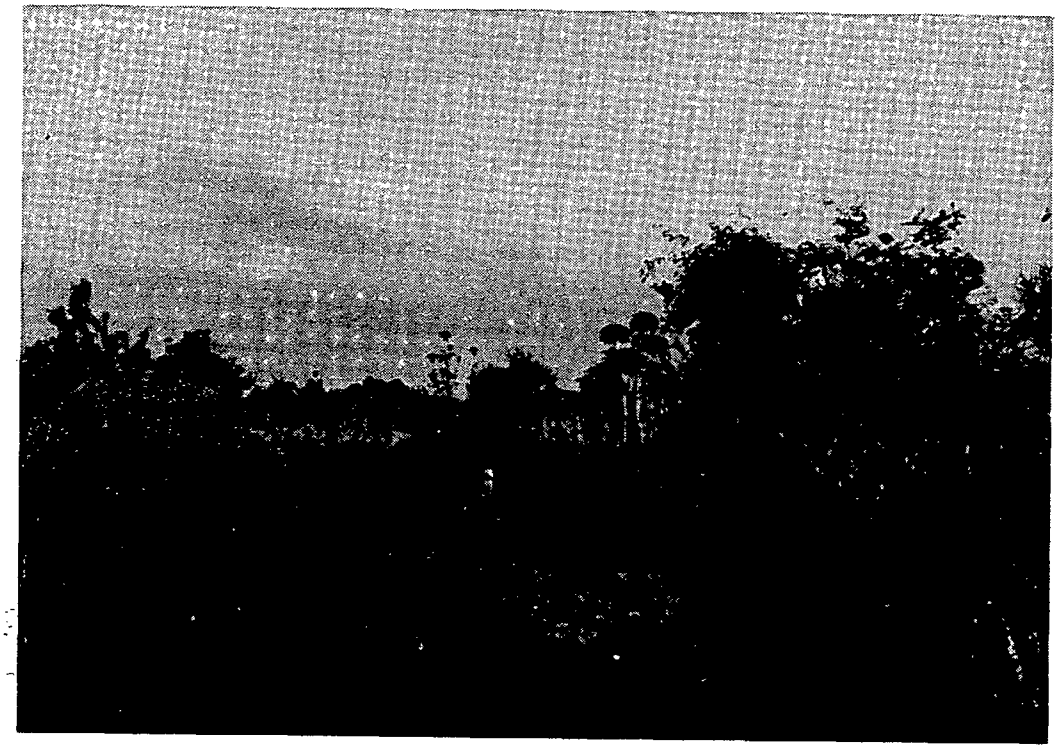
TRAINING PROJECT IN PEDOLOGY

KISII KENYA



A Detailed Soil Survey of the Mbita Area

PRELIMINARY REPORT NO 11

AGRICULTURAL UNIVERSITY
WAGENINGEN - THE NETHERLANDS

A DETAILED SOIL SURVEY

OF THE

MBITA AREA

by
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TRAINING PROJECT IN PEDOLOGY, KISII - KENYA
Agricultural University, Wageningen - The Netherlands.

Contens

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, The Netherlands, is the eleventh one if a series to be presented to Kenyan Officials.

The project started in Novemner 1973 after assent had been granted by the Office of the President of Kenya. It is meant for training of post-graduate students of the Agricultural University at Wageningen and for furnishing research opportunities of 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 further 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 report has been written by Mssrs H.v.d. Ham and D. Noordam, who also drew the two maps. The compilation and editing of the report has been done by Mr. H.W. Boxem who correlated the survey with the one carried out on Mfangano Island by Mr. P. van Oostrom (PR. 12,)

From August to November 1974 fieldwork was carried out in order to survey the soil characteristics in the area around Mbita including a part of Rusinga Island. This was done by two graduate students from the Agricultural University of Holland during their practical training in the program of the Training Project in Pedology at Kisii. One student from the department of Tropical Soil Science carried out a semi detailed soil survey after this detailed one. The other student form the Department of Tropical Rural Engeneering and Irrigation conducted some irrigation trials afterwards as a check on the Irrigation - suitability map. This detailed survey of about 100 ha was surveyed in detail and the possibilities for surface irrigation were briefly studied.

As only a few data on chemical and physical properties of the soils were avalilable, this survey should be seen as preliminar and initiating further surveys. It is considered a general guideline for local development virtues.

We do 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

PART I: THE ENVIRONMENT

1. General description of the area:

1.1. Location and extent

The Mbita area is located between latitudes $0^{o}25'$ and $0^{o}28'$ south and longitudes $34^{o}11'$ and $34^{o}17'$ east in Nyanza Province, Southwest Kenya (Fig.1, page 7).It covers a part of approximately 1000 ha in Mbita location South-Nyanza district.

The surveyed area covers a strip of approximately 1 km width along the coast of Lake Victoria. The eastern boundary is the neighbourhood of Kirindo, while the western is formed by the Lulonge hill on Rusinga-island (Fig.2 page 9). Main village is Mbita, which is divided in two parts, one on the continent and one on Rusinga-island.Mbita is both an administrative centre and an important market.

The area is reasonably accessible in the dry season; in the wet season it might be impossible to reach the area by road.Rusinga-island can be reached by a ferry at daytime only.From Mbita there are boats going to Mfangano, Uyoma and Homa Bay.

1.2. Population

The continental part of the area is inhabited by members of the Luo tribe. This tribe is from Nilotic origin. They entered the area in the 15th century, coming from the Sudan travelling along the Nile. The people who lived in the area at that moment were the Basuba, who were dislodged to remotes, like islands and difficult accessible valley (e.g. Rusinga-island, Mfangano-island, Roo-valley etc.)

The Luos are originally pastoralists and fishermen, but gradually they adapted themselves to farming. They used to live on higher positions in villages which were surrounded by fences of Euphorbia because of the raiding Masai. They still live on higher spots also because of flooding hazard of the low valleys, but most the fences have disappeared.

