracted our attention. The baobab, a 20m tall huge stem succulent, points his mostly leaveless branches to the sky. Sterculia rhynchocarpa is also a stem succulent, although in lesser degree. In the dry season Delonix elata and Terminalia brownii are conspicuous. Delonix elata has beautiful big flowers and Terminalia has red winged fruits.

Q : ACACIA NILOTICA - TERMINALIA BROWNII
The most important species in the Acacia nilotica Wooded bushland are:

	NAME:	FAMILY:
trees:	Acacia nilotica	Mimosaceae
	Terminalia brownii	Combretaceae
	Bridelia taitense	Euphorbiaceae
shrubs:	Grewia bicolor	Tiliaceae
	Maytenus sp.	Celastraceae
	Canthium phyllanthoideum	Rubiaceae
	Pentas parviflora	Rubiaceae
herbs:	Acalypha indica	Euphorbiaceae
	Pentanisia ouranogyne	Rubiaceae
	Triumphetta flavescens	Tiliaceae
grasses:	Tetrapogon cenchriiformis	Gramineae
	Aristida adscensionis	,,

The Acacia nilotica wooded bushland is found at the wetter places of Ls VI. A wet type can be differentiated occuring on tops of hills with a deep soil and in the neighbourhood of Chiokariga near Kijege forest. The dry wooded bushland type occurs in the neighbourhood of seasonal rivers and in former river beds. In both types Acacia nilotica and Terminalia brownii dominate in the tree layer of 8-10m. It is striking to find Combretum zeyheri, a bushland species of Ls IV, scattered in the wet type.

Figure 6 Q1&2: Two characteristic structure diagrams of the Acacia nilotica developed bushland.
Left the dry, right the wet type.



In the understorey of both types there are annual grasses, perennial herbs and 1m tall dwarf shrubs (Maytenus spp.and Canthium phyllanthoideum).
Perennial grasses (Heteropogon contortus) occur in the wet type whereas leave succulents (2 Cissus spp. and the Asclepiadaceous Caralluma dummeri) are found in the dry type.

R : HYPHAENE THEBAICA - CASSIA LONGIRACEMOSA
The most important species in the Hyphaene thebaica fallow communities are :

	NAME:	FAMILY:
trees:	Hyphaene thebaica	Palmae
shrubby herbs:		
	Cassia longiracemosa	Caesalpiniaceae
	Heliotropium subulatum	Boraginaceae
herbs:	Tephrosia villosa	Papilionaceae
	Hermannia glanduligera	Sterculiaceae
	Acanthospermum hispidum	Acanthaceae
	Solanum incanum	Solanaceae
grasses:	Aristida adscensionis	Gramineae

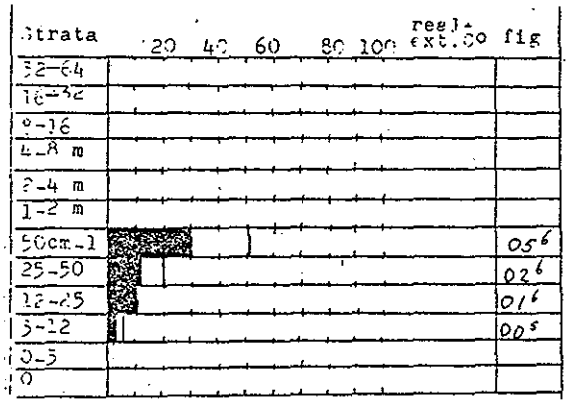
The Hyphaene thebaica fallow communities occur on the river terraces of the Tana river and other perennial rivers in landscape VI. Compared to the fallow communities L and M the Hyphaene thebaica fallow communities have a much shorter rotation scheme with a fallow period of only 2-3 years, because on the river terraces the soil is deep and fertile.
Cassia longiracemosa and Hyphaene thebaica , the doompalm, are the characteristic species. Hyphaene thebaica and some other trees up to 12m are spared when cultivating. They are up to 12m tall and cover about 5-10%. In the understorey Cassia longiracemosa, the perennial grass Aristida adscensionis and weeds (Solanum incanum and Acanthospermum hispidum) are common between 0.3 and 1.5m.

S : PENNISETUM TYPHOIDES* - SORGHUM BICOLOR*.
The most important species occuring in the Pennisetum typhoides* (millet) community are :

	NAME:	FAMILY:
herbs:	Gossypium hirsutum* (cotton)	Malvaceae
	Commelina sp.	Commelinaceae
	Euphorbia hirta	Euphorbiaceae
	Duosperma sp "A"	Acanthaceae
	Ipomoea pes-tigridis	Convolvulaceae
	Solanum incanum	Solanaceae
	Vigna aureus* (greengrams)	Papilionaceae
grasses:	Sorghum spp* (sorghum)	Gramineae
	Pennisetum typhoides* (millet)	,,

The Pennisetum typhoides(millet) communities represent the agricultural parcels in Ls VI. Sorghum and especially millet are the most important foodcrops. They are often intercropped with greengrams (Vigna aureus). The cashcrop cotton occurs on pure stands on the river terraces.

Figure 6S: A structure diagram of millet intercropped with greengrams, representative of the Pennisetum typhoides communities.



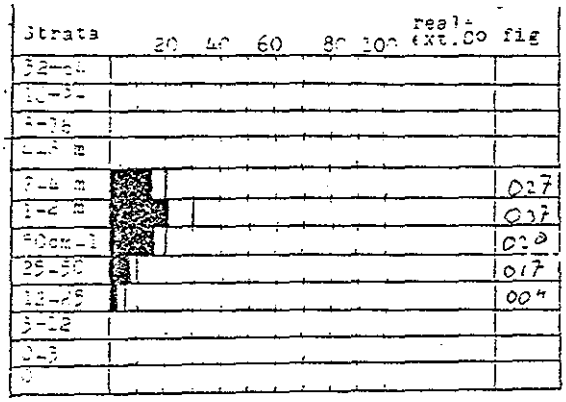
On the riverterraces, where these plant communities are common, there is often a transition between fallow communities R and these Pennisetum typhoides communities S. In such a situation there are agricultural crops as well as river terrace (fallow) species, occurring respectively in sociological group 27 and 26.

T : LAWSONIA INERMIS - SPHAERANTHUS SP.
The most important species occuring in the Lawsonia inermis wadi communities are:

	NAME:	FAMILY:
shrubs:	Lawsonia inermis	Lythraceae
	Acacia nilotica	Mimosaceae
herbs:	Sphaeranthus sp.	Compositae
	Kohautia caespitosa	Rubiaceae
	Indigofera tinctoria	Papilionaceae
	Heliotropium subulatum	Boraginaceae
	Calotropis procera	Asclepiadaceae
grasses:	USP 9	Gramineae

Lawsonia inermis, a 3m tall evergreen shrub is in and along the wadis the characteristic species. It also occurs at very small seasonal rivers. Along the wadis Acacia nilotica is the only Acacia shrub. Generally the shrub is a riverine species.

Figure 6T: A structure diagram of a hillock in the wadi covered with Lawsonia inermis and Acacia nilotica shrubs.



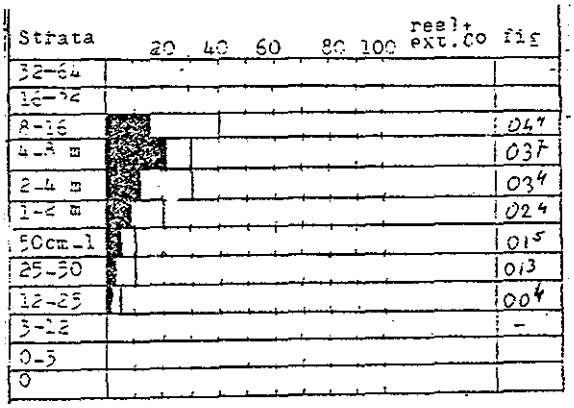
It is striking that the herbs have mostly woody stems (Kohautia caespitosa and Indigofera tinctoria), an adaptation to protect themselves against streaming water. Calotropis procera, an Asclepiadaceous species, can survive in the wadi on sandy places as it survives at the edge of sandy roads in landscape VI.
There is a transition in the wadi from very dynamic to more static situations; together with this the sand is becoming more fine. In these transitions, there are often small cliffs, dividing small plateaus at several altitudes.
In Arabic countries Lawsonia inermis, the "henna" plant, is used for dying the hair and painting hands and feet.

U : COMBRETUM SP. - COMMIPHORA AFRICANA
The most important species in the Commiphora africana Scrub forest are:

	NAME	FAMILY
trees:	Commiphora africana	Burseraceae
shrubs:	Combretum sp.	Combretaceae
	Acalypha fruticosa	Euphorbiaceae
herbs:	Triumphetta flavescens	Tiliaceae
	Ocimum basilicum	Labiatae
	Ecbolium hamatum	Acanthaceae
grass:	Dactyloctenium aegyptium	Gramineae

The Commiphora africana shrub forest occurs in Ls VII in the Nyamatu hills and near Mumoni forest. In this forest Commiphora africana, a Combretum species and Acalypha fruticosa are the most common species. These species form sociological group 29.

Figure 6U: The characteristic structure diagram of the Commiphora africana shrub forest.



The deciduous Commiphora africana forms the upper layer of 10-12m Its external cover is 40%. The internal cover depends on the season. Structure diagram 6U was made in the dry season. In the wet season the real cover of the upper layer is (04x07=) 28%, instead of (04x04=)16%
The Combretum sp. with medium sized evergreen leaves (mesomorph) dominates in the shrub layer of 7m. The deciduous Acalypha fruticosa is abundant in the lower shrub layer of 1.5-4m.
Striking features of this shrub forest are the poverty in plant species, the dominance of 3 species and the absence of special live-forms such as lianas, thorns and succulents. It is easy to walk through this forest without stooping and being pricked by thorns.

