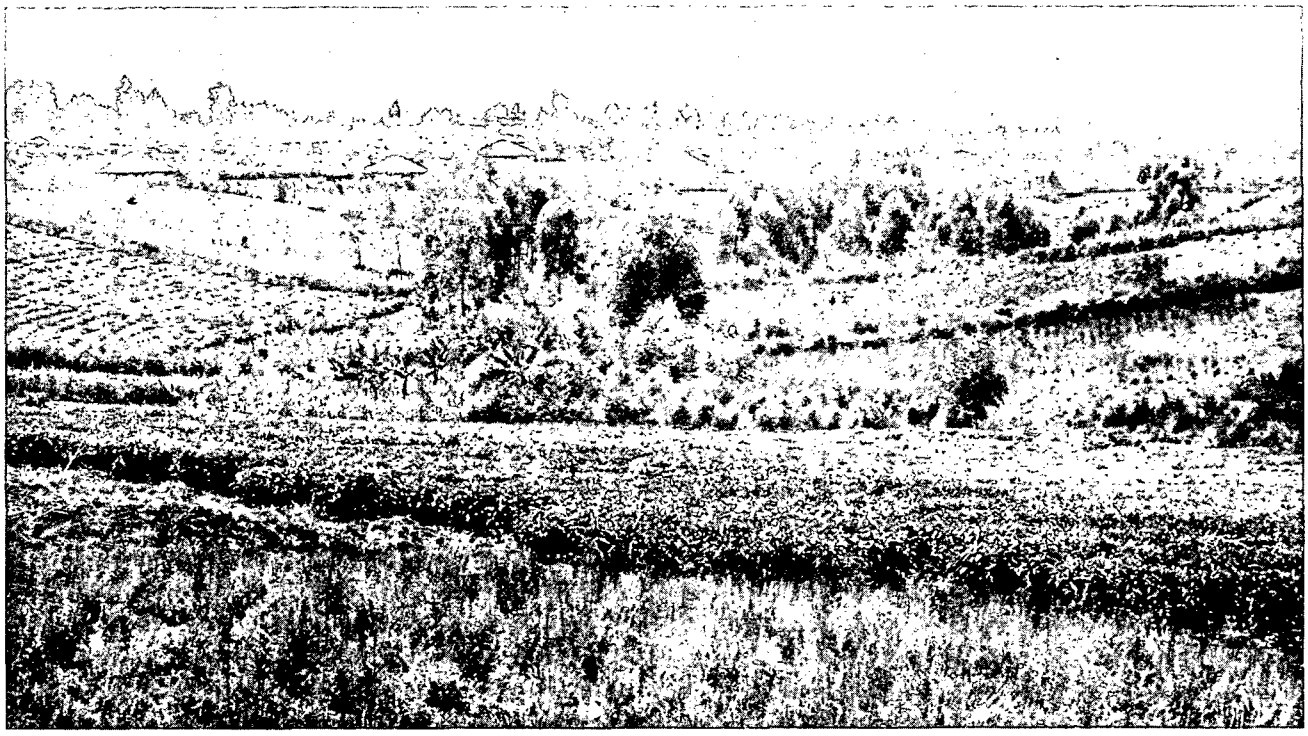
TRAINING PROJECT IN PEDOLOGY

KISII KENYA



Climate, physiography and land use of south western Kenya

PRELIMINARY REPORT NO 1

GRICULTURAL UNIVERSITY

AGENINGEN - THE NETHERLANDS

CLIMATE, PHYSIOGRAPHY AND LAND USE OF SOUTH-WESTERN KENYA

A reconnaissance study

by W.G. Wielemaker (ed.).

Preliminary Report nr. 1

December 1974

TRAINING PROJECT IN PEDOLOGY, KISII KENYA.

Agricultural University, Wageningen - The Netherlands.

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Appendices:

Preface

This report of the Training Project in Pedology at Kisii, Kenya, of the Section on Tropical Soil Science of the Agricultural University at Wageningen, Netherlands, is the first one of a series to be presented to Kenyan officials.

The project started in November 1973 after assent had been granted by the Office of the President of Kenya. It is meant for training of postgraduate students of the Agricultural University at Wageningen and for furnishing research opportunities to the staff. The activities of students and staff are directed to obtaining a better knowledge of the soils and the agricultural conditions of the project area to provide a basis for the futher agricultural development of the area.
The project in Kisii is conducted by:
Ir. W.G. Wielemaker, teaching and research
Ing. H.W. Boxem, management.
Visiting specialists from the Agricultural University at Wageningen help to resolve special problems.

This first report has been compiled and partly written by Mr. Wielemaker. The following reports in this series will mostly be students' reports.

We hope to pay back with these reports a small part of the great debt we owe to Kenya in general and to many Kenyans in particular for their valuable contributions to the good functioning of the project.

The supervisor of the project

J. Bennema, Professor of Tropical Soil Science

Introduction

In an early stage of the Training Project in Pedology, the need for information on the available soil resources in both Kisii and South Nyanza districts, was felt. On the one hand it was necessary to plan future survey and research activities of the Training Project, while on the other hand planning of agricultural activities in both districts demanded a quick presentation of these data.
The report with maps, presented here, meets the above mentioned requirements. One should however realize, that this report is a pre-stage for further work. It is advisable to discuss eventual conclusions based on it, with the editor of this report.

The area covered by the physiographic map is shown in figure 1A. Climate and landuse map do not cover the area located in Narok district. Last mentioned maps have been compiled by two participants of the Training Project, who are now completing their M.Sc. at the agricultural University of Wageningen, the Netherlands.
Detailed soil surveys scale 1 : 12,500 and reconnaissance surveys scale 1 : 100,000 either completed or in progress are indicated in figure 1B.
In the surveyed areas studies on soil fertility and crop management are in progress. Those studies are needed to supply the data for a soil suitability map.
Since most work so far was concentrated on areas in and around Kisii district, the map sheet covering that area will be completed first. (Map sheet 130 of Survey of Kenya on scale 1 : 100,000)

LOCATION OF THE AREA

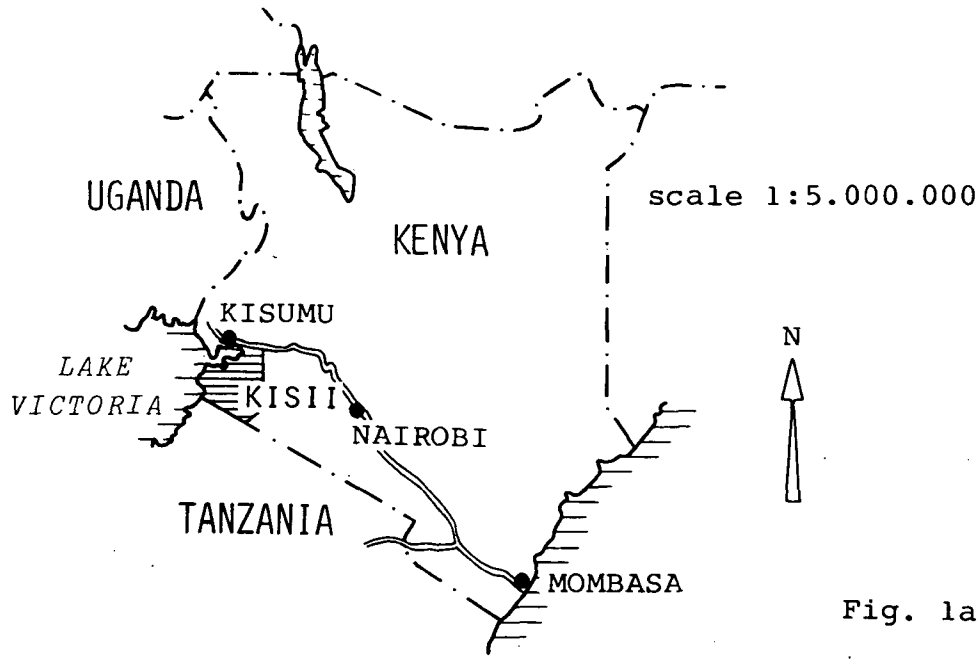

Fig. 1a

LOCATION OF SURVEYS (1974)