The density of population of this part is 80 - 100 persons/km^2.It is somewhat higher near the lake and it is gradually decreasing with increasing distance from the Lake.As already mentioned above Rusinga-island is inhabited by the Basubas. They are from Bantu origins.

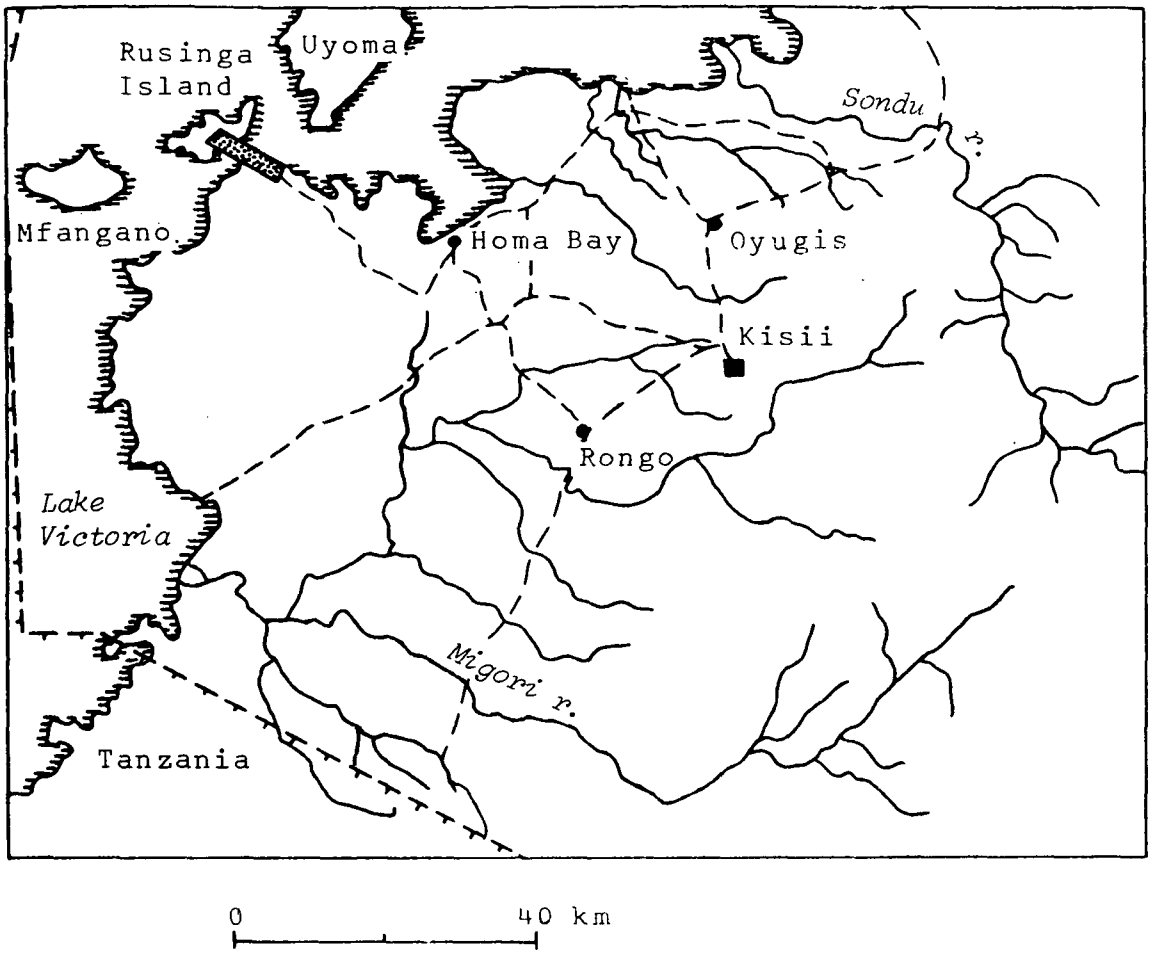


Fig. 1 Location of the Mbita detailed soil-survey area

Nowadays they are strongly mixed with the Luo tribe, only the older people are still able to talk the Basuba language. Their villages have the same structure as those of the Luo, but the fences of Euphorbia are still present on most places. The density of population is approximately 140 persons/km^2. The villages occur scattered all over the island except for the hills.

1.3. The physical environment.

1.3.1 Physiography.

The area can be divided in two main physiographic regions

A. The part on the continent

B. The part on Rusinga-island.

A The part on the continent.

This part of the area is covering the lower footslopes of the Gem-hills. These hills are a remnant of a volcano slope consisting of nephelinite-agglomerates. The hills

themselves have steep, stony slopes with shallow soils. Height is 1900 m. In the survey area the following subdivision can be made.

1. Very gently sloping remnant hills with shallow soils and stony surface. Steep slopes with rockoutcrops may occur towards the alluvial plains.
2. Sloping remnant hills usually very stony with a lot of rockoutcrops. Very shallow soils.
   Gently sloping, straight pediment slopes, with moderately deep to deep clay soils. They have a low density of gullies these are from approx. 1155 m. to 1250 m.
4. Very gently sloping alluvial valleys with concave slopes. Deep clay soils with impeded drainage. Few very shallow wide gullies.

Along the lakeshore the plain is nearly flat. Deep clay soils occur where the water-movement is rather gentle, but more sandy soils are found on positions which are exposed to the wind and which have a strong watermovemnet (breakers). The latter can be observed around the Mbita-point.