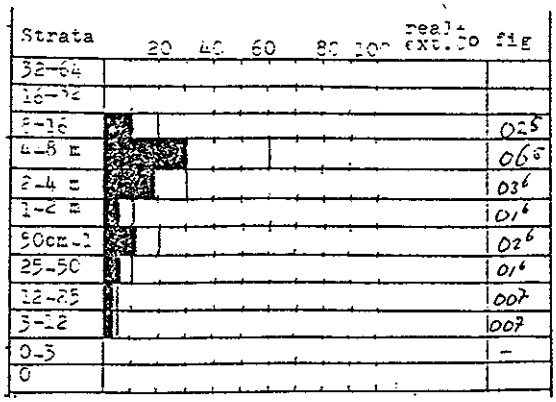
V : USP 10 - OCHNA OVATA

The most important species occurring in the Ochna ovata Scrub forest are:

	NAME:	FAMILY:
trees:	Ochna ovata	Ochnaceae
	Acacia brevispica	Mimosaceae
	Cordia ovalis	Boraginaceae
	Commiphora boiviana	Burseraceae
	,, holtziana	,,
	USP 10	
shrubs & lianas:		
	Premna olichotricha	Verbenaceae
	Capparis tomentosa	Capparidaceae
	Bauhinia tomentosa	Caesalpiniaceae
	Dalbergia lactea	Papilionaceae
	Boscia angustifolia	Capparidaceae
	USP 11 (liana)	Papilionaceae
herbs:	Crabbea velutina	Acanthaceae
	Isoglossa laxa	,,
	Ecbolium hamatum	,,
	Rhinacanthus gracilis	,,
	Leucas glabrata	Labiatae
	Commelina sp.	Commelinaceae
ferns:	Pellaea longipilosa	Pteridophytes
	Actiniopteris radiata	,,

The Ochna ovata shrub forest is found on the mountains of landscape VII; Kijege forest and Kierere forest in the northeast and Mumoni forest in the southeast of the survey area.
The Ochna ovata shrub forest is a result of a law which was passed 40 years ago to protect the area against erosion. This law forbade people to live on the mountains. Witness of the past (over)landuse are the big erosion gullies in Mumoni forest and the vegetation itself. The vegetation is dense and complicated. It is difficult to know from which stem a leave originates by the many lianas and intertwining bushes.
Ochna ovata, a low growing tree with small leather like evergreen leaves, is very common and often dominating. Acacia brevispica is everywhere but never dominating. In the understorey 0.25-0.75 m tall Acanthaceae herbs are most common.
Cordia ovalis, Commiphora boiviana, Commiphora holtziana, USP 11 (a Papilionaceous liana with big deciduous leaves) and USP 10 (a big tree, with a winged stem and older than 40 years) occur only in Mumoni forest. In Kijege forest two fern species are common.

Figure 6V: The characteristic structure diagram of the Ochna ovata shrub-forest in the dry season.



In the structure diagram which was made in the dry season 08^4 in the two highest layers was found, which should be at least 08^7 in the rainy season. In the second layer 03^7 is found, because the evergreen bushes and shrubs do not change much in cover per season (Ochna ovata, Capparis tomentosa, Boscia angustifolia and Bauhinia tomentosa).

4.4 Description of the mapping units

1 Ocotea usambarensis - Strombosia scheffleri Ls

Climate and Soil

This Landscape is situated in the north-western part of the study area between 2100 and 1600 meter. Several hundred meters higher (outsite our area) it borders the Bamboo zone.
It is the wettest part of the area with an annual rainfall of 1800 - 2200 mm. The area is covered by several lahar flows (flow of a heterogeneous mixture of lava with mud), forming several layers causing a step-like appearance. Soils are deep-weathered Nitisols, with an decreasing humous topsoil going downstairs.

Past, Present and Future

The majority of the forest is still virgin and differs not much from the forest in the past. The forest border (mapping unit 1.3) and the forest near the tracks have been heavily exploitated.
Forestry has practised intensive selective felling to cut timber trees like Campher (Ocotea) and Podo (Podocarpus). Only near the tracks suitable trees are cut, not beyond the first deep valley. Near the tracks useless trees are left (often secondary species like Croton sp. or very old Camphers).
Individual people are allowed to cut trees for fuelwood, which they gather in the lower parts of the forest.
Also farmers with their neighbouring shambas put pressure upon the forest. They slowly move the forest boundary back to start profitable tea plantations. Quite recently the Kenya government decided to allow farmers to move 100 meter into the forest. The government motivated this decision by saying that the new plantations will provide a buffer between squatters and the forest (Redfern 1985).

Mapping units

1.1 Podocarpus milanjianus - Galiniera coffeoides
Vegetation types: A (80%), B (20%)

1.2 Ocotea usambarensis - Strombosia scheffleri
Vegetation types: B (80%), A (10%) and C (10%)

1.3 Prunus africana - Celtis africana
Vegetation types: C (80%) and B (20%)
Most influenced part of the Forest

1.4 Ensete ventricosum - Newtonia buchani
Vegetation types: C (70%), B (20%) and A (10%)
Only in the steepest valleys a different vegetation can be found (with slopes of over 100%). A large part of this unit is covered by the Prunus - Celtis veg.type with a Newtonia buchani Woodland along the rivers. Higher in the Forest also vegetation types B and C occur. On the steepest slopes with shallow soils wild bananas (Ensete) and tree ferns (Cyathea sp.) occur.

2 Croton megalocarpus - Coffea arabica Ls

Climate and Soil

This landscape stretches from the boundaries of the Rainforest to the Combretum Woodland and spans an area with an average annual rainfall of 1200 - 1600 mm. Ecological more important is the length of the growing season. In the dry season in the "Tea-zone" (which overlaps partly unit 2.1) the top soil contains still more than 30% moisture (weight). Only the upper few centimeter are dry. Downstairs in the area near Ls 3 this moisture content in the topsoil is less than 15%, too dry for most plants to grow optimally.

Obviously the soils in the cultivation area near the Forest have a darker topsoil than the soils in the lower part. Going down soils get more structure, shiny pedfaces are pronounced and finally, in the extreme eastern part, the soils are less deep.

Past, Present and Future

The area near the Rainforest (at least unit 2.1) are quite recently (last century) deforestated. There used to be a forest like the Prunus africana - Celtis africana vegetation type. With a population growth of 3-4% this landscape will change rapidly. Especially in unit 2.2 this might have tremendous efects when the present ecologically adapted landuse system has to change (see unit description).

Mappingunits

2.1 Pteridium aquilinum - Camellia sinensis
Vegetation types: D (85%), E1 and E2 (10%) and C (5%)
The highest and wettest part of landscape 2 with a very typical landuse which is reflected in the name which Jaetzold gives for this agro-ecoloigical zone: Tea - Dairy zone. Near the homesteads, on the ridges, there are small pastures and gardens with foodcrops (maize, beans).
On the valley slopes tea plantations are situated.

2.2 Croton megalocarpus - Coffea arabica
Veg. type E1 and E2 (80%), C, D and F (20%)
One of the most extended mapping units with a lot of variation in slopes, valleys and landuse. However a major component is the typical building block of this landscape. Farmers grow their foodcrops near the homesteads on the ridges; coffee is planted on terraces on the often steep slopes; on the valley bottom bananas are planted. Especially near the homesteads trees are abundant (E2).

2.3 Eucalyptus camaldulensis - Pinus raddiata
Plantation forest which was planted ± 20 years ago

2.4 Albizia gummifera - Newtonia buchani
Vegetation types: E 1/2 (50%), C (30%) and D (20%)
Valleys with still an abundant tree vegetation, remnants of the former forest and comparable to the lower part of unit 1.4. Often forest is earlier cleared on the ridges than in the valleys.

2.5 Albizia gummifera - Newtonia buchani
Vegetation types: E 1/2 (50%), D (40%) and C (10%)
The whole valley is cultivated but remnants of the forest can be found along the rivers.

2.6 Musa sp. - Coffea arabica
Vegetation types: E 1/2 (100%)
Smaller valleys where even cultivation, mainly bananas, is practised on the banks of the streams.

3 Dombeya rotundifolia - Mangifera indica Ls

Climate and Soil
Subhumid climate, with an annual average rainfall of ± 1100-1300 mm and two long dry seasons.
Nitisols dominate in the western part of this landscape, Acrisols dominate in the eastern part of this landscape.

Past , Present and Future
In the past there was a forest, much opener and lower than the present Rainforest. Towards the east this forest gradually became a kind of Woodland with more drough resistent trees.
Although the land pressure is very high, small areas can be found with a fallow vegetation of five or more years (veg. type H). But the majority of the land is cultivated, with in contrast to the previous landscape, fallow periods of up to two years (grass- or weed fallow).

Mapping units

3.1 Mangifera indica - Zea mays
Vegetation types: F (70%), E 1/2 (25%) and G (15%)

3.2 Dombeya rotundifolia - Mangifera indica
Vegetation types: F (50%), E1/2 (30%) and G (20%)

3.3 Lantana camara - Zea mays
Vegetation types: G (40%), F (30%) and E 1/2 (30%)

3.4 Albizia gummifera - Newtonia buchani
Vegetation types: F (50%), E 1/2 (30%), C (10%) and G (10%)

3.5 Musa sp. - Zea mays
Vegetation types: F (60%), E1/2 (30%) and G (10%)

4 Combretum zeyheri - Combretum binderianum Ls

Climate and Soil

The majority of this landscape is sub-humid with an average annual rainfall of ± 900-1200 mm and a prolonged dry season. The majority of the soils are quite deep Acrisols with a moderate fertility and moderate physical properties. But near the edge of the plateau (in the southern part of the area) they become much shallower and gravellier. Within one meter depth murm (iron - manganese concretions) can be found and finally the last kilometer of the plateau, the soils become less than 20 cm deep (Lithosols). Although the majority of this landscape is of volcanic origin, in some valleys Basement System rocks are the parent material for soil genesis, causing many similarities with landscape 6.

Past, Present and Future

Especially north of the Thuchi river (Meru district) this landscape is quite extended. It is relatively undisturbed, which is striking when going down the slopes of Mt. Kenya through it's intensively cultivated land (landscapes 2, 3 and 6). This can be explained by it's buffer position between the countries of different (sub)tribes: the Chuka (highlands, Ls 2 and 3) and the Tharaka (lowlands, Ls 6) people. Only recently this area became safe enough to start cultivation, but it's population density is still low. The vegetation is influenced by an extensive burning regime which caused the dominance of Heteropogon contortus but saved the tree layer (in contrast to Ls 5).
In future much more cultivation will be practised in the northern part of the landscape, in the southern part most of the suitable places are already cultivated. A grazed Bushland is left, offering little opportunities to cultivate due to it's very shallow soils.

Mapping units

4.1 Combretum zeyheri - Heteropogon contortus
Vegetation types: H (70%) and F (30%)

4.2 Combretum zeyheri - Zea mays
Vegetation types: H (50%) and F (50%)

4.3 Aloe secundiflora - Euphorbia nyikae

4.4 Heteropogon contortus - Euphorbia nyikae

4.5 Zornia apiculata - Ocimum basilicum
On some places flows of Lahar streamed further away from Mt. Kenya. One of these probably reached a depression in the Basement System and formed a plain. Developed soils are very shallow and moderately fertile. North of the Chuka-south area this landscape is much more common. This area is heavily grazed and the shrubby herb Ocimum basilicum and Heteropogon contortus (grass) dominate. Zornia apiculata is an indicator of heavy grazing pressure.

Spots of heavy clay soils (Vertisols) occur, developed in a poorly drained environment as can be expected on these flat areas. Here a quite different vegetation can be found (K). In the dry season grazing cattle and goats concentrate on the green vegetation, which grows on these spots.

4.6 Combretum zeyheri - Terminalia brownii
Vegetation type: J (100%)
This Woodland is found on the Materi basalt Plateau and on the Plain of lahar, where also unit 4.5 is situated. Both locations are surrounded by Landscape 6, which illustrates the importance of the parent material (the assumption of the same climatic circumstances seems to be realistic). Compared to unit 4.5 this unit has a much less human-influenced vegetation type (especially burning).