detailed soil survey

reconnaissance soil survey

map sheet 130

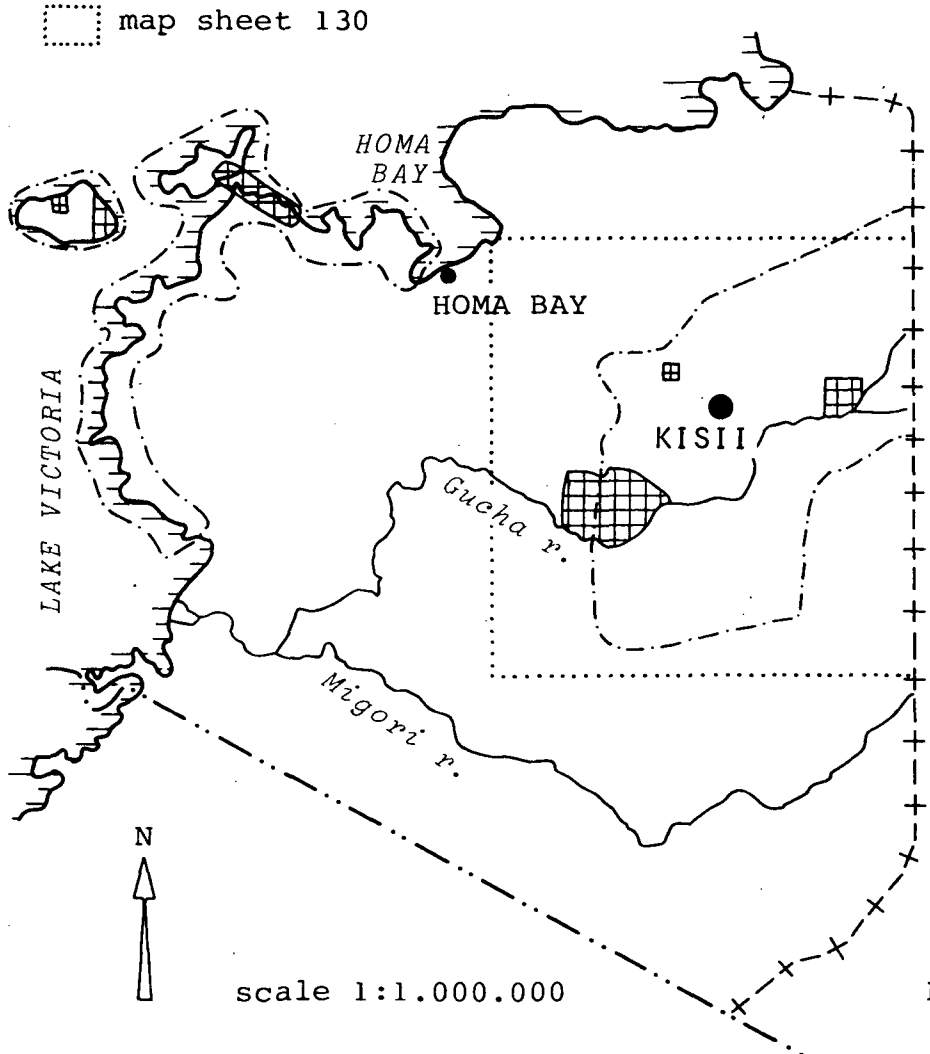

Fig. 1b

2. Climate.

by D. van Mourik.

2.1 Introduction.

Rainfall as well as temperature and amount of sunshine are strongly correlated with altitude. This means that as a general rule temperatures and average hours of sunshine per day decrease towards the Kisii-Highlands, while the amount of rainfall increases.

Monthly temperatures near the Lake shore (elevation 3769 feet) are as follows: average 21 - 25°C, maxima 33 - 27°C and minima 14,5 - 18°C.

In Kisii town the average monthly temperature fluctuates between 18 and 22°C and between 11 - 14°C respectively.

Strong winds are rare, except at the start of thunderstorms. Winds near the lake are normally S.W. and have a velocity in the dry season of 4 to 6 meter per second in the afternoon. During the night and morning winds blow towards the lake.

2.2. Rainfall probability. (see App.1)

The rainfall data are recorded at 18 stations the data covering a period of 25 years have been processed. From those data the lower limit of the P = 0.5 confidence level is calculated.

P = 0.5 means: the chance of obtaining less than a specific level of rainfall once in four years or in other words: the level of rainfall that should be exceeded three out of four years.

This low confidence level is chosen for economic reasons: the lack of capital makes the farmer vulnerable for cropfailure and hence a low risk has to be taken into account.

The result of the processed data are the isohyetes, drawn on map nr. 1 of the appendix.

From the histograms (figure 2) it is clear, that the rainfall is bimodal, especially towards the Kisii-Highlands. A short dry season occurs in June and July and a longer one in December, January and February.

The total yearly rainfall decreases from 1,800 mm in the western part of the Kisii-Highlands to 800 mm along the coast of Lake Victoria (Mbita point: average is 890 mm, lowest is 575 mm and highest rainfall is 1,325 mm). From the maximum amount in the western part of the Kisii-Highlands around Kisii township (Kisii: average is 1,912 mm, lowest is 1,275 mm and highest rainfall is 2,325 mm) towards the east, the rainfall decreases to 1,200 mm at the boundary with the Rift-Valley Province.