B. The part on Rusinga-island.

This part has mainly been formed on Miocene lakebeds. It can be subdivided in

1. Isolated remnant hills mainly consisting of Miocene lakebeds and nephelinites on top. Their slopes are very steep and have a low density of small gullies. Soils are very shallow and many outcrops occur. Altitude ranges from lakelevel to approx. 1400 m but is usually between 1180-1300 m.
2. Smooth, straight pedimentslopes on Miocene lakebeds. They are generally sloping (up to 12%) and strongly dissected by deep gullies. Soils are shallow overlying soft rotten rocks. Altitude ranges from lakelevel to 1200 m. (generally from 1170 - 1190 m.)
3. Gently undulating country with concave smooth slopes (to 5%)Mainly formed on alluvium/colluvium of pediment-slope. Soils are deep to moderately deep. Very few, very shallow gullies.

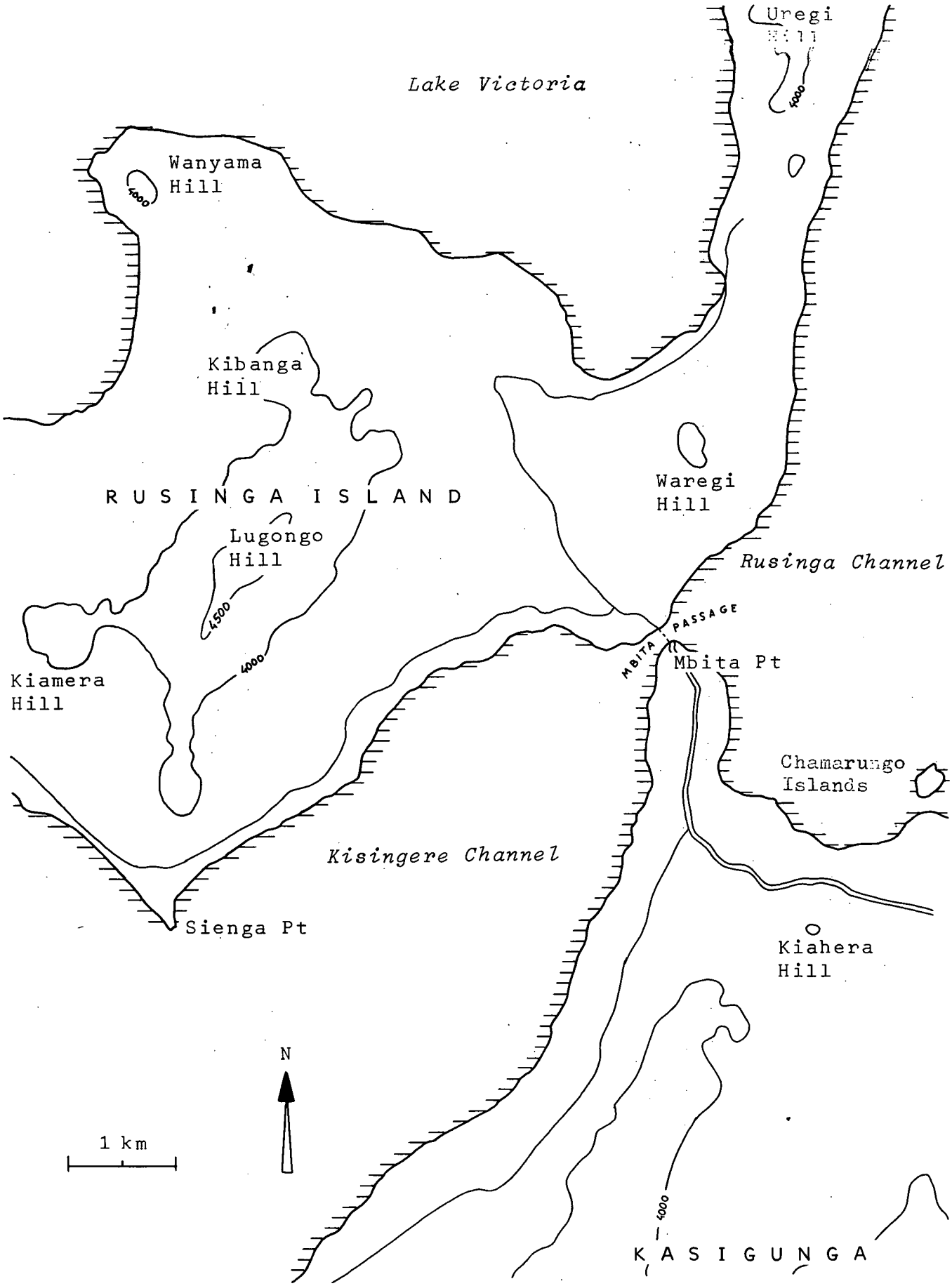


Fig. 2 Section of topographical map 1 : 50,000 (Rusinga, 115/3)

1.3.2 Geology.

The Precambrian peneplain is blanketed by Tertiary volcanics. The volcanism started with the emplacement of carbonatite plugs and ring complexes at centres over which the peneplain was upwarded into domes, at Rangwa as much as 600 m. Subsequently a large volcano built up the Kisingiri Range. Extensive lavaflows covered and preserved wide spread patches of sediments (among others the Miocene lakebeds of Rusinga). Riftfaulting took place later, mostly during Pleistocene. The central zone with the volcano-cones was down faulted between the Kanyamua and Mfangano faults. Erosion led to a central carbonite plug (Rangwa) encircled by an upstanding ridge of volcanic rocks of greater height of which Gembe hills is a part. The survey area is divided in two parts by the Mfangano fault, which is situated in the Mbita channel between Mbita-point and Rusinga-island. The continental part is mostly covered with Tertiary lavaflows, but along Lake Victoria some Miocene lakebeds are outcropping. Rusinga-island is mainly built up by Miocene lakebeds Only on the tops of the highest hills (e.g. Lulonge hill) small remaining patches of Tertiary volcanics are found.