4.7 Euphorbia nyikae - Acacia brevispica
Vegetation types: F (60%), G (20%) and O1 (20%)
Valleys with locally shallow soils, which are partly derived of Basement System rocks having it's influence relativelly far to the west.

4.8 Combretum binderianum - Combretum zeyheri
Vegetation types: H (40%), G (30%) and S (30%)
No Basement System influences

5 Hyparrhenia sp. - Heteropogon contortus Ls

Climate and Soil

Volcanic influences no longer dominate in the three eastern landscapes. This change in geology goes together with a steadily decreasing amount of rainfall, in this landscape ± 1000 mm a year.
This landscape occurs only in the north eastern part of the Chuka - south area and has slopes of over 20%. Soils are moderately deep, often with murm .

Past, Present and Future

Probably this landscape used to be covered by a kind of Bushland, more or similar to unit 5.1. Fire is the main factor which has caused this Wooded Grassland. The fire tolerant Heteropogon contortus dominates here. The high biomass, which is burnt and the time of burning (just before the onset of the rains) causes hot fire, which is reflected in the low tree coverage.
Due to the steep slopes, shallow soils and demographic factors (see Ls4), this landscape has never been cultivated to any extend. Only on a few suitable spots and near the transition to the other landscapes (especially the footslopes) cultivation is possible.

Main landuse is grazing (mainly cattle). During the dry season the Hills are covered by a layer of "standing hay" with a very low foodquality. Only below the irritating needles of Speargrass (Heteropogon contortus) some fresh leaves can be found or the nutricious leaves of Indigofera binderi. However after burning during the rains a layer of green fresh grasses is formed, which is very palatable and nutricious. Till the flowering of Speargrass the Hyparrhenia sp. - Heteropogon contortus Ls is heavily grazed. During flowering (dry season), the animals shift to the valleys and landscape 6 where browse forms an important dry season forage resource.

Mapping units

5.1 Gardenia jovis-tonantis - Heeria reticulata
Vegetation types: Q (90%) and I (10%)
Vegetation type Q is dominant, but some open places (especially in the Mutharanga forest near Chiokarige) occur. Fire is not important, only the fringe of the scrub forest is regularly burned. This is the only grazed part of the unit.

5.2 Heeria reticulata - Heteropogon contortus
Vegetation type: I (100%)

5.3 Gardenia jovis-tonantis - Heeria reticulata
Vegetation types: Q (90%) and I (10%)

5.4 Hyparrhenia sp. - Heteropogon contortus
Vegetation type I (100%)

6 Acacia senegal - Commiphora africana Ls

Climate and Soil

This landscape occupies most of the eastern part of the Chuka-south area, the lowest and driest part of this area with an annual average rainfall of 600-900 mm. It belongs to the Basement System which stretches several hundred kilometers to the east and is covered by an endless sea of thornbush. Each part of this area has once been cultivated, therefor vegetation is a reflection of the stage in the bush-fallow system.

The majority of the soils are Chromic Luvisols, developed of gneisses rich in ferro-magnesium minerals, which are quite deep and moderate fertile (chemical) but have a very low organic matter content. They are all eroded and have lost their humous topsoil. This caused the sealing of the exposing subsoil, which reduces the infiltration capacity very much (often more than 50% of the rainwater runs off!). On specific places, near rivers and streams, Calcic Luvisols occur comparable in chemical fertility to the Chromic Luvisols. However surface sealing does not occur here.
Especially near the Mountains and Hills other soils occur, formed of colluvium. In the river terraces quite different soils occur, of which the parent material is both of volcanic and Basement System origin. These alluvial soils are deep, relatively fertile and have a good physical structure.

Past, Present and Future

In 1938 Maher, then soil conservation officer for Kenya wrote a report about Embu district based on four weeks of field investigations. He writes about the Acacia senegal - Commiphora africana landscape: "Bare granitic rocks and scanty sands in semi-arid country situated at low altitudes reflect back a pitiless sun. Stunted animals and poverty-stricken inhabitants seek sustenance in a barren semi-desert where all hope of progress is futile and where famine is ever waiting at the door - the most promising method of dealng with these people appears to be to move them, lock, stock and barrel, leaving their present land to regenerate to bush and to become once again the haunt of the elephant, the rhinoceros and the buffalo - abandonment of the land to the slow but sure healing of Nature is the only praticable remedy".(Maher, 1938, Vol.I:2; Vol.II:1,64, quoted by Brokensha and Riley 1980)

Nearly fifty years later the physical situation seems to be much the same. A newspaper wrote in an article about new funds which are provided for the EMI programme to help farmers in the dry parts of Embu, Meru and Isiolo districts. They write about the area:"to assist (the farmers) with the task of earning a living from some of Kenya's poorest and most arid land - to prevent further deterioration of the arid land and to boost agriculture, forestry and livestock production - They were hard hit by the drough last year and the population exploitation in Kenya has forced farmers to use the land more extensively with the results that the soil does not recover" (Nation; januari, februari 1986)
No discussion has to be held about the severity of the

degradation, but the report of 1938 leads to the posing of questions about the rate of it.
Due to the availability of permanent water and easily exploitable land, this landscape has been cultivated already a long time ago. Shortly afterwards degradation became more serious till the situation in 1938 and nowadays. The situation before cultivation started can be reconstructed:

Older people remember the times (more than 50 years ago) that the northern part of this landscape (Tharaka, in Meru district) was covered by forests with high trees and harboured abundant wildlife of lions, giraffes and antilopes. Especially the footslopes of the hills and mountains were covered by a Woodland of tall Acacia tortilis trees (mapping units 6.1 and 6.2). Remnants of these can still be found near Kijege forest.

Probably the majority of the area (mapping units 6.4 and 6.5) was covered by a vegetation which nowadays can be found in Meru National Park, 40 Kilometer north-east of the Chuka-south area. Uncultivated land remains there under comparable climatic and pedological conditions. Four layers can be distinguished in the vegetation:

A ground layere 0 - 0.8m. with perennial grasses, especially Chloris roxburghiana and Enteropogon macrostachys.

A shrub layer 1.2 - 1.7m. with Grewia villosa, Combretum aculeatum, Bauhinia taitensis and Triumfetta flavescens.

A high shrub or low tree layer $\pm$ 5m. with Commiphora africana, Acacia senegal and Acacia tortilis.

A tree layer $\pm$ 15m. with Acacia tortilis.

Here the humous top soil is $\pm$ 25 cm thick in which all rain water can infiltrate. However also in this protected area spots of bare soil occur with species common in cultivated land, like Ocimum basilicum, Tetrapogon cencriiformis, Tragus berteronianus and even Blepharis linariifolius. They occur where animals gather, like tracks, elephant pools and on old termite mounds. This illustrates the sensitivity of the ecosystem to erosion. The humous topsoil is lost exposing a subsoil which is easily sealed, causing a low infiltration capacity. Perennial grasses disappear and can be replaced by annual grasses, but more often they are replaced by a dense shrub layer. This is the so called bush encroachment.

Present Landuse

In the majority of the area a bush-fallow agriculture is practised. People start cultivation by clearing a particular bush, usually a few ha large. Not all trees are cut, especially Sterculia rhynchocarpa, Delonix elata and Adansonia digitata are spared, Commiphora and Acacia trees are often only cut remaining a one meter high stem. A few months after clearing all biomass is burned, usually just before the expected onset of the rains. Cultivation starts with as major foodcrops millet, sorghum and green grams and most important cash crop cotton. On spots receiving more rain, cotton is grown.
Usually the gardens are protected against livestock by fences of thorny Acacia senegal or A. tortilis branches, but after the harvest in the harsh dry season animals are driven into the gardens to graze weeds and millet or sorghum stalks.

After two or three years of cultivation, land is left fallow. The first year only heavily grazed annual grasses and herbs grow. Trees which were spared during cultivation grow out and are the spots of a slowly recovering vegetation. Dependant of the amount of depletation of the soils and the grazing pressure, regeneration can occur, or not. In the latter case the land remains bare, soil surface seals and any regeneraton will be very unlikely. The situation is often worsened due to grazing animals for which this area is very attractive.

The regenerating land slowly grows out of reach of cattle and goats and "shoots" then several meters high. First it forms dense thickets, but becoming older (more than 10 years?) trees grow higher and a kind of Scrub forest is formed (7m high trees). This stage is hardly reached anymore, because before that moment trees are already cut for a new cultivation stage. Nowadays especially the transition from bare soils with outgrowing trees into bushland is gradually hindered. More exhausted soils and a higher grazing pressure are responsible for this. Although landclearing as such is not accelerating, the amount of older A. senegal-C. africana bush decreases due to a decrease in developing of bush after cultivation.
In a first visit one would be inclined to think that this ecosystem is deteriorating. We have already seen that the way and the rate show that new "equilibria" are formed. This means that overstrained measurements (like abandoning land, destocking etc) will not solve anything. No clear solutions can be offered but a few ideas are discussed elsewhere (Scholte '86b).
The situation on more favourable sites like the river terraces is quite different, see under unit descriptions for more details.

Mapping units

6.1 Bauhinia tomentosa - Acacia brevispica
Vegetation type O (100%)
Thicket and Bushland on the footslopes of the scarp between Ls 4 and 6. This rather luxuriant vegetation contrasts with the sparse vegetation upwards (unit 4.3). Here the moisture availability is very high due to seepage of groundwater from the plateau.

6.2 Commiphora holziana - Commiphora africana
Vegetation type N (100%)
Mainly Scrubforest on a ridge in the centre of this landscape

6.3 Acacia senegal - Commiphora africana
Vegetation types O1 and O2 and P
On a few places extended areas of Bushland and Woodland can be found. This unit is very heterogenous, the majority consists of relative old bushland

6.4 Pennisetum typhoides - Commiphora africana
Vegetation types: N(25%),S(20%),M(20%),P(15%),O(15%), F(5%)
The most common mapping unit in this landscape

6.5 Pennisetum typhoides - Commiphora africana
Vegetation types: N(40%), M(30%),S(20%), P(5%), L(5%),F(5%)
In many aspects comparable to unit 6.4, but not the conspicuous chess-board form of thicket and farmland

6.6 Pennisetum typhoides - Aristida adscensionis
Vegetation types: S(30%), N(30%), M(20%), O(20%)

6.7 Pennisetum typhoides - Acacia tortilis
Vegetation types: S(40%), O(30%), M(15%), L(15%)
Farmland with Acacia tortilis Woodland along the water courses and in general a high tree cover.

6.8 Terminalia brownii - Hyphaene thebaica
Vegetation types: N(30%), S(20%), O(20%), Q(20%), M(10%)

6.9 Pennisetum typhoides - Gossypium sp.
Vegetation types: S (50%), L (30%), M (10%)
In many aspects this unit resembles the next one, but it is not situated on a riverterrace.