Availability of water periods

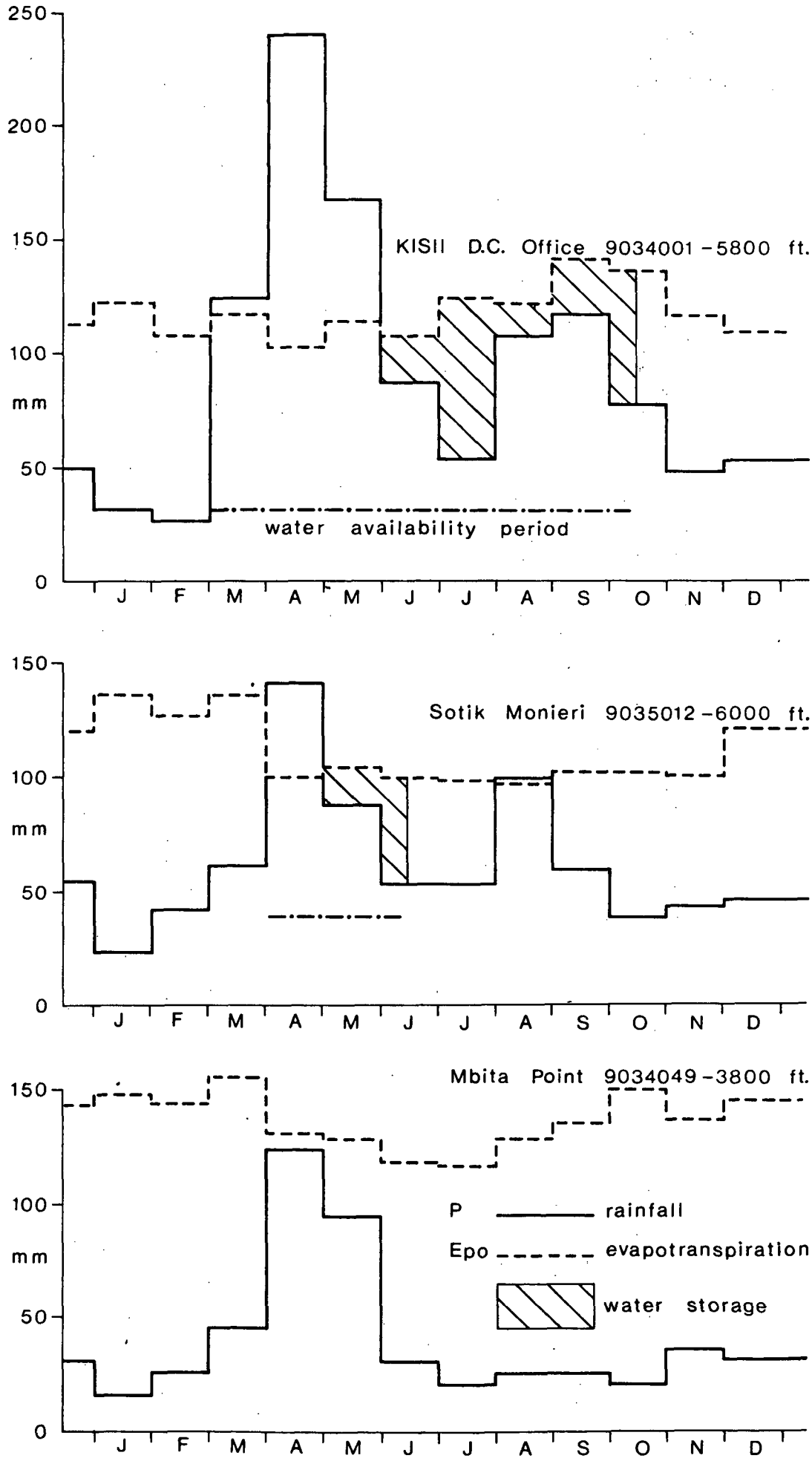

Fig. 2

2.3 Evaporation.

The following discussions are based on the optimal potential evapotranspiration (Epo). The Epo is the consumptive use of a crop at the end of the vegetative period with optimal water availability. The Epo is about equal to 0.82 Eo .

Eo = evaporation of an open water surface.

The factor 0.82 is an average cropfactor for crops growing in Kisii and South Nyanza districts, varying from 1.2 for irrigated rice to o.6 for finger millet (preliminary estimates by the author based on private communications and literature: Goldschmidt, 1970, Israelsen and Hansen, 1962).

Both numbers reflect growthstages of the plants at the end on the vegetative period, when consumptive use is highest.

The Epo does not take into account, as does the Ep (potential evaporation), the smaller consumptive use of crops in the early growing phase and during ripening. The Ep is therefore a more realistic measure for the exact crop water requirement, than the Epo.

If a significant (i.e. at the P = 0.10 level) inverse correlation between evaporation and rainfall exists due to elevation and/or rainfall, the upper limit of the P = 0.50 confidence level of non-moving monthly evaporation totals is used.

The calculation of the probability figures of evaporation totals is justified with the normal distribution, due to the more conservative character of the evaporation figures (Brown and Cochemé, 1973) and the non-skewness

The small variation in evaporation, compared with the variation in rainfall, geographically, does not require the calculation of the Epo for more than three stations in the area.

2.4 Water balance and drought intensity.

The rainfall and evaporation are evaluated with a waterbalance, made according to the method of Thornthwaite. This is done by means of histograms (figure 2).

The existance of zero, one or two cropping seasons at a specific level of risk of cropfailure (i.e. risk of waterdeficit at special levels of rainfall and evaporation) can be assessed.

The length of the period, during which water is available for the plant is indicated in the histograms. In order to calculate the availability period, it is assumed that the soil can store 180 mm of water.

The availability period can be calculated by addding the water surplus

(amount of mm of water above the Epo-line), which can be put in storage in the soil, to the consecutive monthly water deficits (i.e. amount of mm of water below the Epo-line in the histograms) till the stored water is used. From the length of the water availability period can be calculated, how many crops can be grown and the length of the growing season for each crop. From the histograms also an index for the intensity of the drought in the three consecutive driest months can be calculated. The drought intensity-index is arrived at by a sommation of the quotients of P and Eo of the three consecutive driest months, divided by three.
Lines indicating the same drought-intensity are drawn on the climatic map, appendix 2.
The drought-intensity index (as well as the rainfall probability) gives probably a good correlation with risk of erosion and fire hazard.
This parts from the assumption (chapter 3), that the larger the waterdeficit the more serious the vegetation will suffer and the easier erosion may occur at the onset of the rains.

2.5 Literature.

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3. A reconnaissance of the physiography of South-Western Kenya.

by W.G. Wielemaker.

3.1 Introduction.

The physiographic map (appendix 2) covers the districts Kisii and South Nyanza, and also part of Central Nyanza district up to the Kano-planes and a part of Rift Valley Province up to the escarpment, bordering Masai Mara Game Reserve.

The total mapped area has a surface of about 960 000 hectares.

The landscape units have been defined by photo-interpretation of aerial photographs with a scale of 1:50,000. About ten days of field checking helped to define the soils and the main physiographic features.

Information on the photographs was transferred to 1:50,000 topographical maps, which were reduced to a scale of 1:150,000. The definitions of permeability and drainage are according to the Soil Survey Manual (1951).

The classification of the soils, according to FAO's latest revision of the Soil Map of the World, is tentative and not yet supported by any laboratory analysis.

3.2 Set up of legend. (see map legend)

The broad physiographic units, indicated by the first capital letter, reflect climatic zones. Landscape F is however an exception, since conditions of impeded drainage or just youth of the alluvial deposits overrule the climatic factor. In that case climatic zones may be expressed by the first minuscule following the capital letter. Differences in topographic features are however the principle criteria for subdivision on that level.

The third letter, being a capital letter, stands for the rocktype or the alluvial material. Not all rocktypes are differentiating for soil properties, but where possible the exact rocktype has been indicated.

Where the geology was too diversified, rocktypes intermediate in acidity between the acid and basic ones, have been grouped as mixed (M).

M may include: andesite(A), conglomerate(K), diorite(D), rhyolite(R) and shale(S).

Acid rocktypes: Granite(G) and Quartzite(Q) and basic rocktypes: Basalt(B) and mela-nephelinites including phonolites(V) are seperately mentioned. Basalt may however form inclusions in the intermediate rocktypes.

In some cases a second minuscule was necessary to account for some special features within the landscape.

3.3. The legend.

S: landscape with stable (foot)slopes up to 20%, covered with deep red soils.

Climate: this landscape coïncides with a yearly rainfall of over 1,400 mm, (lower limit of P = 0.5, see chapter 2), where the dry season is pronounced ($\sum_{i=1}^{3} (P_i/E_2)$ /3> 2) and with more than 1,200 mm, where the dry season is less pronounced (> .3).

Altitude: 4,500 ft to 7,000 ft.

Geomorphology and soils.

The deep red soils occurring in this climatic zone are characterized by a high infiltration rate and a strong structure stability especially, where a dark organic rich top layer is present. These characteristics allow surface run-off only to occur at very high rainfall intensities.
This implies that the major part of the rain filtrates into the soil.
This high amount of leaching rainfall causes a fast weathering of the underlying rocks.
Under those favourable conditions the only movement wich takes place is through the downward momentum of the raindrops on soil particles.
This effect is of course positively correlated with the slope of the soils.
Stucture stability is strongest in soils developed on basalt and least in soils developed on quartzite. Also the amount of organic matter is generally lower in the soils on quartzite.
So under favourable conditions a stable (straight) slope of 8-20% can exist for a prolonged period of time. Favourable here means: a good continuous vegetative cover of the soils, decreasing the direct impact of the raindrops and conserving the organic matter content.
Cultivation, especially of anual crops, hastens however the downward movement of soil particles:

1) by exposing the soil to the direct impact of the rain which causes a stucture decay, splash of soil particles and some surface run-off, as a result of the slight surface sealing.
2) Oxidation of organic matter as a consequence of high soil temperatures caused by direct solar radiation. This is especially so in the lower altitude region, where temperatures are higher and the rainfall less.

Counter measures in the form of terraces, already established in the major part of the area, check this effect. The new slope established on terraces is gentler than the overall slope, indicating that without terraces, a stable condition could only be reëstablished at a lower overall slope percentage.