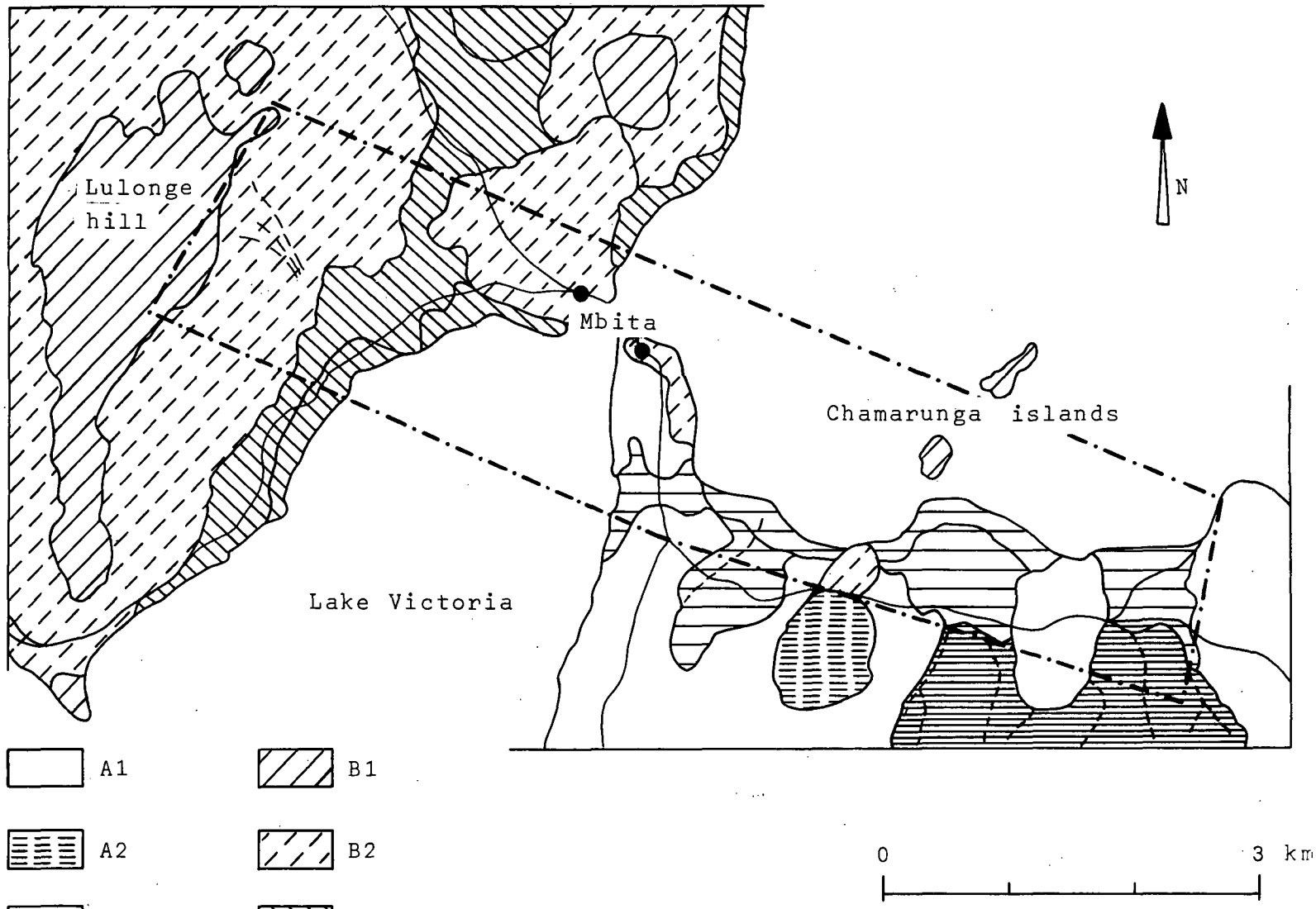
1.3.3 Parent materials.

The rocks in the survey area comprise (1) Tertiary volcanics and (2) Miocene lakebeds.

1. These include melanites, melanephelinites and nephelinites. These are dark-coloured, fine textured basic rocks. They give rise to montmorillonitic clayey soils.
2. These include a wide range of shale-like rocks, among others tuffs, boulderbreccias, tuffaceous sandstones. The rocks are usually soft, multicoloured and calcareous although also noncalcareous rocks occur at some places. They give rise to shallow soils.

1.3.4 Hydrology and erosion.

The survey area is drained by many small gullies and some bigger gullies, all of them are nameless. They are without water during most days of the year; only during heavy rains they are filled with fast streaming water. Hardly any of these dry rivers (gullies) reaches the lake, most of them loose their water and the erosion materials via a very wide and shallow gully on the new developed alluvial fans along the lake border, causing severe flooding.


Lulonge
hill
Mbita
Chamarunga islands
Lake Victoria
N
0
3 km
A1
A2
A3
A4
B1
B2
B3
road
gully