6.10 Tephrosia sp.- Cassia longiracemosa
Vegetation types: S(60%), L(30%)and R(10%)
Along several rivers extended riverterraces have been formed, which due to their fertility are all intensively cultivated. The majority of this unit is presently cultivated or fallow (usually less than 2 year). Only small patches of less intensively used land occcur.

6.11 Acacia rovumae - Cassia longiracemosa
Vegetation types: S(40%), L(30%), R(25%) and T(5%)
Along the Tana river extended riverterraces have been formed. In the south it is dissected and has a slope of ±5%, in the northern part it is flat and younger. The majority of this unit has been cultivated with short fallow periods (<5 years). The only older vegetation can be found on the banks of the river which are covered by a high Woodland. Acacia rovumae and Ficus sycomorus dominate in the southern part, Acacia elatior, Hyphaene thebaica and Ficus sycomorus dominate in the northern part. In the upper northern part of this unit a small island of ± 5 ha in the Tana river is situated (near the Grand Falls). A riverine forest is developed with the same species as on the riverbanks together with Pandanus and Phoenix palms.

6.12 Acacia mellifera - Acacia senegal
Vegetation type: 02 (100%)
Old riverterrace with Bushland, 5 m high, with a very low ground cover due to the heavy grazing pressure.

7 USP 10 - Ochna ovata Ls

Climate and Soil

In the extreme eastern part of the Chuka-south area a range of mountains is situated, which rises more than 500 m above the surroundings. This altitude causes a lifting (eastern) air which is responsible for a nearly doubling of the annual rainfall (1200 versus 700 of the surroundings). Often clouds were seen hanging around the summits of the mountains. They reduce the amount of evaporation and cause condensation at the vegetation.
Soils range from shallow to moderately deep (especially on the footslopes), their fertility is moderate. In the footslopes soil moisture conditions are relative favourable.

Past, Present and Future

People living near the Kijege - Kiere Forest range remember the times that the presently uninhabited Mountains were densily populated and intensively cultivated. Baobabs (Adansonia digitata) were the only trees which remained. These Mountains were especially attractive during the times that nomads crossed the area and the people fled into the Mountains and stayed there long after.
In 1945 the British colonial goverment decided to protect the heavily exploitated Mountains and forbad all cultivation and inhabitation of these Mountains (except the Kibiro hills). Most people were chased away, but a few could escape the British. Kijege was one of them. He was a witch doctor, who could make himself invisible with special herbs and could continue to live in what is now called Kijege Forest. His son is still living in Chiokarige.

Striking is that after independance (1963) the forests remained unoccupied in contrast to an overall tendency in Kenya to neglect colonial anti-erosion measures. Up to the moment no cultivation and grazing has been practised in these gazetted Mountains. In these 40 years a dense Scrub Forest developed above which baobabs rise, remnants of the cultivation land.
The Kibiro hills which were never gazetted (why?) probably show the situation of all the Mountains before gazetting. A stone-rich bare soil with an occasional shrub and no cultivation anymore. Only some grazing is practised by herds of people living near the Tana river. The boundary of the gazetted forests can be found back as sharp lines in the landscapes. On some spots it looks like a fire lane.
Long before the time of cultivation, these Mountains were covered by a high forest. Especially on the higher slopes this might have resembled the Mt.Kenya forest. Nowadays only on the highest peak of Mumoni forest "real" forest can be found (less than 5 acres). Due to it's inaccesibility we could not visit it, but it is possible that vegetation types like Prunus africana - Celtis africana occur there.

Nowadays the majority of this Scrub Forest is formed by the Ochna ovata- Acacia brevispica vegetation type, characteristic for a recovering environment with a not too shallow soil and slopes of less than 50%. Baobab trees form the upper layer (15m high). On steeper slopes other vegetation types occur. On the top of rock-faces (with a very shallow soil) Euphorbia nyikae is dominant together with some Commiphora trees. Under these rockfaces a dense thicket, evergreen , ± 1.5 m high of an unknown species stands , benefitting of the availability of rain water running of the rocks.

Mapping units

7.1 Ochna ovata - Acacia brevispica
Vegetation type: V (100%)
The majority of this landscape is formed by the USP 10 - Ochna ovata veg.type which occurs on the slopes. On the footslopes an Acacia tortilis Woodland can be found. Patches of grassland occur, especially on the western side of the range. They belong to the Hyparrhenia sp - Heteropogon contortus vegetation type, indicating that since the gazetting burning has been practised on a small scale.

7.2 USP 10- Ochna ovata
Vegetation types: V (80%) and U (20%)
The Scrub forest on Mumoni mountain differs from that of Kijege in having a slightly different species composition. Especially the presence of USP 10 (unknown species), a tree with a winged stem was obvious. The majority of the footslopes have been cultivated in Mumoni forest, however no open patches occur. On the peak of Mumoni (1700 m) Mountain Rainforest occurs.

7.3 Canthium phyllantoideum - Boerhavia erecta
Vegetation type M (100%)
The only not gazetted "forest" shows clearly the effect of protecting during more than 40 years, although one has to realise that protecting the Mountains increased the pressure on this Hill. Why the colonial goverment excluded this Hill is not clear. Nowadays it is covered with a sparse fallow vegetation and a few scattered bushes of Balantes aegyptica.

DISCUSSION

The presented Vegetation and Landuse map of the Chuka-south area is the first map of this scale of the area.
Differences in physiography were the first criteria for interpretation. With field data the landunits were described in terms of vegetation. Clear vegetation / landuse differences were considered as important as physiographic differences (for example the division of the Mountain footridges in two landscapes: the forest and cultivated land). In this way both physiographic and vegetation/landuse differences were used on the highest level. Criteria for discriminations between units on the lowest level are based on differences in landuse and vegetation types.

In the Chuka-south area differences in physiography are highly correlated with differences in geology and climatology, see table 9

TABLE 9: CORRELATION BETWEEN PHYSIOGRAPHY, GEOLOGY, CLIMATOLOGY IN THE SEVEN LANDSCAPES

Ls 1+2	Ls 3+4	Ls 5	Ls 6	Ls 7
Mt. Footridges	Plateau,Uplands	Hills	Uplands	Mountains
volcanic	volcanic	intrusive	metamorf	intrusive
humid	semi-humid	semi-arid	semi-arid	semi-humid

The consequence is a high correlation of both vegetation and soil with these environmental conditions. Land use (as a derivation of this) is also highly correlated.
These factors are especially strongly correlated in the drier eastern part of the area (Basement System), also on a more detailed scale. In the western part differences are much less obvious (for example the Intrusives in the western part of the area compared to the surrounding volcanic areas.)

It is clear that the used landscape guided method suits the best in those areas where differences in physiography, geology, climate, soils, landuse and thus of vegetation are strongly correlated, as is the case in the Chuka - south area.

In 1976 a 1:250,000 vegetation and landuse map of South- and Central Kenya was made (Trapnall et al), based on air photographs and ground survey. The value of this map lies particular in the possibility of extrapolating the results of more detailed studies to surrounding areas.
They distinguish 18 units in the Chuka-south area (the presented map 42) and obviously do not distinguish our landscapes 4 and 5 and call both of them undifferentiated Combretum types. No units were distinguished in landscape 6, which is completely classified as Acacia - Commiphora. It is clear that the 1:250,000 scale is too large to map differences in landuse. Therefor the map has to been seen as a slightly corrected potential vegetation map.

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Appendix I

LEGEND OF THE VEGETATION AND LANDUSE MAP OF THE CHUKA-SOUTH AREA

1 **Ocotea usambarensis-Strombosia scheffleri Ls**
Mountain Rain Forest on Mountain Footridges, developed on Mt. Kenya volcanics

1.1 Podocarpus milanjianus - Galiniera coffeoides
Montane Rain Forest (above 1950 m) on Mountain Footridges

1.2 Ocotea usambarensis - Strombosia scheffleri
Sub-montane Rain Forest (1700-1950 m) on Mountain Footridges

1.3 Prunus africana - Celtis africana
Transitional Rain Forest (±1600-1700 m) on Mountain Footridges

1.4 Ensete ventricosum - Newtonia buchani
Forest in steep Valleys of Mountain Footridges

2 **Croton megalocarpus - Coffea arabica Ls**
Very intensively cultivated land on Mountain Footridges, developed on Mt. Kenya volcanics

2.1 Pteridium aquilinum - Camellia sinensis
Intensively cultivated land with tea plantations and small dairy pastures on Mountain Footridges

2.2 Croton megalocarpus - Coffea arabica
Intensively cultivated land with coffee plantations, on Mountain Footridges

2.3 Eucalyptus camaldulensis - Pinus radiata
Plantation Forest on Hills of (granitic) Intrusives.

2.4 Albizia gummifera - Newtonia buchani
Woodland along the river and scattered in the whole Valley with Farmland

2.5 Albizia gummifera - Newtonia buchani
Farmland with Woodland along rivers in Valleys

2.6 Musa sp. - Coffea arabica
Farmland without trees in Valleys

3 **Dombeya rotundifolia - Mangifera indica Ls**
Intensively cultivated land on Plateaus and (volcanic) Uplands, developed on Mt. Kenya volcanics

3.1 Mangifera indica - Zea mays
Intensively cultivated Farmland with a tree cover < 20% , on strongly dissected Plateaus

3.2 Dombeya rotundifolia - Mangifera indica
Farmland , less intensively cultivated than 3.1, same tree cover on Plateaus

3.3 Lantana camara - Zea mays
Farmland and Fallow land in chess-board form, in volcanic Uplands

3.4 Newtonia buchani - Albizia gummifera
Farmland and Woodland along rivers in Valleys

3.5 Musa sp. - Zea mays
Farmland in Valleys

4 **Combretum zeyheri - Combretum binderianum Ls**
Extensively cultivated Bushland and Woodland on Plateaus and volcanic Uplands, developed on Mt. Kenya volcanics

4.1 Combretum zeyheri - Heteropogon contortus
Homogeneous Bushland, extensively cultivated (< 30% Farmland) on Plateaus and volcanic Uplands

4.2 Combretum zeyheri - Zea mays
Farmland (1/2) and Bushland (1/2) in mosaic form in volcanic Uplands

4.3 Aloe secundiflora - Euphorbia nyikae
Thicket and Bushland on very shallow soils at the edge of the Plateau

4.4 Heteropogon contortus - Euphorbia nyikae
Complex of 4.1 (75 %) and 4.3 (25%)

4.5 Zornia apiculata - Ocimum basilicum
Grassland with shrubby herbs on Plains (lahar) and Plateaus

4.6 Combretum zeyheri - Terminalia brownii
Woodland on Plateaus (basalt) or Plains (lahar)

4.7 Euphorbia nyikae - Acacia brevispica
Farmland and Thicket in Valleys with shallow soils, partly developed of Basement System

4.8 Combretum binderianum - Combretum zeyheri
Bushland in Valleys

5 **Hyparrhenia sp. - Heteropogon contortus Ls**
Very extensively cultivated Wooded Grassland on Hills and Mountains, developed on (basic) Intrusives in Basement System