First subdivision.

Sf The whole landscape is covered with deep red soils. This occurs, where the straight lateral slopes of 8-20%, become gentler and convex towards and on the tops.

Sm At least 70% of the landscape is occupied by deep red soils on straight slopes ranging between 8 and 20%. These slopes are found underneath tops, covered with moderately deep and shallow rocky and stony soils on slopes of over 20%.

Ss As Sm but the steeper rocky and stony parts occupy up to 50% of the surface.

Sw This landscape is like Sf apart from the valleys, which are flat bottomed. The drainage is therefore impeded and flooding is frequent.

Second subdivision.

This is based on differences in lithology. At the first view soil characteristics seem not te be greatly influenced by the type of parent rock. Besides the characteristics of structure stability and organic matter content, already mentioned, probably the fertility of the soil will differ according to lithology.

The general morphology of the landscape is however clearly influenced by the parent rock: the quartzite ridges resist erosion strongly and rise high above the rest of the land; they even protect the upperstream lying areas against erosion.

This phenomenon is seen in the area east of Sameta, where the Gucha River has not yet cut through the resistant quartzite rocks. The slow downcutting of the Gucha River east of Sameta may account for the broad flat bottomed valleys occurring there. In the same unit outcropping layers of conglomerate occur, which cause steps in the flatbottomed valleys.

At these places valleys are V-shaped and cataracts are frequent there.

On the flat topped ridges, within the granite landscape (SfGp) occur slightly depressed flat waterlogged areas. The soils consist of dark grey compact impermeable clay. The depressions are bordered by a strip of ironstone with shallow to moderately deep red soils on it.

The deep red soils have a reasonable water storage capacity of about 15% (Boxem, 1974, unpublished data), especially when a dark humus rich top soil is present.

R: Ridges with lateral slopes between 6 and 20%, covered with shallow to moderately deep reddish soils.

Climate. This landscape coïncides with a yearly rainfall of 1,000-1,400 mm (lower limit of P = 0.5), where the dry season is pronounced, ($\sum_{i=1}^{3}$ (P1/Ei)/3<.2) and with more than 800 mm where the dry season is less pronounced. ($\sum_{i=1}^{3}$ (Pi/Ei)/3>,2).

Altitude: It ranges from 6,000 ft near the escarpment with Masai Mara to 4,000 ft at its Western and North-Western occurrence.

Gemorphology: this landscape consists of longitudinal ridges, which often appear to be remnants of a former plain. From the top of the ridges, the slope increases at the lateral sides, which have a slope percentage varying between 6 and 20%. The bottom slopes are normally concave and V-shaped valleys are rare.

Soils. Although slope form and percentage resemble the landscape described under Sf, soils do not. They are shallow to moderately deep and their texture especially of the ones developed on granite, has a relatively high content of quartz grains. a result of selective erosion.

The erosion hazard in this landscape is considerable. Using the land for agricultural purpose one must be aware of this and apply an agricultural system that counteracts the harmfull affects of erosion.

First subdivision.

Rf The tops of the ridges have convex slopes. Soils here are shallow to very shallow, stony and rocky, while on the lateral slopes of the ridges the shallow to moderately deep reddish soils occur. Ironstone is quite common on lateral slopes.

RpV As Rf, but for the tops, which have extensive nearly flat areas with moderately deep to deep red clayey permeable soils. The gentle slopes on these flat areas reduce the erosion risk.

Second subdivision.

Lithology: Ridges of granite (RfG) bear coarse to medium textured soils. The other rocktypes (RfK, RfM. RfR) bear medium to fine textured soils. Water storage is limited due to the shallowness of the soils and also due to the coarse texture of the soils from granite.

Third subdivision

RfGp Ridges of this type have extensive flat tops due to the occurrence of ironstone. The very shallow soils on it suffer of either waterlogging or droughtiness.

H. Hills with stable footslopes up to 8%.

Climate. This landscape coincides with a yearly rainfall of 600-1,400 mm (lower limit of P = 0.5, see chapter 2).

Altitude. It ranges from 5,000 ft near the Kisii-highlands to 3,300 ft at the level of Lake Victoria.

Geomorphology. The hills in this landscape consist of rather steep rocky and stony parts. (slopes between 20 and 60%) with gently sloping (up to 8%) soilscovered parts at their feet. Due to backwearing of the steep rocky parts, only gently sloping parts may remain. Of the original rocky parts some isolated boulders remain.

Soils. Lithology exerts strong influence on soil and slope characteristics.

First subdivision.

Hf Low hills with no slopes over 8%. Isolated boulders do occur. Rock is normally found within one meter.

Hm Hills with footslopes and steeper rocky parts. The steeper rocky parts occupy up to 50% of the landscape.

Hs Hills with footslopes and steeper rocky parts. The steeper rocky parts occupy up to 80% of the landscape.

Hl The landscape is characterized by rather deeply incised parallel running rivers.

Second subdivision.

Lithology.

1) Volcanic rocks, mainly mela-nephelinites: (HfV, HmV, HsV).

The shallow, dark brown clayey well structured soils developed on this rock are rich in organic matter. The clays swell and shrink notably on wetting and one can presume therefore, that clay minerals are of the montmorillonitic type. As a result of the swelling and shrinking a fine structured surface developes.

The B-horizon in the well-drained sloping moderately deep soils may be reddish colored. The rest of the deeper soils on gentle slopes are very fine textured and develop large cracks on drying, which close on wetting. All soils, but especially the deeper finer textured ones, have a high water storage capacity. Churning and self mulching assure a continuous supply of fresh nutrients to the surface horizon. Water content of these heavy claysoils is very critical for soil preparation.

Erosion in these soils is not important as long as they are not fully saturated with water. When saturated, all cracks have disappeared and on the

heavier soils permeability will be extremely slow. When that point has been reached a vegetative cover is important in order to prevent erosion.

2) Basalt: (HfB, HmB)

The footslopes in the Hf and Hm carry moderately deep permeable clayey soils. These soils somewhat resemble the ones described under landscape S. A dark humus rich top layer is however rare, while surface sealing and structure decay in the surface layer are considerable.

This results in turn in a lower infiltration rate and more surface run-off than in landscape S. A rather stable situation is thus only possible at a slope percentage of up to 8.

Cultivation exerts an adverse effect on sealing, surface run-off and infiltration rate, also erosion may increase as a result of it. Therefore a land utilization type must be adopted that either promotes structure stability, organic matter content and infiltration rate, or that adopts mechanical measures to combat erosion.

Physical characteristics of the soils are good, but chemically soils are rather leached.

In the depressions occurring within the landscape Hf, deep fine clayey cracking soils occur; They resemble the very fine textured soils discussed under HfV.

3) Andesite, conglomerate, diorite, rhyolite:
(HfA, HfR, HfM, HmA, HlM, HmD, HmR, HsA, HsR, HsM).

On the upper part of the footslopes and also on the upper parts within landscape Hf, reddish brown medium and sometimes fine textured shallow soils occur. Rotten rock always appears within a depth of 50 cm. Ironstone appears often at the surface, as the soil on it has been eroded.

The ironstone occurring at a shallow depth impedes drainage and contributes therefore to surface run-off and erosion. The lower parts of the footslopes suffer from water logging. Soils are dark grayish heavy textured with a medium textured surface horizon. The surface horizon is very suspectible to sealing, while the B-horizon consists of a heavy occasionally cracking clay type. Even when soils are dry, permeability will be low.

Plinthite may occur in transition to the underlaying rocks. The erosion hazard in this landscape is more severe on these soils than in soils developed on the rocktypes mentioned before, at comparable slope percentages.

4) Granite (HfG, HmG, HsG).

On the upper part of the footslopes, shallow reddish, coarse to medium tex-

tured soils occur on decomposing granite or on ironstone. Sometimes only ironstone occurs.