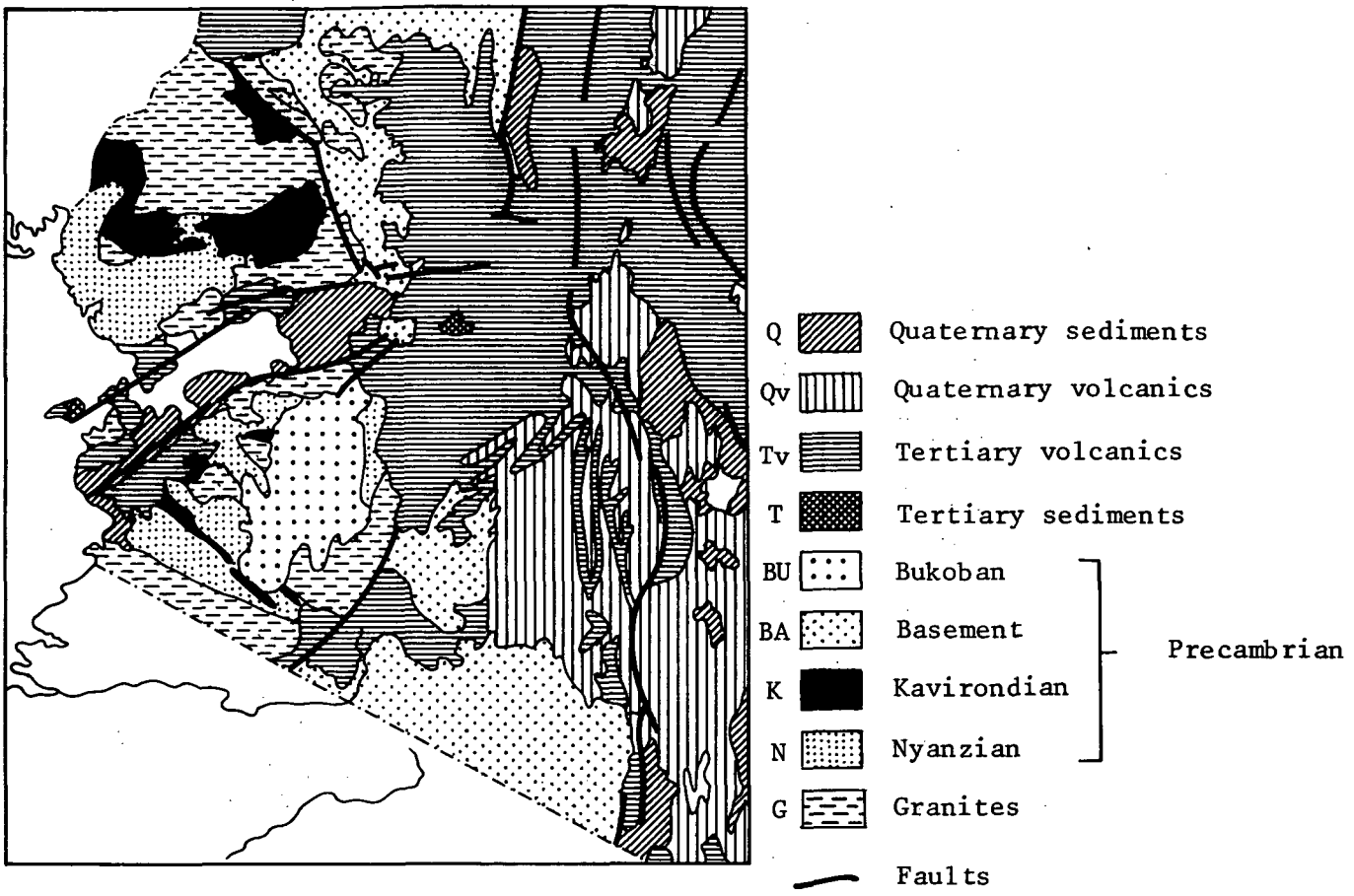


Fig. 4. Geological Map of Southwestern Kenya, Scale 1:3.000.000

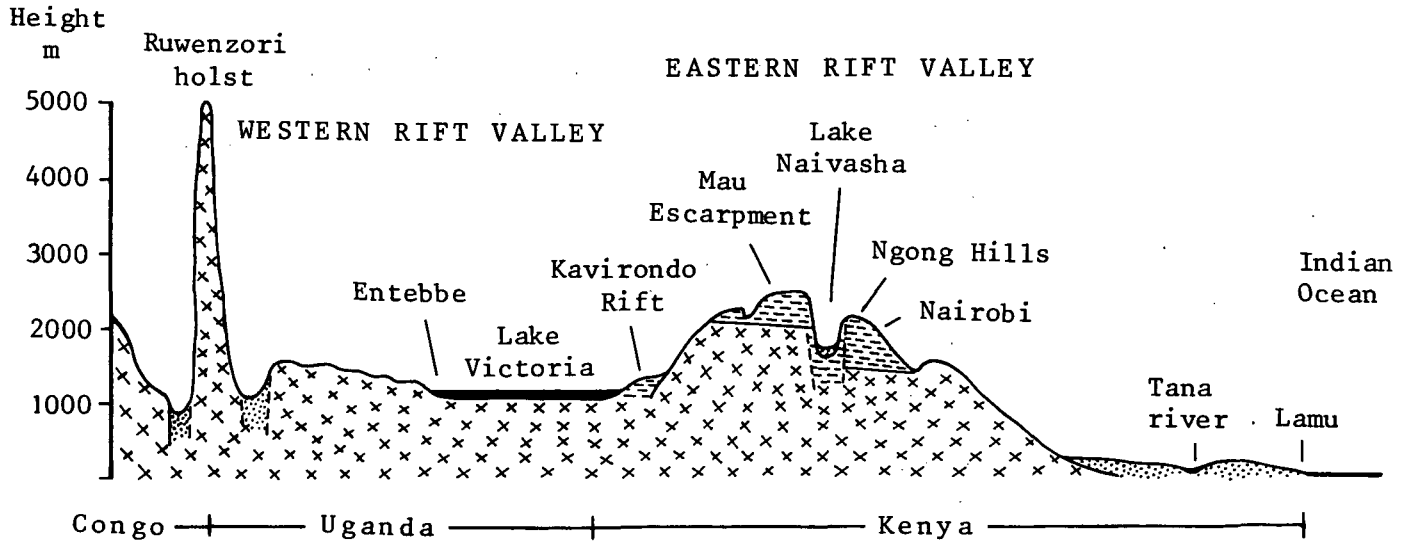


Fig. 5. Schematical geologic cross-section from West to East through Congo to the Indian Ocean.

Quaternary sediment

Tertiary and Quaternary volcanics

Precambrian basement gneiss, granites and sediments

(After K. Bjorlykke, 1972).