5.1 Gardenia jovis-tonantis - Heeria reticulata
Scrub forest with a tree cover > 75%, on Mountains or Hills

5.2 Heeria reticulata - Heteropogon contortus
Wooded Grassland with a treecover < 25%, on Mountains or Hills

5.3 Gardenia jovis-tonantis - Heeria reticulata
Bushland on Footslopes, transition to landscape 6

5.4 Hyparrhenia sp. - Heteropogon contortus
Wooded Grassland on Footslopes, transition to landscape 6

6 **Acacia senegal - Commiphora africana Ls**
Complex of extensively- and intensively cultivated Farmland, Thicket and Woodland in Uplands, developed of Basement System

6.1 Bauhinia tomentosa - Acacia brevispica
Thicket on the Footslopes of the Plateau and areas which are highly influenced by the colluvium and water from it

6.2 Commiphora holziana - Commiphora africana
Thicket on Hills and Mountains

6.3 Acacia tortilis - Commphora africana
Thicket , Bushland , Woodland and Scrub forest in Uplands

6.4 Pennisetum typhoides - Commiphora africana
Mosaic form of Farmland (50%) and Thicket (50%), typical bush-fallow system in Uplands

6.5 Pennisetum typhoides - Commiphora africana
Thicket (50-75%) and Farmland (25-50%), no mosaic form in Uplands

6.6 Pennisetum typhoides - Aristida adscensionis
Farmland and Bushland along streams

6.7 Pennisetum typhoides - Acacia tortilis
Farmland (75%) , Bushland and Woodland, large areas of both types with a high treecover, in Uplands

6.8 Terminalia brownii - Hyphaene thebaica
Farmland (75%) with a relative high treecover, in Uplands

6.9 Pennisetum typhoides - Gossypium sp.
Intensively cultivated Farmland in Uplands

6.10 Tephrosia sp. - Cassia longiracemosa
Intensively cultivated Farmland on River terraces

6.11 Acacia rovumae - Hyphaene thebaica
Farmland and Woodland on Tana river terrace

6.12 Acacia mellifera - Acacia senegal
Bushland on River terrace

7 USP 10 - Ochna ovata Ls
Scrub Forest on Mountains, Intrusives of granites and granitoides

7.1 Ochna ovata - Acacia brevispica
Scrub Forest on Kijege - Kiere Mountains

7.2 USP10 - Ochna ovata
Scrub Forest on Mumoni Mountains

7.3 Canthium phyllanthoideum - Boerhavia erecta
Almost bare area on Mountains

APPENDIX III : List of plant species :

Scientific names with their families, landscapes (LS) where they occur with a scale of abundance (1=rare, 2=occasional, 3=frequent, 4=abundant, 5=very abundant), vernacular names; Embu and Meru (Vern.) and sociological groups (Soc.).

Name	Family	LS	Vern.	Soc.
Abutilon fruticosum	Malvaceae	VI2		
,, hirtum	,,	VI2		
,, longicuspe	,,	VI2		
,, mauritianum	,,	VI3		
Acacia albida	Mimosaceae	VI2		
,, brevispica	,,	VI3	mugucii	25
,, depranolabium	,,	VI1		
,, elatior	,,	VI1		
,, mearnsii	,,	II2		
,, mellifera	,,	VI3		23
,, nilotica	,,	VI3		24
,, podalyriifolia	,,	II1		
,, rovumae	,,	VI1		
,, senegal	,,	VI4		21
,, seyal	,,	IV3	V3 mugunga	14
,, tortilis	,,	VI5		21
Acalypha fruticosa	Euphorbiaceae	VI3	VII3	
,, indica	,,	VI2		24
,, lanceolata	,,	II4		7
,, volkensii	,,	II2		
Acanthospermum australe	Compositeae			
,, hispidum	,,	II2	III3 VI4	19
Acanthus eminens	Acanthaceae	I4		
Achyranthus aspera	Amaranthaceae	II2	III3 VI	22
Achyrospermum radicans	Labiatae	I2		
Achyrothalamus marginatus	Compositae	V1		
Actiniopteris radiata	Pteridophytae	VII3	VI1	30
Adansonia digitata	Bombacaceae	VI3	VII2 baobab	
Adenia globosum	Passifloraceae	VI2		23
Aerva javanica	Amaranthaceae	VI3		
,, lanata	,,	VI3		
Afrocrania volkensii	Cornaceae	I2		
Agave sisalana	Agavaceae	III3		11
Ageratum conyzoides	Compositae	II5	kigubai	6
Albizia anthelmintica	Mimosaceae	VI3		23
,, gummifera	,,	I2	II2 mukorwe	8
Alchemilla kiwuense	Rosaceae	I2		
Alectra parasitica	Scrophulariaceae	VI1		
Allophylus africanus	Sapindaceae	IV3		13
,, ferrugineus	Sapindacea	I2		
Aloe secundiflora	Liliaceae	VI2		
,, sp.	,,	VI1		
Alternanthera pungens	Amaranthaceae	II2		
Amaranthus graecizans	Amaranthaceae	II4		7
Ananas comosus*	Bromeliaceae	II2	III1	
Aneilema aequinoctiale	Commelinaceae	II3		
Anthocleista grandiflora	Loganiaceae	I2		4

Aningeria adolfi-friederici	Sapotaceae	I2		muna	1
Apodytes dimidiata	Icacinaceae	I1			
Aristida adscensionis	Gramineae	VI4			19
Arundinaria alpina	Gramineae	I1	II1		
Asparagus sp.	Liliaceae				
Aspilia mossambicensis	Compositae	IV3	VI2		12
Asplenium mannii	Pteridophytes	I3			
,, sandersonii	,,	I3			
Astripomoea hyosciamoides	Convolvulacea	V1			
Asystasia schimperi	Acanthaceae	II3			
Balanites aegyptica	Simaroubaceae	VI3			
Barleria argentea	Acanthaceae	VI3			22
,, acanthoides	,,	VI4			19
,, eranthemoides	,,	VI4			19
,, grandicalyx	,,	V2			15
,, micrantha	,,	VI2			
,, sp. A	,,	IV1			
Bauhinia tomentosa	Caesalpiniaceae	VI3	VII2		25
Begonia keniensis	Begoniaceae	I2			
Berchemia discolor	Rhamnaceae	VI2			
Bidens pilosa	Compositae	II4	II2		6
Blepharis linariifolia	Acanthaceae	VI3		kithunguca	
,, maderaspatensis	,,	VI2			19
Boerhavia erecta	Nyctaginaceae	VI4			19
Borassus aethiopum	Palmae	VI1			
Boscia angustifolia	Capparidaceae	VI2			25
,, coriacea	,,	VI4		muthio	25
Boswellia neglecta	Burseraceae	VI2			23
Bougainvillea*		II1			
Breonadia microcephala	Rubiaceae				
Bridelia scleroneura	Euphobiaceae	IV4		muce	13
,, taitensis	,,	VI3	VII3		25
Caesalpinia decapetala	Caesalpiniaceae	I1	II1		
Cajanus cajan*	Papilionaceae	III5			11
Calotropis procera	Asclepiadaceae	VI2			
Callistemon citrinus	Myrtaceae	II1			
Camellia sinensis*	Theaceae	II2			5
Canthium gueinzii	Rubiaceae	I2			
,, phyllanthoideum	,,	VI4		mutonga	21
Capitanya otostegioides	Labiatae	VI2			20
Capparis sepiarea var.fischeri	Capparidaceae	VI3		mutambogo	22
,, tomentosa	,,	VI2	VII2		22
Caralluma dummeri	Asclepiadaceae	VI1			14
Cardiosperma sp.	Sapindaceae	VII2			
Carissa edulis	Apocynaceae	V1			
Carica papaya*	Caricaceae	II3	III2		10
Cassia absus	Caesalpiniacea	VI2			19
,, didymobotrya	,,	II2			
,, longiracemosa	,,	VI3			26
,, mimosoides	,,	IV2	V2		14
,, occidentalis	,,	VI3			19
,, singueana	,,	VI3		mugengetha	23
,, spectabile*	,,	VI1			
Cassipourea malosana	Rhizophoraceae	I2			
Catha edulis	Celastraceae	II1		miraa	

Celtis africana	Ulmaceae	I3			4
Cenchrus ciliaris	Gramineae	VI2			
Chascanum hildebrandtii	Verbenaceae	VI3			21
Chloris roxburghiana	Gramineae	VI2			
,, virgata	,,	VI2			
Chlorophytum gallabatense	Liliaceae	VI2			
Chrysanthellum americanum	Compositae				
Cissampelos pareira	Menispermaceae	VI4			22
Cissus aphyllantha	Vitaceae	VI2			
Cissus quadrangularis	,,	VI4	VII3		21
,, rotundifolia	,,	VI4	VII3		21
Citrus sp.*	Rutaceae	II3	III3		10
Cleome allamanii	Capparaceae	VI2			18
,, schimperi	,,				
Clerodendrum johnstonii	Verbenaceae	I3			
,, myricoides	,,	IV3	V3		14
Clitoria ternata	Papilionaceae	VI3			
Clutia abyssinica	Euphorbiaceae	I2			
Coffea arabica*	Rubiaceae	II5		kahawa	7
Colocasia antiquorum*		II2			
Combretum aculeatum	Combretaceae	VI4	VII3		21
,, binderianum	,,	IV4		muraba	13
,, molle	,,	IV4			13
,, padoides	,,	VI2	VII2		22
,, zeyheri	,,	IV4	VI1	muthithi	13+24
,, sp.	,,	VII3			29
Commelina benghalensis	Commelinaceae	II3			
,, diffusa	,,	VI3			
,, latifolia	,,	II4			9
,, sp.	,,	VII4			30
Commicarpus plumbaneus	Nyctaginaceae	VI1			
Commiphora africana	Burseraceae	VI4	VII3	mukau	20+29
,, holtziana	,,	VII2		muthegeyko	
,, madagascariensis	,,	IV2		muthukundu	
,, boiviana	,,	VII2		mura	30
Conostomium quadrangulare	Verbenaceae	VI2			21
Conyza floribunda	Compositae	II3			6
Cordia abyssinica	Boraginaceae	II4	III3	muringa	10
,, ovalis	,,	VII2			30
Crabbea velutina	Acanthaceae	VII3			30
Crassocephalum bojeri	Compositae	I2			
,, crepidioides	,,	II3			5
mannii	,,	I2			
,, montuosum	,,	I2			
,, vitellinum	,,	I2	II2		
Crossandra subacaulis	Acanthaceae	VI2			
Crotalaria axillaris	Papilionaceae	II2			
,, cephalotes	,,	IV2			13
,, emarginella	,,	VI2			20
,, goodiiformis	,,	VI2		muchuguchugu	
Croton macrostachyus	Euphorbiaceae	II4	III3	mutuntu	10
,, megalocarpus	,,	II4		mukinduri	8
Cucumis prophetarum	Cucurbitaceae	VI2			
Cyathea manniana	Cyatheaceae	I1			
Cynanchum defoliascens	Asclepiadaceae	VI1			