The soils in the upper parts of landscape Hf are often shallow grayish brown, sandy over rotten rock or ironstone. Areas with no soil on the ironstone or rotten rock are common. On the lower parts of the slopes grayish heavy textured compact clayey soils always occur. If present their surface horizon is sandy. Permeability is almost zero and most water disappears as surface run-off.

The erosion hazard is high even on very gentle slopes. Erosion once started breaks the soil down till only some ironstone and sand remains. The sandy parts are cultivated during the rainy season. In the compact clay soils only poor pasture occurs.

P. Alluvial fans and pediments.

Climate: The yearly rainfall (lower limit of P = 0.5) ranges from 600 - 1,200 mm.

Altitude. It ranges from 3,300 to about 4,500 ft.

Geomorphology. Alluvial fans are clearly visible, where the alluvial material is derived from granite. Those fans are coalescing and form a piedmont alluvial plane. Gullies in the upper part of this piedmont alluvial plane dissect and are already eroding the older fan surface.

The lower fan surface is undissected and still silted up.

The fans and pediments around the hills and mountains of volcanic rocks are not easily recognized as such. Dissection and erosion are severe in former tertary lake sediments. (Pd).

The unit Pn, which is normally not dissected, includes a few valleys, which are dissected in the upper part.

On Mfangano Island Pn consists merely of young alluvial deposits.

Soils.

PnG In the dissected but non eroded upper part of the fans with slopes of up to 10%, brown colored medium textured soils occur. In the middle part with slopes up to 6% the same soils occur, but also coarse textured ones as a consequence of recent alluvial deposition. In the lowest gently sloping part of the fan with slopes up to3% the same brown medium textured as well as the coarse textured soils occur. Besides this, gray compact clayey soils with a medium textured surface horizon, being very susceptible to sealing, occur. Ironstone is common as well.

The lower part of the fans may occasionally suffer from flooding and

deposition of sand on the former land surface.

PdV The rather soft tertiary sediments are strongly dissected and eroded. Many parts of it have no soil cover. The remaining shallow dark brown clayey soils have the same characteristics as the shallow soils developed on volcanic rocks (HmV, HsV). Protective forestry would be necessary to avert further erosion.

PnV In the somewhat steeper (up to 10% slope), upper parts of the pediments and fans, soils are sometimes reddish clayey. The surface layer is always a dark brown clay with fine structure as described for the soils developed on volcanic rocks (H).

In a few valleys (e.g. Roo Valley) not self mulching red clays occur on the intergully-divides in their dissected middle and upper parts.

The major part of this mapping unit consists of moderately deep very fine textured dark brown clay soils, forming a fine structured surface layer and deep wide cracks on drying. Permeability is good as long as the soils are not fully saturated. After that soils become very slowly permeable, but even then drainage will be good, provided there is sufficient slope.
The soils in this unit on Mfangano Island are only brown clayey.
Structure developement is weak, probably due to the relatively young age of the soils there. All soils have a high (between 15 and 30%) water storage capacity. (Makin and Nyandat, 1965).
Erosion hazard is considerable, when soils are water saturated, and a good vegetative cover is lacking (See HfV, HmV, HsV).

F Flat to slightly undulating with maximum slopes of 5%.

Climate. One can hardly talk of climatic zones. Zones exist occasionally at the level of the first subdivision.

Altitude. 5,500 ft to 3,300 ft.

Soils. The soil characteristics are strongly determined by parent material.

First and second subdivision.

Fh A slightly undulating plain with maximum slopes of 5%.

1) Volcanic. (FhV).

On the sloping parts there occur moderately deep dark brown clay soils, which develop a fine structure on drying. In the rather flat depressions occur dark brown to black moderately deep heavy clays, which develop, apart from the fine surface structure also deep wide cracks. When wet, drainage is somewhat impeded and flooding may occasionally occur. Soils have a high water storage capacity.

2) Basalt: (FhB).

On the gently sloping upper parts occur well drained moderately deep, red clay soils as described for HfB. On the transition to the rather flat depression ironstone occurs. The soils in the depressions are often water logged and consist of dark gray compact heavy clays.

3) Andesite, conglomerate, diorite, rhyolite: (FhA, FhM, FhR).

On the flat topped upper parts, shallow gray medium textured soils over ironstone occur. Water logging is common on these soils.

On the gently sloping parts, shallow, reddish, medium textured soils over rotten rock and occasionally ironstone, occur. The flat depressions have deep dark gray compact clay soils with a medium textured surface horizon, which is very susceptible to sealing. The soils are thus very slowly permeable and suffer often from water logging.

Fp Flat without a perceivable slope.

Parent material again very much determines the soil characteristics.

1) Volcanic: (FpV).

Soils are similar to the ones occurring in the depressions of FhV.

2) Mixed: (FpM).

Soils have a gray and somewhat bleached surface layer over dark gray compact heavy clay. The surface layer is very susceptible to sealing. Flooding and waterlogging are common features in this lanscape.

3) Sand along the lake-shore: (FpL).

These soils often have a dark humus rich topsoil over a white sandy subsoil. Occasionally, where the watertable is continuously high, salty spots occur (at Sindu). In that case no dark topsoil is present.

Fw The landscape is flat or has a very gentle straight slope. Parent material, which is in most cases alluvial, is not very important for soil characteristics. Soils have a dark humus rich topsoil over a rather compact gray heavy clay. In the area, where the Masai live, soils bear an exuberant grass vegetation.

Water logging during the rainy season is common.

Fd The flat parts of this landscape are similar to Fw.

The deep V-shaped river valleys have shallow coarse textured soils on granite rock. On the transition to the flat areas ironstone occurs.

L Lacustrine plane. Slightly above the lavel of Lake Victoria.

Two unitsare recognized.

LpV Flat depressions filled with heavy clay, derived from the volcanic area.

Soils are grayish to black and often waterlogged. When dry large cracks develop as well as a fine structured surface layer. According to Makin and Nyandat (1965), alkaline soils are common here.

LwM These are sandy and clayey alluvial deposits along the shore of Lake Victoria. They are covered with reeds and dry seldomly.

MV Mountains are only recognized in the volcanic area, where a strong relief exists. The highest mountaintop is 7,450 ft high.
Many parts are rocky without much soil. Existing soils are normally clayey and rich in organic matter.