Another aspect which has its influence on the drainage regime of the area is the gradual increase of the water level of Lake Victoria. This aspect may stimulate the development of alluvial fans or renew other fans.

Groundwater never comes to the surface in the survey area. It streams in the sublayers directly into Lake Victoria. The amount of surface water and groundwater streaming to the Lake is not known.

Erosion occur mainly on the slopes of the surrounding hills (Gembe hills), the pedimentslopes and the oldest alluvial fans. All types of erosion-forms occur in these parts of the area and has resulted in a subparallel or semi-dendritic pattern. On Rusinga-island the Kiangata series (KiM) of the Miocene lakebeds are more susceptible to erosion than the Rusinga-series (RuM), which also originates of miocene lakebeds. On top of KiM-series a layer of small stones and gravel are visible, which is probably the result of sheet-erosion. The erosion finally results in a low density of medium deep gullies. Only on Rusinga island some protection measurement are taken. On a few places you can see some Euphorbia tirucalli planted along contourlines, while stones are placed on the roots of them, to catch soil particles. These measurements have resulted in the forming of terraces. On other places people have only put stones along the lines. This measurement resorted a lesser effect.

1.3.5 Climate and meteorology of the area.

According to Koppen's classification the climate of the area of the east-coast of Lake Victoria is sub-humid tropical savannah-climate.

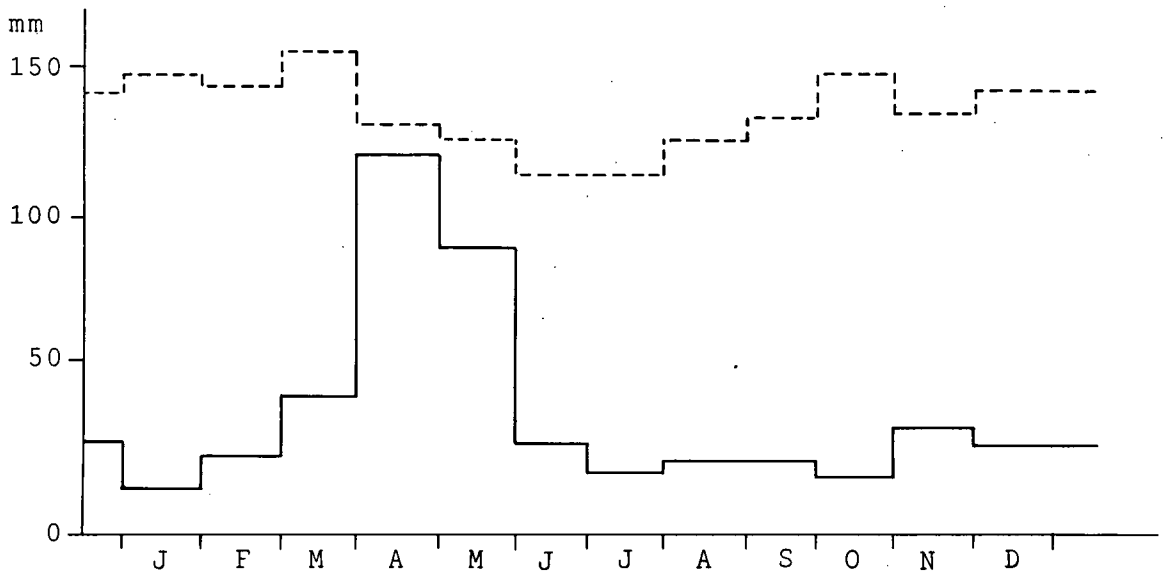
Mean temperature is about 23°C. Max. day temperature ranges from 27°C to 34°C; min. night temperature ranges from 14°C to 18°C.

Precipitation in the area is about 750 mm.; three quarters of which in the months of march, april and may. In the remaining part of the year the rain falls at irregular time, but it seems that in November and December there is somewhat more rain. Also the rain is not divided regularly over the area according to inhabitants. Even some kilometers N.E. of Mbita-point there is remarkable more precipitation than one the point itself. This is mainly due to the topography of the area.

Wind pattern is rather constant throughout the year. 2m/s., During night and morning windspeed is mostly less than coming from N.E. to E. direction. Around noon windspeed decreases to about 0 m/s., than changes to the direction of S.W. to W. with an average speed of 5 m/s. After about 6 hours, so around 6 p.m. windspeed decreases and wind changes from direction again to come to the situation at night. At the end of the dry season in January and February the windspeed in the afternoon increases up till sometimes 8 - I0/s. and there are more irregulaties on the windpatten.

The relative humidity in the eastern coastal area of Lake Victoria is about 50% with extreme values: 25% and 65% at daytime in the dry season. At night average value is around 90% with extreme values I00% and 80%.

About the potential evapotranspiration no measurements are known. Only in two different places for a very short time mainly in the dry season evaporation of an open water surface is measured. The first place (I) was a flat plain with hardly any high vegetation (II) was a small spot surrounded by trees of 4-5m. and a steep escarpment of about I0m. height on 8-I5m. distance of the evaporation-pan. The pan used is a class A evaporation-pan. The measurements of the (open pan) evaporation ranges from 7 mm./day- 9 mm/day on place I and from 5,5-7, 5 mm/day on place II. So the topography and the vegetation (windbreaks) may reduce the evapotranspiration with about 25%.