Cynodon dactylon	Gramineae	VI3			
Cyperus esculentus	Cyperaceae	II4			7
,, rotundus	,,	II3			
Cyphia glandulifera	Campanulaceae	IV2			
Cyphostemma maranguense	Vitaceae	VI3			21
,, nierense	,,	II2			9
Dactyloctenium aegyptium	Gramineae	VI3			19
Dalbergia lactea	Papilionaceae	VI2	VII2		23
Dalechampia scandens	Euphorbiaceae	VI2			
Datura sauveolens	Solanaceae				
,, stramonium	,,	II3			9
Deinbollia cf.borbonica	Sapindaceae	VI1			
Delonix elata	Caesalpiniaceae	VI3	VII2	murnga	23
Desmodium repandum	Papilionaceae	I2			
Dichrostachys cinerea	Mimosaceae	VI1			
Dicliptera sp.	Acanthaceae	VI2			23
Dicoma tomentosa	Compositae	VI3			19
Digera muricata	Amaranthaceae	VI2			
Digitaria scalarum	Gramineae	II4			7
Dioscorea sp.	Dioscoreaceae	I2			
,, sp.	,,	II1			
Diospyros consolata	Ebenaceae	VII1			
Dombeya rotundifolia	Sterculiaceae	III4		mutoo	11
Dracaena steudneri	Agavaceae	II2		muthare	
Drymaria cordata	Caryophyllaceae	I2	II3		9
Drynaria volkensii	Pteridophytes	I2			
Duosperma sp.A	Acanthaceae	VI1			
,, kilimandscharicum	,,	VI4			
Dyschoriste depressa	Acanthaceae	IV2			16
,, perrottetii	,,	VI1			
,, thunbergiflora	,,	VI2			23
Ecbolium hamatum	,,	VI2	VII3		25
Ehretia cymosa	Boraginaceae	II3		mulembu	8
Ekebergia capensis	Meliaceae	I1			
Elaeodendron buchananii	Celastraceae	IV2		mura	15
Elatostema orientale	Urticaceae	I2			
Eleusine indica	Gramineae	II3			
Endostemon camporum	Labiatae	IV2			
,, tereticaulis	,,	VI4			19
Ensete ventricosum	Musaceae	I1			
Enteropogon macrostachys	Gramineae	IV3	VI3		15+22
Eragrostiella bifania	,,	VI2			
Eragrostis cilianensis	,,	VI3			
Eragrostis macilenta	,,	VI3			
Eryobotrya japonica*		II2		mucuca	9
Erytrina abyssinica	Papilionaceae	II3	III4	mufuti	10
Erythrochlamys spectabilis	Labiatae	VI2			20
Erythroxylum emarginatum	Erythroxylaceae	I2			
Eucalyptus camaldulensis	Myrtaceae	II3			
Euclea divinorum	Ebenaceae	III1			
Euphorbia candelabrum	Euphorbiaceae	VI1			
,, cotinifolia	,,				
,, cuneata	,,	VI2			
,, geniculata	,,	II3	III3		10
,, heterochroma	,,	VI2			

,, hirta	,,	II3	III3	VI3	10
,, novae	,,	VI3			
,, pulcherrima*	,,	II1			
,, pseudograndtii	,,	VII1			
,, sp.A [UKAF]	,,	VI1			
,, tirucalli	,,	II3	III4		11
Fagaropsis angolensis	,,	I3		mukarakati	3
Faurea saligna	Proteaceae	III3			11
Ficus capensis	Moraceae	II2	III3	mukuu	10
,, natalensis	,,	I2	III2		
,, stuhlmannii	,,	II2		muthanda	
,, vallis-choudae	,,	VI1			
Fuerstia africana	Labiatae	II3			9
Galiniera coffeoides	Rubiaceae	I4		muhoha	2
Galinsoga parviflora	Compositae	II4			7
Gardenia jovis-tonantis	Rubiaceae	V4			15
Geniosporum hildebrandtii	Labiatae	VI2	VI2		
Gesceintia cujete	Cucurbitaceae	III2			11
Girardinia diversifolia	Urticaceae	I2			
Gloriosa simplex	Liliaceae	II2			
Gomphocarpus fruticosus	Asclepiadaceae	VI1			
Gossypium hirsutum*	Malvaceae	III3	VI3	(cotton)	27
Grevillea robusta*	Proteaceae	II4	III3	muvarite mukima	10
Grewia bicolor	Tiliaceae	VI3	VII2		25
,, similis	,,	II2			
,, villosa	,,	VI3	VII3	mubuu	21
Grumilea megistostipta	Rubiaceae	I3		mukomakoma	1
Gutenbergia cordifolia	Compositae	IV2			
Haemanthus multiflorus	Amaryllidaceae	I2	VI2		
Hapiocoelum foliolosum	Sapindaceae	VI2			23
Harrisonia abyssinica	Simaroubaceae	V4			15
Harungana madagascariensis	Hypericaceae	I3		munyamwa	3
Heeria reticulata	Anacardiaceae	V4		mwai	15
Helianthus annuus*	Compositae	III3			10
Heliotropium somalense	Boraginaceae	VI2			
Heliotropium steudneri	,,	VI2			
,, undulatifolium	,,	VI3			
Hermannia exappendiculata	Sterculiaceae	IV3	VI2		12
,, glanduligera	,,	VI2			28
Heteropogon contortus	Gramineae	IV5	VI4		14
Hibiscus calyphyllus	Malvaceae				
,, cannabinus	,,	III3			12
Hybanthus fasciculatus	Violaceae	VII2			30
,, micranthus	,,	VI2			
Hydrocotyle mannii	Umbelliferae	I2			
Hyparrhenia sp.	Gramineae	IV3	VI4		
Hypoestes hildebrandtii	Acanthaceae				
Hypolepis sparsisora	Pteridophytes	I3			
Hyphaene thebaica	Palmae	VI2			26
Ilex mitis	Aquifoliaceae	I1			
Indigofera arrecta	Papilionaceae	II3	III3	IV3	12
,, atriceps	,,	II2	II2		
,, binderi	,,	IV4	V4	mekione	14
,, lupatana	,,	VI2			
,, tinctoria	,,	VI1			28

,, viticoides	,,	VI1			
Impatiens rubromaculata	Balsiminaceae	I3			
Ipomea cetatas	Convolvulaceae	III3		ngwaci	11
,, hildebrandtii	,,	VI3			
,, obscura	,,				
,, senotherae	,,				
,, tessmannii	,,	VI2			27
,, sinensis	,,	VI2			
Isoglossa laxa	Acanthaceae	VI2	VII3		25
Isoberlinia mimosifolia*		II2	III3		10
Jasminum fluminense	Oleaceae	IV3			13
Jatropha spicata	Euphorbiaceae	VI2			
Juniperus procera	Cupressacea	II2			
Kalanchoe densiflora	Crassulaceae	IV2			
,, lanceolata	,,	VI2			
Kanahia laniflora	Asclepiadaceae	VI2			
Kedrostis gijef	Cucurbitaceae	VI2			
Kigelia aethiopum	Bignoniaceae	VI2		muratine	
Kohautia caespitosa	Rubiaceae	VI1			28
Kyllinga cylindrica	Cyperaceae	II3			5
,, erecta	,,	II3			5
Lactuca capensis	Compositae	III3	VI2		
Landolphia buchananii	Apocynaceae	I2			
Lannea edulis	Anacardiaceae	III2		muthumeke	11
,, trichylla	,,	VI3		kitharara	20
Lantana camara	Verbenaceae	II3	III4	IV3	12
,, rhodesiensis	,,	IV1			
Lasiosiphon kraussii	Thymelaeaceae	IV1	VI1		
Lawsonia inermis	Lythraceae	VI2			28
Leonotis nepetifolia	Labiatae	II3			
Leucas martinicensis	,,	VI2			
,, mollis	,,	IV3	V3		12
,, mwingensis	,,	VI2			
,, nepetifolia	,,	I1	II2		
,, urticifolia	,,	VI1			
,, glabrata	,,	VII2			
,, ingensis	,,	VI1			
Loranthus dregeanus	Loranthaceae	VI2			20
,, sengerensis	,,	VI1			
Loxogramme lanceolata	Pteridophytes	I3			
Lycopersicon esculentum*	Solanaceae	II2			
Maerua crassifolia	Capparidaceae	VI2			22
,, edulis	,,	VI2			22
,, kirkii	,,	VI2			19
,, triphylla	,,	VII2			
Mangifera indica*	Anacardiaceae	II3	III4		10
Manihot esculenta*	Euphorbiaceae	II3	III3		10
Markhamia hildebrandtii	Bignoniaceae	II3		mukwego	8
Maytenus putterlickioides	Celastraceae	VI2			
,, senegalensis	,,	IV3	V2		14
Melhania ovata	Sterculiaceae	VI2			
,, velutina	,,	VI4		murancagi	21
Melia volkensii	Meliaceae	VI2		mukau	
Merremia pinnata	Convolvulaceae	VI2			
Mikaniopsis clematoides	Compositae	I2			

Millettia dura	Papilionaceae				
Momordica foetida	Cucurbitaceae				
Monechma debile	Acanthaceae	VI3			
"mugambanyoni"		I2			1
"muganjuki"		I2			1
Musa sp*.	Musaceae	II3	III3		
"mutugati"		I2			4
Myosotis vestergrenii	Boraginaceae	IV2			16
Myrianthus holstii	Moraceae	I2		mutuya	4
Mystroxylon aethiopicum	Celastraceae				
Neoboutonia macrocalyx	Euphorbiaceae	I3		mutuntuki	3
Newtonia buchananii	Mimosaceae	I1	II3	mukui	4
Nicotiana tabacum*	Solanaceae	III3			11
Nuxia congesta	Loganiacea	I1		mwangati	
Nymphaea caerulea	Nympheaceae	II1			
Ochna holstii	Ochnaceae	I3		mungarima	1
,, ovata	,,	VI2	VII3	muruti	25
Ocimum basilicum	Labiatae	IV4	VI5		19
,, lamiifolium	,,	IV2			
,, suave	,,	II3	III3	mukandu	6
,, sp.	,,	I3			
Ocotea usambarensis	Lauraceae	I3		camphor	2
Odontella fischeri	Loranthaceae	VI2		(=Loranthus f.)	
Oldenlandia herbacea	Rubiaceae	II2			
Olea hochstetteri	Oleaceae	I3		musharagi	2
Opilia campestris	Opiliaceae	VI2			
Oplismenis hirtellus	Gramineae	I3			
Ornithogalum donaldsonii	Liliaceae	VI1			
Oxalis latifolia	Oxalidaceae	II3			5
Oxygonum sinuatum	Polygonaceae	II4		ntaugu	9
Ozoroa insignis	Anacardiaceae	II2		mura	11
Pachycarpus schweinfurthii	Asclepiadaceae	IV1			13
Paederia pospischilii	Rubiaceae	VI3			20
Pandanus embuensis	Palmae	VI1			
Passiflora edulis*	Passifloraceae	II1			
Pauridiantha holstii	Rubiaceae	I3			
Pavetta tutana	Rubiaceae				
Pavonia ellenbeckii	Malvaceae				
,, zeylanica	,,	VI2			20
Pellaea longipilosa	Pteridophytes	VII2			30
Pennisetum clandestinum	Gramineae	II4			5
,, purpureum	,,	II4			9
,, typhoides*	,,	VI4		(millet)	27
Pentanasia ouranogyne	Rubiaceae	VI2			24
Pentas lanceolata	,,	II3			6
,, parvifolia	,,	IV3			14
Peperomia abyssinica	Pteridophytes	I2			
Phaseolis vulgaris*	Papilionaceae	II4			10
Phoenix reclinata	Palmae	VI1			
Phyllanthus fischeri	Euphorbiaceae	II4			9
,, maderaspatensis	,,	VI3			19
Pilea johnstonii	Urticaceae	I2			
,, rivularis	,,	I2			
Piliostigma thonningii	Caesalpiniaceae	III3	IV3	V3 mukurah	15
Pinus elliotii*	Pinaceae	II2			