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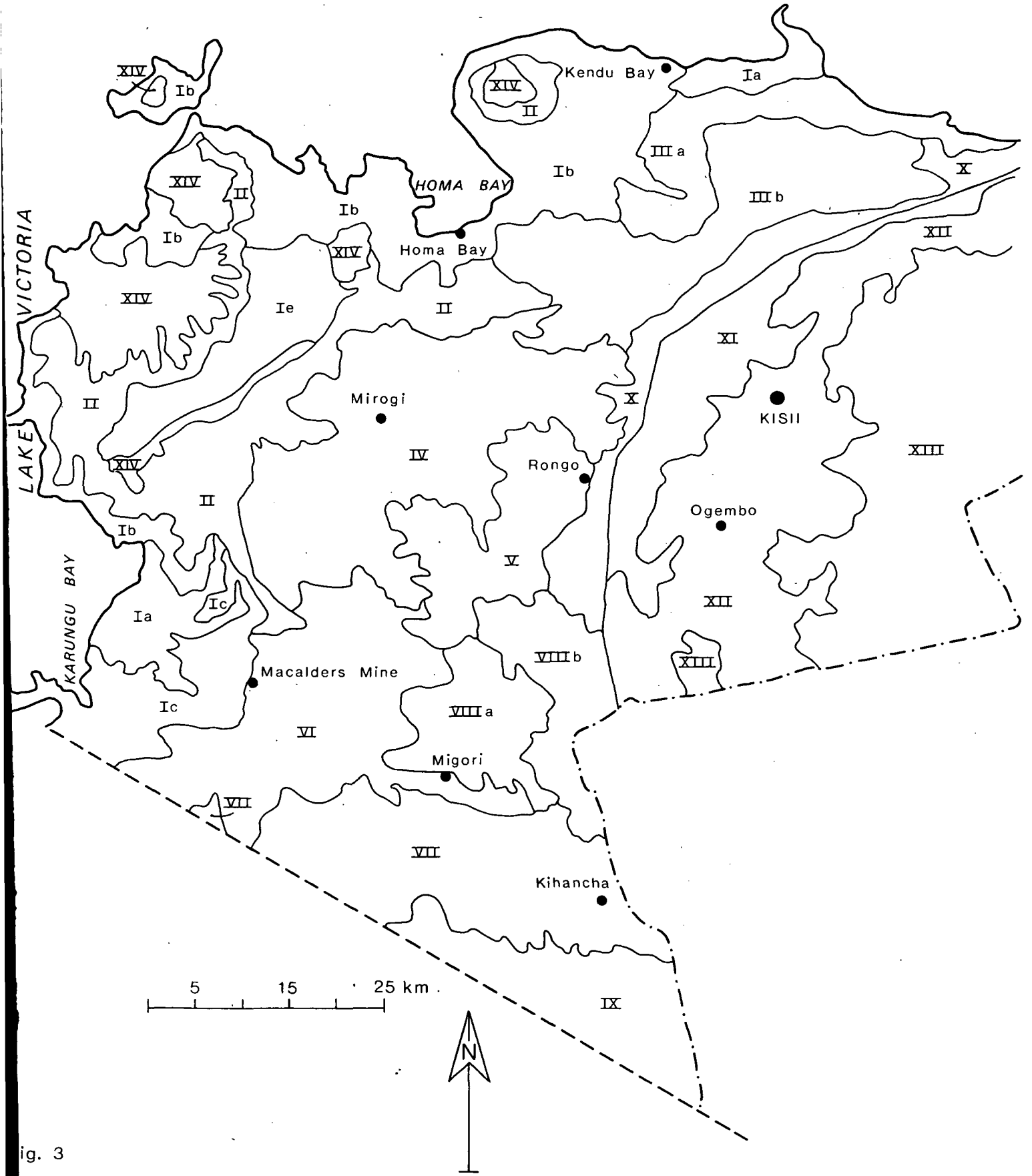
AGRO – ECOLOGICAL REGIONS



ig. 3

4. Landuse according to agro-ecological regions.

by H.L.M. van Wissen.

4.1 Introduction.

The following material has been used in order to arrive at a map of agro-ecological regions (see figure 3).

1) The climate and vegetation map of Kenya (D.O.S. 1970). The four vegetation zones are also drawn on the climatic map (see appendix 1).
2) Vegetation Survey of South Western Kenya, Trapnell,C.G. e.a. (1968).
3) Map of contourlines (see appendix 4).
4) Physiographic map (see appendix 2).
5) Landuse map (see appendix 3).

Information on landuse originates from the agricultural staff, from anual reports of Kisii and South Nyanza district, from aerial photo-interpretation and from field checks.

The landuse will be discussed per agro-ecological region (figure 3); it is advised to compare fig.3 and appendix 3 with the appendices 1, 2 and 3.

Data on climate are from the climate and vegetation map (D.O.S. 1970).

Vegetation data are from the vegetation survey (Trapnell, 1968).

Data on population are from the population census of 1969.

4.2 The regions.

I The areas near Lake Victoria.

Ia) 200 - 220 persons per km^2 Luo.

Altitude:	1,135 to 1,220 m.
Climate:	Main rainfall peak in April with variable dry [1] periods in January-February, June, July and September-November; Rainfall:850-1,250 mm; seasonal temperature 16°C or more; range about 11°C.
Vegetation:	70% Intermediate semi-evergreen thicket and associated types: derived clearings, cultivation communities and bushland, undifferentiated (46).[2]

1) In the definition of seasonal rainfall the term "dry" is used of months with an average rainfall of 75 mm or less. The term "continuous" rainfall is used where the monthly rainfall throughout the year is above 75 mm.
2) Numbers refer to the vegetation type on the vegetation map of Trapnell (1968).

30% Vegetation on soils with impeded drainage:
a) Acacia and allied vegetation on clay plains, undifferentiated (56) and b) Papyrus, swamp grass and reed swamp (9).

Present landuse: Semi-permanent cultivation and grazing: mainly SAIII.
Major crops: sorghum, cassava, sisal, groundnuts,mixed beans, cowpeas;
Minor crops: hybrid maize, wimbi, pawpaw, vegetables,
Sporadic: sugarcane (chewing), bananas, mangoes, citrus, green grams.

1b) East of Homa Bay: + 200 persons per km^2, Luo.
West of Homa Bay: ± 80 persons per km^2, Luo.
Altitude: Mainly between 1,135 and 1,220 m.
Climate: Main rainfall peak in April with variable dry periods in Jan.-Febr. and June to Nov.; rainfall 750-1,000 mm; mean minimum teperature 16°C, range about 11°C.
Vegetation: 70% Intermediate semi-evergreen thicket and associated types; derived clearings, cultivation communities and bushland, 1) undifferentiated (46);
ii) Euphorbia-Rhus-Acacia seyal mixtures (46c);
iii) Balanites and Acacia-seyal-Balanites types (46d);
30% Vegetation on soils with impeded drainage:
a) Acacia and allied vegetation on clay plains,
i) undifferentiated (56); ii) Acacia seyal and Balanites (56c).
b) Papyrus, swamp grass and reed swamp (9)
c) Saline grassland and salt pans (32)

Present landuse: Semi-permanent cultivation and grazing: mainly SCIII and SDIII;
Major crops: local maize, sorghum, cotton;
Common crops: cassava, sweet potatoes, sisal, ground nut, mixed beans, cowpeas;
Minor crops: hybrid maize, simsim, vegetables, pawpaw;
Sporadic: wimbi, rice, sugarcane (chewing), sunflower, castor, bananas, pineapple, water melon, citrus, green grams.

Ic) 80 - 100 persons per km^2, Luo.

Altitude: Between 1,135 and 1,220 m.

Climate: Main rainfall peak in April/May. In the eastern part of this area variable dry periods in January/Febr. and June/November. Near the lake the dry period is from June/Febr. Rainfall 650-1,000 mm; mean minimum temperature 16°C, range 11-17°C.

Vegetation: Intermediate semi-evergreen thicket and assiocated types: derived clearings, cultivation communities and bushland, undifferentiated (46).

Present landuse: Semi-permanent cultivation and grazing: mainly SOIV;
Major Crops: sorghum, cotton;
Common crops: rice, cassava, sweet potatoes, sisal, groundnuts, mixed beans, corpeas, green grams;
Minor crops: local maize, wimbi, simsim, pawpaw, vegetables;
Sporadic: hybrid maize, sugar cane (chewing (9), castor, sunflower, macadamia nuts, bananas, mangoes, citrus.

Id) 20 - 40 persons per km^2, Luo.

Altitude: 1,135 - 1,180 m.

Climate: Main rainfall peak in April or April/May and June to February dry; Rainfall: 650-900 mm; mean minimum temperatures 16°C, range between 11-17°C.

Vegetation: Vegetation on soils with impeded drainage: mainly
i) Euphorbia with Acacia and thicket remnants (56d)
ii) Acacia seyal and Balanites (56c),
iii) grassland and clumpgrassland, vlei and drainage types (8),
iv) Papyrus swamp grass and reed swamp (9).

Present landuse: Semi-permanent cultivation and grazing: mainly SOII and 20% SCIII;
Major crops: sorghum, cotton, rice;
Common crops: sweet potatoes, mixed beans, cowpeas;
Minor Crops: local maize, simsim, sisal, vegetables;
Sporadic: hybrid maize, wimbi, cassava, pawpaw, sugar cane, sunflower, bananas, citrus, mangoes, macadamia nuts.

Ie) 5 - 10 persons per km^2 Luo.

Altitude: 1,160 - 1,260 m.

Climate: In general the rainfall in two seasons, March/May and September/November; Rainfall: 850-1,200 mm; mean minimum temperature 16°C, range 11°C.