——— Lower limits of 50% (P=0.5) confidence levels of monthly rainfall

---- Evapotranspiration Epo

Altitude : 3800 ft

Total annual rainfall: 750 mm

Fig. 6 Monthly rainfall and evapotranspiration rainfall for Mbita

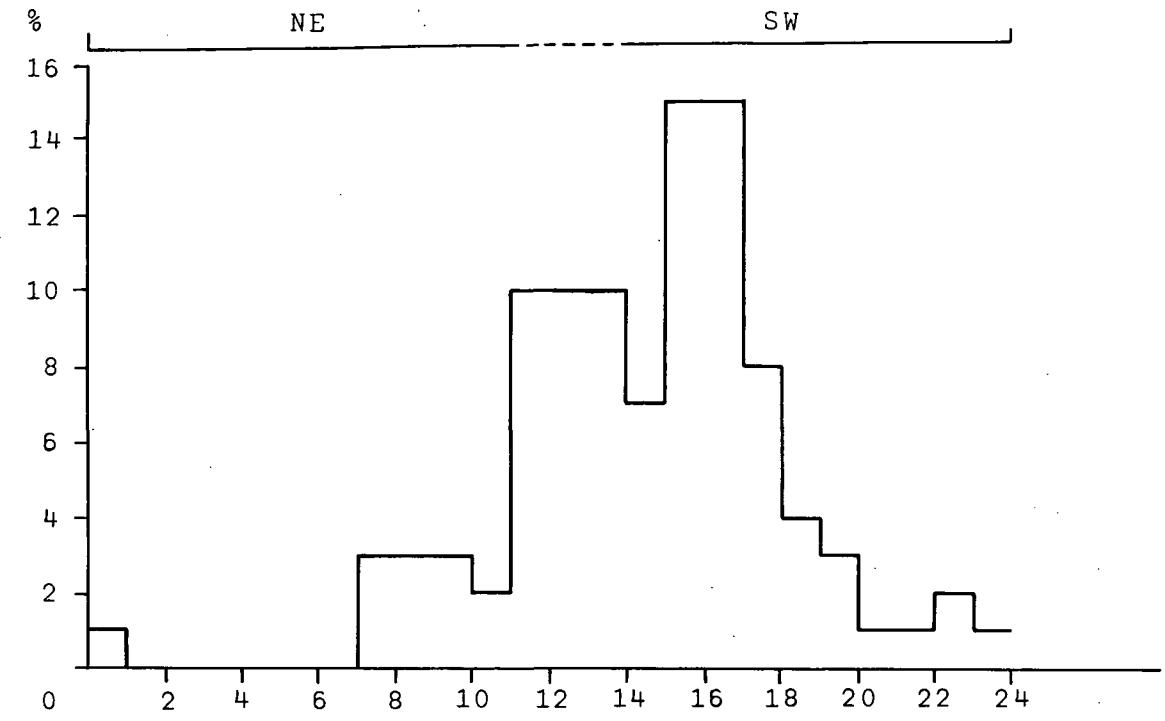


Fig. 7 Wind profile of one day. The figure shows the length of the way covered by the wind per hour expressed as % of the total way length.

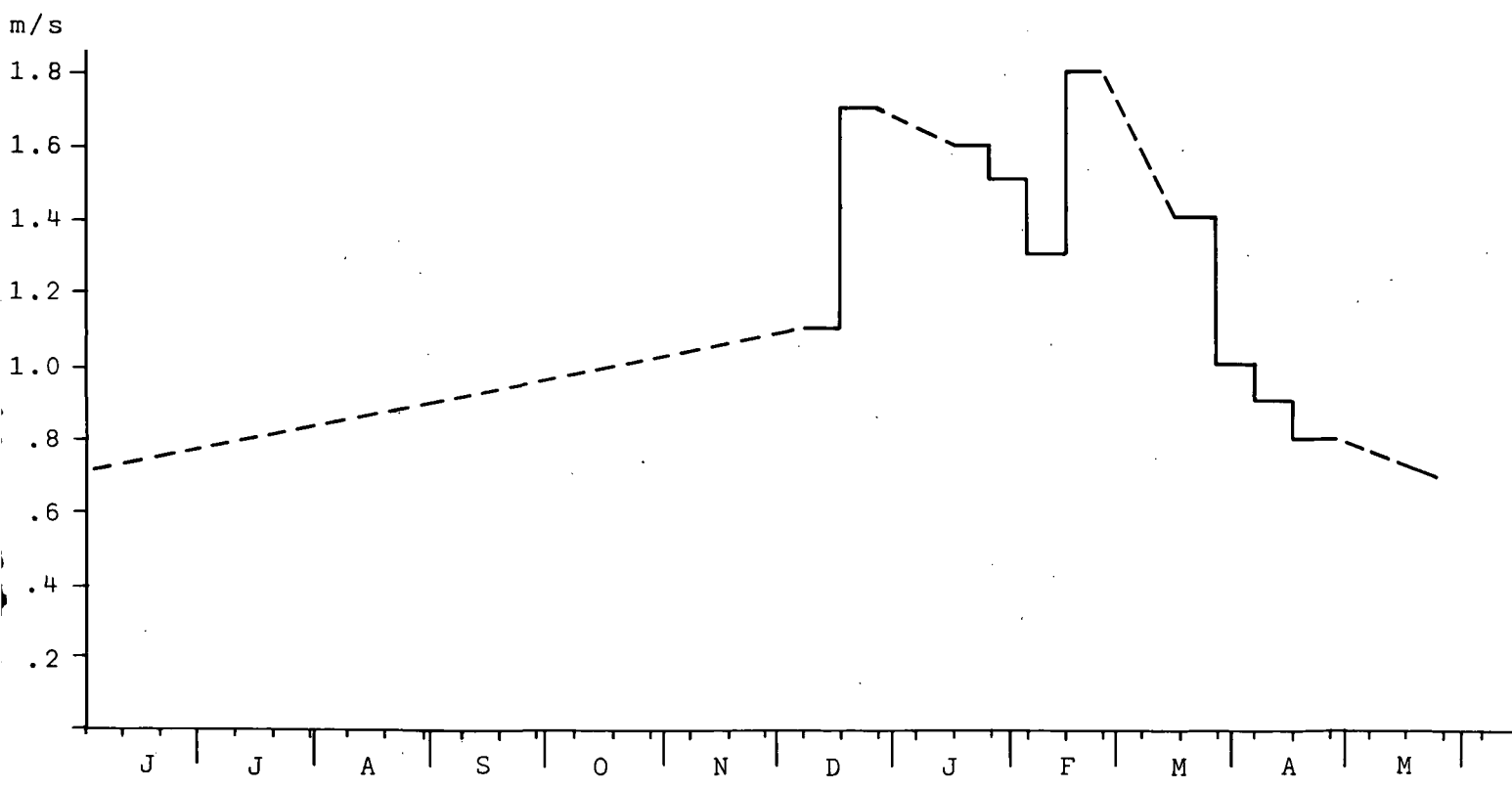


Fig. 8 Average windspeed in m/s per decade (10 days)