,, patula*	,,	II2			
,, radiata*	,,	II2			
Piper capense	Piperaceae	I5			
Platycerium angolense	Pteridophytes	I2			
Plectranthus luteus	Labiatae	I2			
,, sylvestris	,,	I3			
Pleopeltis macrocarpa	Pteridophytes	I3			
Pleurostylia africana	Celastraceae				
Plumbago zeylanii	Plumbaginaceae	VI2			23
Plumiera acutifolia	Euphorbiaceae	II1			
Podocarpus milanjianus	Podocarpaceae	I3		podo	1
Polygala erioptera	Polygalaceae	IV2			
,, kilimandscharika	,,	VI1			
,, liniiflora	,,				
,, persicariifolia	,,	VI2			19
,, sadebeckiana	,,	VI2			19
Polyscias kikuyuensis	Araliaceae	I2		mucherachero	4
Premna hildebrandtii	Verbenaceae	VII2			
,, oligotricha	,,	VI2	VII3		25
,, resinosa	,,	VI2			
Priva cordifolia	Verbenaceae	VI2			
Prunus africana	Rosaceae	I2		mueria	4
Pseudarthria hookeri	Papilionaceae	VI2			
Pteridium aquilinum	Pteridophytes	I2	II3		5
Pupalia lappacea	Amaranthaceae	VI4			19
Raphia ruffia	Palmae	I1			
Rauvolfia mannii	Apocynaceae	I3			
Rhinacanthus gracilis	Acanthaceae	VI3	VII3		25
Rhus natalensis	Anacardiaceae	IV1			
,, longipes	,,	IV1			
Rhynchelytrum repens	Gramineae	II3	III3	IV3 VI2	12
Rhynchosia densiflora	Papilionaceae	VI2			
,, malacophylla	,,	IV2			
,, nyasica	,,	IV3			14
,, sublobata	,,	VI2			
,, sp.	,,	VI2			
Richardia braziliensis	Rubiaceae	II3			5
Ricinus communis	Euphorbiaceae	II3	III2		9
Ruellia patula	Acanthaceae	VI3			22
Salvadora persica	Salvadoraceae	VI2			
Salvia coccinea	Labiatae	II3			
Sanicula elata	Umbelliferae	I2			
Sansevieria ehrenbergi	Liliaceae	VI2			
Schefflera volkensii	Araliaceae	I3			
Sclerocarya birrea	Anacardiaceae	VI2	VII2	mucomothi	25
Scutia myrtina	Rhamnaceae	I1			
Securinega buchanani	Euphorbiaceae	VI3			21
,, virosa	,,	VI3			21
Senecio discifolius	Compositae	II3	III4		10
Sesamothamnus rivae	Pedaliaceae	VI2			20
Sesbania quadrata	Papilionaceae	VI2			
,, sesban	,,	VI2			
Sida cuneifolia	Malvaceae	II3			5
,, ovata	,,	IV3	VI3		10
Sigesbeckia orientalis	Compositae	II3			9

Solanum incanum	Solanaceae	II2	III3	VI4	19
,, nigrum	,,	II3			9
,, tuberosum*	,,	II3			9
Sonchus oleraceus	Compositae	II3	III3	VI2	10
Sorghum vulgare*	Gramineae	III3	VI4		27
Spathodea campanulata*	Bignoniaceae	II3			8
Spermacoce princei	Rubiaceae	II3			5
,, senensis	,,	VI4			19
,, sphaerostigma	,,	VI3			19
Sphaeranthus sp.	Compositae	VI2			28
Sporobulus fimbritus	Gramineae	VI3			19
Sterculia rhynchocarpa	Sterculiaceae	VI2		muria	23
Streptocarpus montanus	Gesneriaceae	I2			
Strombosia scheffleri	Olacaceae	I4		museringu	3
Strychnos madagascariensis	Loganiaceae	V1			
Stylosanthes fruticosa	Papilionaceae	VI3			
Suregada procera	Euphobiaceae	I2		rieme	1
Syzygium guineense	Myrtaceae	I2			4
Tagetes minuta	Compositae	II4		muvangi	6
Talinum portulacifolium	Portulacaceae	VI2			20
Tamarindus indica	Caesalpiniaceae	VI2		muthithi	
Tabernaemontana holstii	Apocynaceae	I3		mwerere	2
Tabernaemontana johnstonii	Apocynaceae	II2		mwerere	
Tapinanthus oehleri	Loranthaceae	VII1			30
Tarenna graveolens	Rubiaceae				
Tephrosia elata	Papilionaceae	VI2			
,, hildebrandtii	,,	II2			5
,, polyphylla	,,	VI3			18
,, pumila	,,	VI3			18
,, uniflora	,,	VI3			18
,, villosa	,,	VI3			18
Terminalia brownii	Combretaceae	VI3	VII2	muhutu	16+24
,, orbicularis	,,	VI2			
,, prunioides	,,	VI4		muthunti	24
,, spinosa	,,	VI2			
Tetrapogon cenchriiformis	Gramineae	VI4			
Themeda triandra	Gramineae	IV1			17
Thunbergia alata	Acanthaceae	II3			
,, garckeana	,,	VI1			
Tinospora caffra	Menispermaceae	VI2			
Tithonia diversifolia	Compositae	II4		kirurite	9
Tragia brevipes	Urticaceae	VI3			
Tragus berteronianus	Gramineae	VI3			22
Tribulus terrestris	Zygophyllaceae	VI3			
Trichilia roka	Meliaceae	I1	II2	mururi	8
Trichodesma zeylanicum	Boraginaceae	II2	III3		10
Trichomanes melanotrichum	Pteridophytes	I2			
Tridax procumbens	Compositae	II4	III3	IV3	12
Trifolium semipilosum	Papilionaceae				
Triumphetta flavescens	Tiliaceae	VI4			19
,, macrophylla	,,	I1	II2		
,, rhomboidea	,,	II4	III2	murindangurue	6
USP 1	Gramineae	IV 3			
USP 2	,,	IV1			17
USP 3	?	IV1			17

USP 4	Gramineae	VI3		19
USP 5	,,	VI3		19
USP 6	Malvaceae	VI2		
USP 7	Labiatae	VI2		
USP 8	?	VI2		
USP 9	Gramineae	VI2		
USP 10	?	VII2		30
USP 11	Papilionaceae	VII2		30
Vangueria madagascariensis	Rubiaceae		mupilu	
Vernonia aemulans	Compositae	IV4		12
,, auriculifera	,,	II2		
,, brachycalyx	,,	IV1		
,, cinerascens	,,	V2		
,, lasiopus	,,	II3	muthatha	6
,, stenolepis	,,	VI1		
Vigna unguiculata*	Papilionaceae	III4	thoroko	4
,, aureus*	,,	VI3		
Vitex keniensis	Verbenaceae	I2		
,, payos	,,	IV3	mufrutri	13
,, strickeri	,,	IV1		
Waltheria indica	Sterculiaceae	IV4	VI3	12
Xymalos monospora	Monimiaceae	I4	murindi	3
Zanthoxylum chalybeum	Rutaceae	VI1	(=Fagara ch.)	
,, macrophyllum	,,	I2		4
Zea mays*	Gramineae	II4	III5 (maize)	10
Zornia apiculata	Papilionaceae	IV2	I3	19

TPIP Appendix IV AGRICULTURE UNIVERSITY (WAGENINGEN THE NETHERLANDS)

RELEVE DATA SHEET | DATE: | NR:

M. van Oostveen; P. Scholte

Photo: Run:
Area:
Mapsheet:
Coordinates:

ALTITUDE (m)

DESCRIPTION OF SITE & LANDUSE

RELEVE AREA: | SPOT AREA:

TERRAIN DATA

Geological:
Lithology:
Landform:

RELIEF TYPE:
o almost flat (0-2) o hilly (16-30)
o undulating (2-8) o steeply
o rolling (8-16) dissected (>30)

Slope | Exposition

Micro&Mesorelief

EROSION- SURFACE SEALING

VEGETATION DATA

Strata	20	40	60	80	100	real. ext.	Co fig
32-64							
16-32							
8-16							
4-8 m							
2-4 m							
1-2 m							
50cm-1							
25-50							
12-25							
3-12							
0-3							
0							

PROV.VEG.UNIT

LABORATORY DATA

SOIL DRAINAGE
o very poorly
o poorly
o imperfectly
o moderately well
o somewhat excessively
o excessively