Vegetation: 70% Vegetation of soils with impeded drainage: Acacia seyal and Balanites (56c);
30% Intermediate semi-evergreen thicket and associated types: i) derived clearings, cultivation communities and bushland, undifferentiated (46), ii) intermediate semi-evergreen thicket (60).

Present landuse: The main part of the valley belongs to the Olambwe Valley Game Reserve; the other part has semi-permanent cultivation and grazing, mainly SAIII;
Major crops: local maize, cotton;
Common crops: sorghum, sisal, groundnuts;
Minor crops: cassava, sweet potatoes, mixed beans, vegetables;
Sporadic: hybrid maize, wimbi, sugar cane (chewing), simsim, sunflower, bananas, pawpaw, citrus, cowpeas, green grams.

II) 80 - 100 persons per km^2, Luo.

Altitude: 1,220 - 1,550 m.

Climate: Main rainfall peak in April-January/Febr. and July dry; rainfall: 1,000-1,300 mm; mean minimum temperature 16°C, range 11-17°C.

Vegetation: 70% Intermediate semi-evergreen thicket and associated types: derived clearings, cultivation communities and bushland, mainly undifferentiated (46), but also
i) Euphorbia-Rhus-Acacia seyal mixtures (46c), Balanites and Acacia seyal-Balanites types (46d),
ii) Albizia coriaria Turraea type (46a);
20% Open grassland types on drained soils: open grasslands of semi-evergreen thicket origin (47;IA);
Combretum and allied broad-leaved savanna types: moist Combretum and allied vegetation (undifferentiated Combretum types including cultivation areas (40)).

Present landuse: Semi-permanent cultivation and grazing: ± 65% SAIII, ± 25% SBIII and ± 15% SOIII and SDII;
Major crops: cassava, sweet potatoes, groundnuts, sisal, mixed beans, cowpeas;
Minor crops: hybrid maize, wimbi, sugar cane, simsim, vegetables;
Sporadic: rice, cotton, sunflower, bananas, pawpaw, pineapple, citrus, mangoes.

IIIa) 175 - 200 persons per km^2.

Altitude: 1,220 - 1,500 m.

Climate: Main rainfall peak in April, with variable dry periods in January/Febr., June/July and Semtember/November; rainfall: 1,000-1,300 mm; mean minimum temperature 16°C range 11-17°C.

Vegetation: 80% Combretum and allied broad-leaved savanna types: moist Combretum and allied vegetation: i) undifferentiated Combretum types including cultivated areas (40), ii) Combretum with Combretum/Euclea schimperi (40); 18% Broad leaved savanna mixtures of semi-evergreen thicket origin: i) Combretum-semi-evergreen thicket mixtures (50a), ii) Terminalia-semi-deciduous thicket mixtures (50).

Present landuse: Semi-permanent cultivation and grazing: ± 70% SOIV and ± 25% SAIII;
Major crops: local maize, sweet potatoes;
Common crops: sorghum, cassava, sisal, groundnuts, mixed beans, cowpeas;
Minor crops: hybrid maize, wimbi, green grams, vegetables;
Sporadic: cotton, sugar cane (chewing), bananas, pawpaw, pineapple, mangoes, citrus.

IIIb) 140 - 160 persons per km^2, Luo.

Altitude: 1,220 - 1,520 m.

Climate: Main rainfall peak in April/May with January or January/February dry; rainfall: 1,200-1,500 mm; mean minimum temperature 16°C, range 11-17°C.

Vegetation: 90% Combretum and allied broad-leaved savanna types: moist Combretum and allied vegetation: i) indifferentiated Combretum types including cultivated areas (40), ii) Combretum with Euclea schimperi (40).

Present landuse: Semi-permanent cultivation and grazing: ± 65% SAIII, ± 20% SBIII.

Major crops: local maize, hybrid maize, sorghum, cassava, sweet potatoes, sisal, groundnuts, mixed beans, cowpeas;

Minor crops: wimbi, sugar cane, green grams, vegetables, bananas;

Sporadic: cotton, pawpaw, pineapple, mangoes, citrus, castor.

IV) 80 - 100 persons per km^2, Luo.

Altitude: 1,230 - 1,350 m.

Climate: Main rainfall peak in April, with January or Jan/Febr and July dry; rainfall: 1,050-1,550 mm; mean minimum temperature about 16°C, range 11-17°C.

Vegetation: 95% Vegetation of soils with impeded drainage: i) open grassland areas on clay plains: Hyparrhenia-Pennisetum catabasis (56A), ii) Acacia and allied vegetation on clay plains: Acacia seyal and Balanites (56c); iii) grasslands and clump-grasslands, undifferentiated: ever-green clump-grassland on vlei soils (8a).

Present landuse: Semi-permanent cultivation and grazing: SBIII;

Major crop: sugar cane;

Common crops: local maize, sorghum, cassava, sweet potatoes mixed beans, cowpeas;

Minor crops: hybrid maize, wimbi, rice, sisal, groundnuts, simsim, bananas, green grams, vegetables;

Sporadic: Irish potatoes, tobacco, cotton, sunflower, pawpaw, pineapple, mangoes, citrus.

V) 80 - 100 persons per km^2, Luo.

Altitude: 1,250 - 1,600 m.

Climate: Main rainfall peak in April with January or Jan/Febr and July dry; rainfall: 250-1,650 mm; mean minimum

temperature about 16°C, range 11-17°C.

Vegetation: Combretum and allied broad-leaved savanna types:
i) moist Combretum and allied vegetation: undifferentiated Combretum types, including cultivated areas (40),
ii) Faurea and Parinari-Combretum types: Parinari and Parinari-Combretum mixtures (40h).

Present landuse: Semi-permanent cultivation and grazing: ± 50% SCIII, ± 25% SBII and SBIII, ± 25% SAII and SAIII;
Major crop: local maize;
Common crops: hybrid maize, sorghum, wimbi, sweet potatoes, sugar cane, groundnuts, mixed beans, cowpeas;
Minor crops: cassava, Irish potatoes, tobacco, coffee, simsim, bananas, green grams, vegetables, pawpaw;
Sporadic: castor, sunflower, mangoes, citrus, soya beans.

VI) 80 - 100 persons per km^2, Luo and Luhya, and in southern part, Kuria.

Altitude: 1,220 - 1,500 m.

Climate: Main rainfall peak in April with January or Jan/Febr. and July dry; rainfall: 1,000-1,250 mm; mean minimum temperature 16°C, range 11-17°C.

Vegetation: Combretum and allied broad-leaved savanna types;
i) moist Combretum and allied vegetation: undifferentiated Combretum types, including cultivated areas (40),
ii) Faurea and Parinari-Combretum type: Parinari and Parinari-Combretum mixtures (40h);

Present landuse: Semi-permanent cultivation and grazing: 35% SAII and SAIII, 35% SBIII, 30% SOIII, SOIII and SOIV.
Major crops: local maize, cassava,;
Common crops: sorghum, wimbi, sweet potatoes, sisal, groundnuts, mixed beans, cowpeas;
Minor crops: hybrid maize, rice, green grams, vegetables;
Sporadic: cotton, sugar cane, simsim, Irish potatoes, pawpaw, mangoes, citrus.

VII) 90 - 100 persons per km^2, Kuria.

Altitude: 1,400 - 1,550 m.

Climate: Main rainfall peak in April with January or Jan/Febr. and July dry; rainfall 1,200-1,500 mm; mean minimum

temperature 16°C, range 11-17°C.

Vegetation: 45% Vegetation of soils with impeded drainage: evergreen clump-grassland on vlei soils (8a); 45% Combretum and allied broad-leaved savanna types: i) moist Combretum and allied vegetation: indifferentiated Combretum types, including cultivated areas (40), ii) Furea and Parinari-Combretum types: Parinari-Combretum mixtures (40h).

Present landuse: Semi-permanent cultivation and grazing: SAIII;
Major crops: local maize, cassava;
Common crops: sorghum, wimbi, sweet potatoes, groundnuts, mixed beans, cowpeas;
Minor crops: rice, sisal, green grams, vegetables;
Sporadic: hybrid maize, sugar cane, simsim, bananas, pawpaw, mangoes, citrus.

VIIIa) 80 - 100 persons per km^2, Luo and Luhya (mixed).

Altitude: 1,350 - 1,650 m.

Climate: Main rainfall peak in April with January or Jan/Febr. and July dry; rainfall: 1,250-1,550 mm, mean minimum temperature 16°C, range 11-17°C.

Vegetation: Combretum and allied broad-leaved savanna type: Faurea and Parinari-Combretum type: Faurea and Parinari Combretum mixtures (40h)

Present landuse: Semi-permanent cultivation and grazing: ± 65% SCIII, ± 35% SDII and SDIII;
Major crop: hybrid maize;
Common crops: sweet potatoes, Irish potatoes, coffee, sugar cane, tobacco, groundnuts, bananas, mixed beans, cowpeas;
Minor crops: local maize, wimbi, sorghum, sisal, simsim, green grams, pineapple, vegetables;
Sporadic: cassava, rice, sunflower, passion fruit, mangoes, citrus.

VIIIb) 80 - 100 persons per km^2, Northern part: Luo and Luhya.
Southern part: Kuria.

Altitude: 1,350 - 1,550 m.

Climate: Main rainfall peak in April with January or Jan/Febr. and July dry; rainfall: 1,350-1,550 mm; mean minimum temperature 16°C, range 11-17°C.

Vegetation: 80% Forest clearing and cultavation communities: from intermediate Diospyros-Olea forest: Dombeya and allied clump vegetation (17b); 20% vegetation of soils with impeded drainage: ever-green clump-grassland on vlei soils (8a).

Present landuse: Semi-permanent cultivation and grazing: 70% SCIII, ± 20% SBIII, ± 10% SAIII;
Major crop: hybrid maize;
Common crops: sweet potatoes, Irish potatoes, sugar cane, tobacco, groundnuts, bananas, mixed beans, cowpeas;
Minor crops: local maize, wimbi, sorghum, cassava, sisal, simsim, coffee,green grams, vegetables;
Sporadic: rice, pawpaw, mangoes, pineapple, citrus.

IX) 120 - 140 persons per km^2, Kuria.

Altitude: 1,400 - 1,650 m.

Climate: Main rainfall peak in April/May with January or Jan/Febr. dry; rainfall: 1,500-1,750 mm; mean minimum temperature 16°C, range 11-17°C.

Vegetation: Combretum and allied broad-leaved savanna type: moist Combretum and allied vegetation: undifferentiated Combretum types, including cultivated areas (40).

Present landuse: Semi-permanent cultivation and grazing: ± 50% SCIII, 25% SBIII, 20% SAII and SAIII, 5% SDIII;
Major crop: hybrid maize;
Common crops, local maize, sorghum, cassava, sweet potatoes, coffee, tobacco, groundnuts, bananas, mixed beans, cowpeas;
Minor crops: wimbi,Irish potatoes, sugar cane, sisal, green grams, pawpaw, pineapple, vegetables;
Sporadic: castor, sunflower, macadamia nuts, mangoes, passion fruits, citrus.

X) 150 - 170 persons per km^2, Luo.

Altitude; 1,400 - 1,650 m.

Climate: Main rainfall peak in April/May with January or Jan/Febr dry; rainfall: 1,500-1,750 mm; mean minimum temperature 16°C, range 11-17°C.

Vegetation: Combretum and allied broad-leaved savanna type: moist Combretum and allied vegetation: undifferentiated Combretum types, including cultivated areas (40).

Present landuse: Semi-permanent cultivation and grazing: ± 50% SCIII, 25% SBIII, 20% SAII and SAIII, 5% SDIII;
Major crop: hybrid maize;
Common crops: local maize, sorghum, cassava, sweet potatoes, coffee, tobacco, groundnuts, bananas, mixed beans, cowpeas;
Minor crops: wimbi, Irish potatoes, sugar cane, sisal, green grams, pawpaw, pineapple, vegetables;
Sporadic: castor, sunflower, macadamia nuts, mangoes, passion fruits, citrus.

XI) 300 - 340 persons per km^2, Kisii.

Altitude: 1,500 - 1,650 m.

Climate: Main rainfall peak in April/May with January or Jan/Febr dry; rainfall: 1,500-1,700 mm; mean minimum temperature 16°C, range 11-17°C.

Vegetation: 75% Forest clearings and cultivation communities: from lower moist intermediate forest: cultivated Albizia-Bridelia-Vernonia (25d);
22% Combretum and allied broad-leaved savanna type: moist Combretum and allied vegetation: undifferentiated Combretum types, including cultivated areas (40).

Present landuse: Semi-permanent cultivation and grazing, to permanent cultivation: ± 55% SCIII, ± 20% SDII and SDIII, ± 20% PEII and PEIII, ± 10% SBIII;
Major crop: hybrid maize, sugar cane;
Common crops: sweet potatoes, coffee, groundnuts, bananas;
Minor crops: local maize, wimbi, cassava, sisal, castor, mixed beans, cowpeas, green grams, soya beans, pineapple, vegetables;

Sporadic: sorghum, tobacco, sunflower, macadamia nuts, citrus.

XII) 350 - 400 persons per km^2, Kisii.

Altitude: 1,650 - 1,800 m.

Climate: High April/May peak with continuous rainfall (in the northern part January is more or less dry); rainfall: 1,600-2,100 mm; mean minimum temperature about 10-13°C, range about 17°C.

Vegetation: 95% Forest clearings and cultivation communities: from Moist Montane and intermediate forests:
i) cultivated Croton and Vernonia-Clerodendron (35d),
ii) undifferentiated clearings and scrub (35);
5% Montane Acacia vegetation of probable forest origin: undifferentiated secondary and valley types (5).

Present landuse: Mainly permanent cultivation: 95% PEII and PEIII, 5% SCIII;
Major crops: hybrid maize, coffee;
Common crops: bananas;
Minor crops: local maize, wimbi, sweet potatoes, Irish potatoes, tea, pyrethrum, sugar cane, passion fruit, Mexican 142, black wattle, vegetables;
Sporadic: tobacco, mixed beans, cowpeas, pineapples.

XIII) 400 - 450 persons per km^2, Kisii.

Altitude: 1,800 - 2,150 m.

Climate: High April/May peak with continuous rainfall; rainfall: 1,500-2,200 mm; mean minimum temperature 10-13°C, range about 17°C.

Vegetation: 95% Forest clearings and cultivation communities: from Moist Montane and intermediate forests:
i) undifferentiated clearings and scrub (35),
ii) cultivated Triumfetta-Vernonia (35c),
iii) cultivated Croton and Vernonia-Clerodendron (35d).
3% Montane Acacia vegetation of probable forest origin: undifferentiated secondary and valley types (5).

Present landuse: Mainly permanent cultivation: 95% PEII and PEIII, ± 5% SCIII.

Major crop: tea, pyrethrum;
Common crops: Mexican 142;
Minor crops: hybrid maize, coffee;
Sporadic: sweet potatoes, Irish potatoes, local maize, passion fruit, vegetables.

XIV) 0 - 10 persons per km^2, Luo.

Altitude: 1,135 - 2,400 m.

Climate: No reliable figures available.

Vegetation: At higher altitudes: Moist Montane forest: Catha edulis thicket (35A)
At lower altitudes:
a) broad-leaved savanna mixtures of semi-evergreen thicket origin: i) Hoeria-Rhus and allied savanna (44)
ii) Terminalia-semi-deciduous thicket mixture (50c);
b) intermediate semi-evergreen thicket and associated types: i) intermediate semi-evergreen thicket and associated type (60), ii) Balanites and Acacia seyal-Balanites types (46d).

Present landuse: 0 - 10% is used for grazing.

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