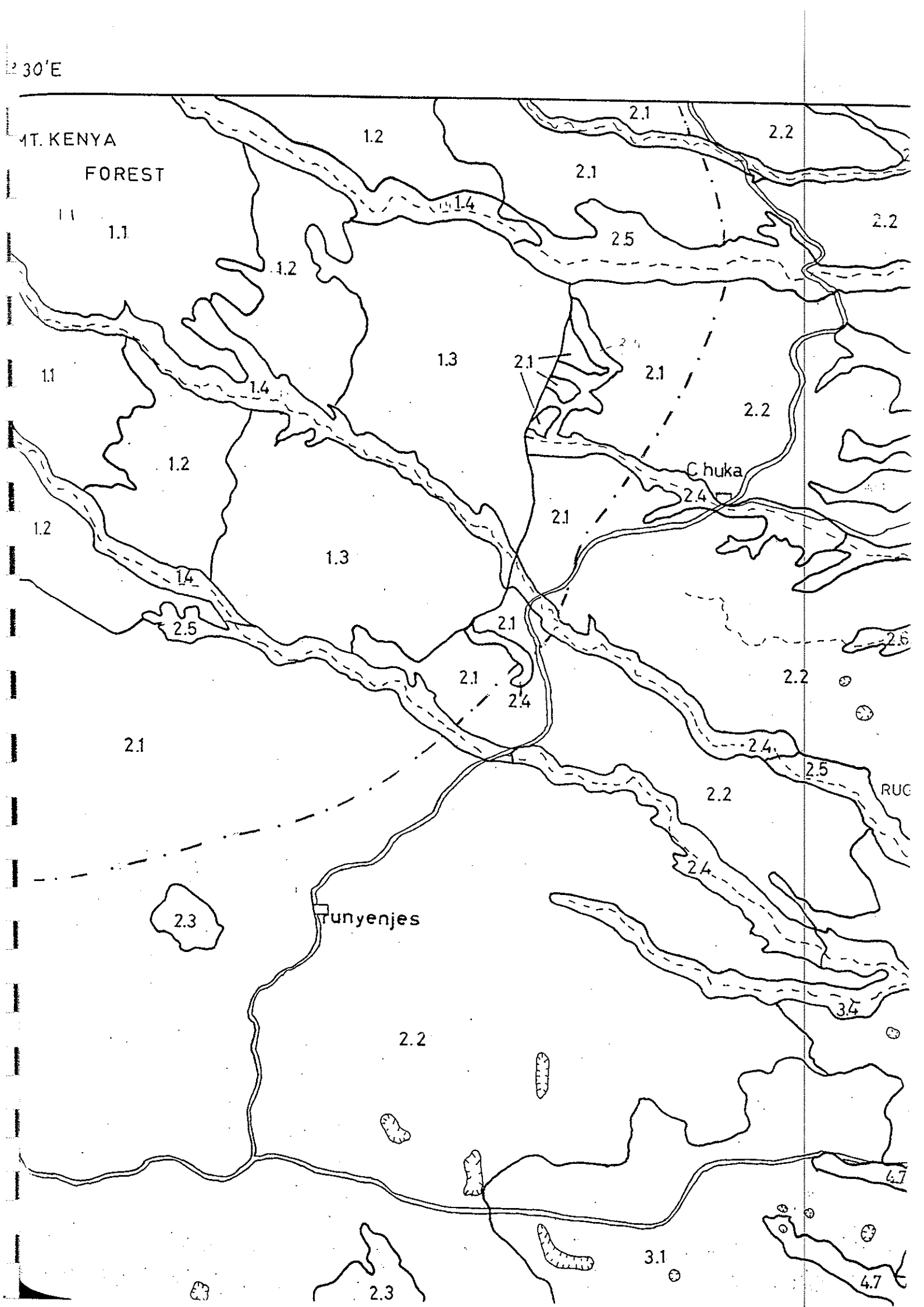
REMARKS

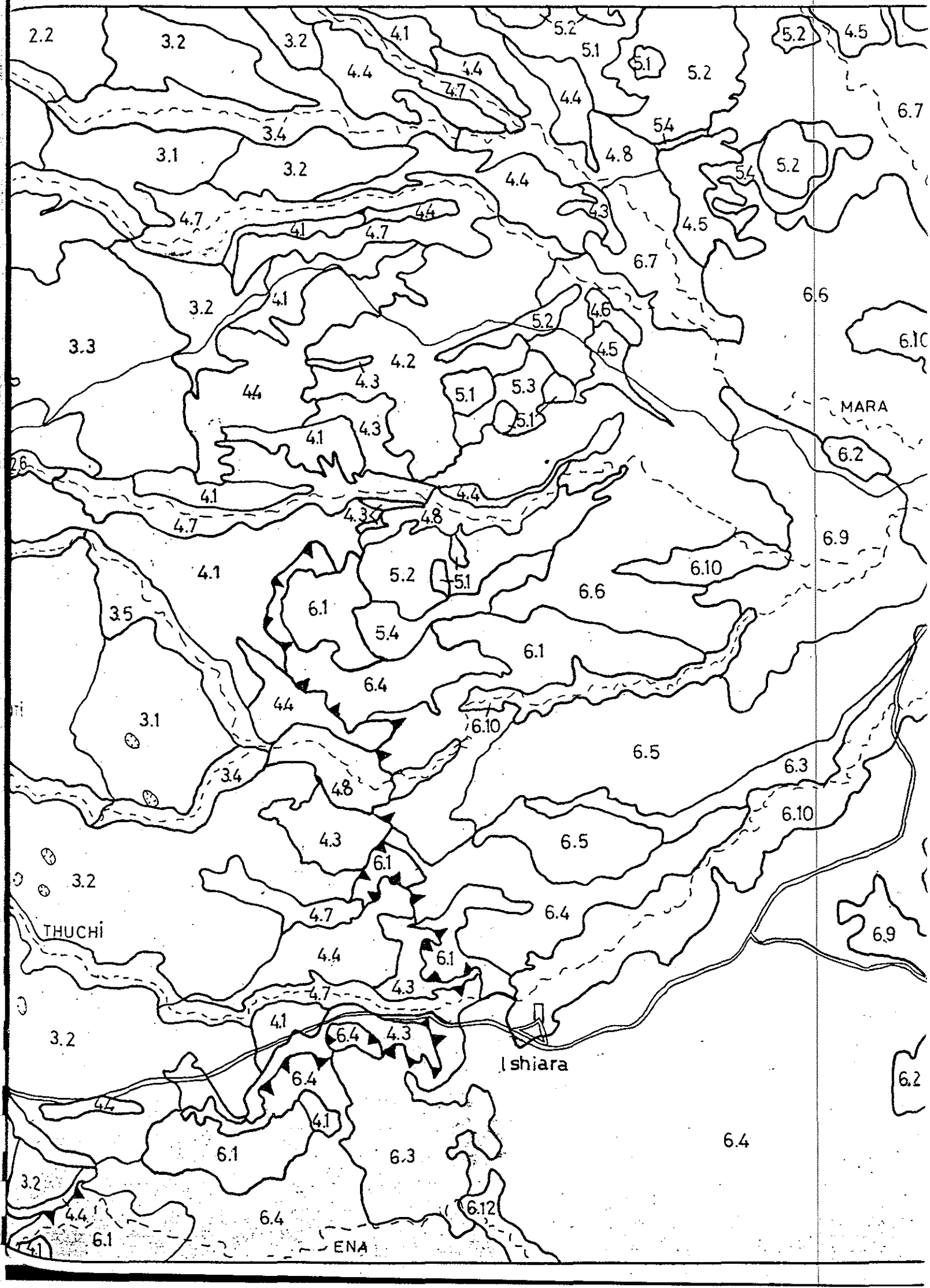
Soil type

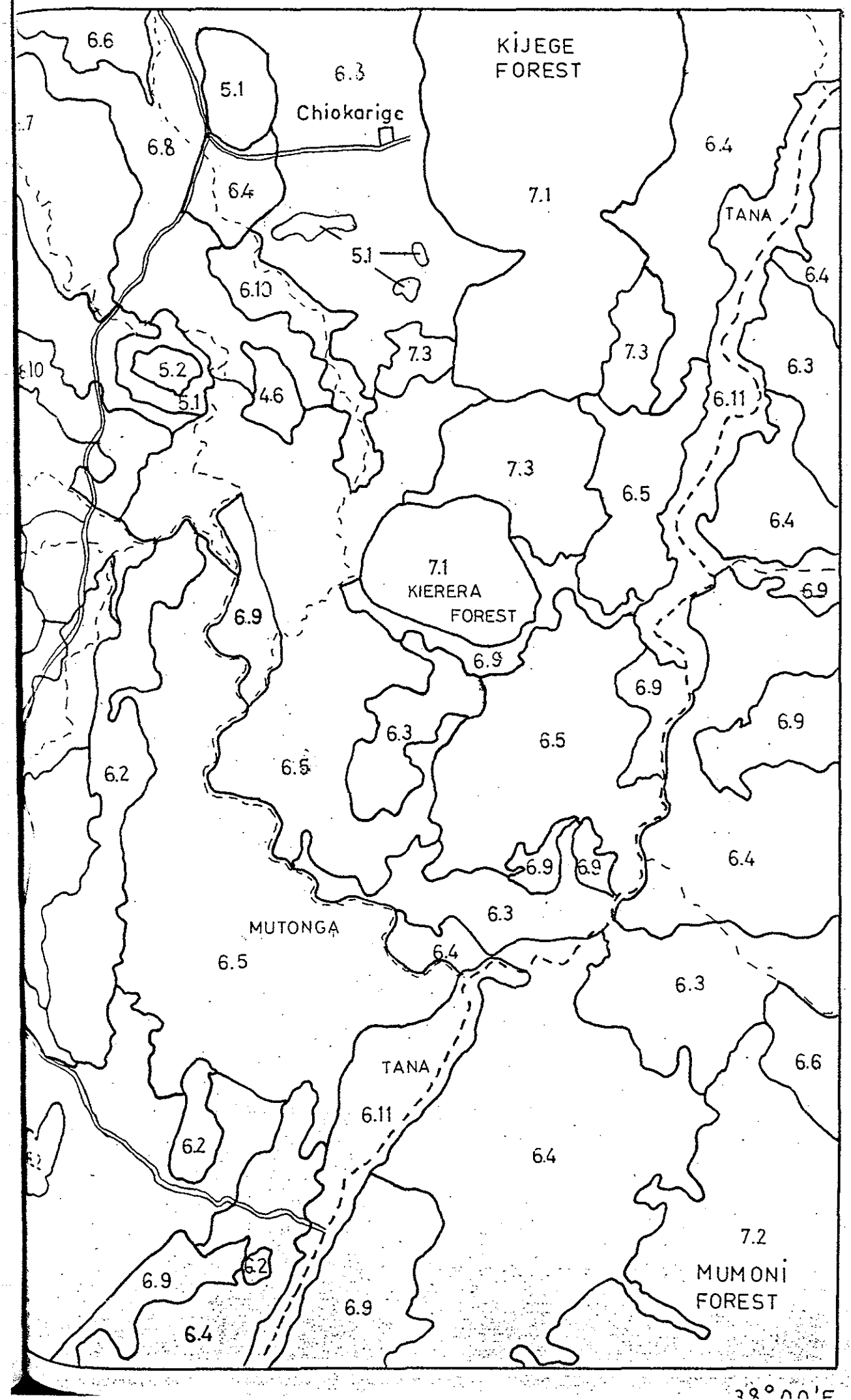
SOIL MAP UNIT

Hor.	Depth(cm)	Texture	Dry colour	Moist colour	Mottling	Consistence	HCl + /-	Ph

FINAL VEGETATION CLASSIFICATION | FINAL MAP UNIT


30'E
MT. KENYA
FOREST
1.1
1.2
1.3
1.4
2.1
2.2
2.3
2.4
2.5
2.6
3.1
3.4
4.7
Chuka
Runyenjes
RUC


MARA
THUCHI
Ishiara
ENA


0°15'S
KIJEGE FOREST
Chiokarige
TANA
KIERERA FOREST
MUTONGA
TANA
MUMONI FOREST
0°30'S
38°00'E