1.4. Vegetation and landuse.

1.4.1. Vegetation.

According to the climate and vegetation map of South-West Kenya (1: 250,000) the major part of the survey area belongs to the western semi-evergreen thicket zone (WT), with intermediate semi-evergreen thicket and associated types including clearings, cultivation communities and bushland(50-75%) (46). Within the area the following vegetation types can be distinguished.

1 Soils with impeded drainage carrying an Acacia seyal-Balanites type (46d).

2 On lowlying positions along the lake papyrus swamp, grassland and reed-swamps occur (9).

3 The vegetation types of the other parts of the survey area is mostly Eyphorbia-Rhus-Acacia seyal mixtures (46c) of undifferentiated (56).

The upper pedimentslopes and lower hillslopes carry Combretum and allied broad-leaved savannah-type: moist Combretum and allied vegetation including few clearings (0-10%) (40).The slopes are burned regularly and used for extensive grazing.

1.4.2. Landuse.

In the survey area 50-75% of the land is cleared. Usually the land is cleared at the end of the dry season. Trees and shrubs are cut and burned together with the dry grass. For the first crop after the clearing no ploughing is done. The fields are scatterd. The situation on Rusinga-island is slightly different. Here the clearings cover 75% or more. The fields are usually protected against cattle by thorny branches or fences of Euphorbia. On the mainland this is seldom done and damage is done to the crop by the cattle. The land is owed by clans, not by individuals. Grazing is found on communal land.

Usually a clan has a large part of land in the higher areas (10-50 m. above lake level) and small one in the coastal plain near the lake.The higher parts are used for semi-permanent cultivation of subsistence crops (staple food) which are consumed locally.

The most important crops are maize, sorghum while cassave is planted now and then. Sisal is exploitated extensively. This sisal is usually planted as a fence and along roads. On the lower parts along the lake there is a yearround cultivation of different subsistence crops. A wide variety of crops is grown in these "shamba's". Common crops are banana. pawpaw, sweet potatoes, sugar cane and vegetables as beans, cabbage. Sporadic crops are green grams, tobacco (Nicoliana rustica), cowpeas and citrus, while on the more sandy parts one finds groundnuts.

The keeping of cattle is of great social importance but has a low economic value, mostly serves as capital investment. The farmer is often more interested in the quantity than in the quality of his cattle that mostly consists of cows, bulls, oxen, goats and sheep. The quality of the grasslands is poor. Uptill now nothing has been done on improving the quality of both, cattle and grassland.

"Forestry"; near Kakrigu school on Rusinga-island is a small plantation (about 4 ha.) of Cassia for firewood. With respect to futural shortage of fire- and constructionwood is may be advisable to establish more of these plantations.

1.5. Soil salinity and alkalinity.

In the lower parts of the survey area many times saline and/or alkaline soils occur. The cause of this can be found in the weathering of the parent materials, through which different kinds of salts are formed. After weathering these released salts are diluted in the rainwater that has penetrated into the soil. This saltish water reaches through groundwater movement the lower plains near Lake Victoria. A part of it flows into the Lake but the bigger part of the groundwater is used by plants, leaving behind the salts. In this way salts accumulate there, causing salinity and/or alkalinity.

In Lake Victoria salts do not accumulate, but there will be a dynamic equilibrium: the amount of salts coming in yearly with groundwater and other contributaries (e.g. rivers) is leaving the Lake again yearly with the water streaming into the white Nile at Jinja.

With respect to the lower saline and/or alkaline plains near the the lake it is possible that there is some groundwater flow from the lake into the soil, which contributes to the salinity and the alkalinity of the soils too.

The actual situation is not fully knwon because only a few scattered soilsamples are taken for analysis of salt contents. Of the results it appears that in some parts of the area the salt contents remain the same throughout the profile (e.g.Mb5) and on other parts they increase with the depth of the profile (e.g. trial plot of Mbita-misseion). Mb5 is a calcareous clayloam to loam profile,while the trial plot consists of clayer montmorillonitic soils.

Futhermore it is clear that the amount of salts, present in the soil, differ strongly from place to place. In general it seems that the salt content in the surfacesoil is rather low to moderate, ECe smaller than 7 mmho, while it is moderate to moderately severe in the subsoil: ECe between 7 and IImmho. On Rusinga-island the contamination with salts seems lower in comparison with the mainland.

Also it appears that the composition of the salts in the surfacesoil is well comparible with the composition of the salts in the water of Lake Victoria. On the other hand the composition of the salts in the deeper subsoil fits well in with the composition of the salts in the groundwater.

To get a good idea of the presence of saline and/or alkaline soils and the seriousness of it more detailed research is necessary. Methods and ideas for improvement are dealt with in chapter 8.

PART II The soils

2. Survey methods and materials.

The area was selected with the aid of the geological map of the Gwasi area (1852) and the topographic map, sheet nr. II5/3 Rusinga.

The area is approximately 1000 ha. It was surveyed partly by 2 participants and partly by one.

The interpretation was done with airphotos and a Topcon stereoscope, the geological map of the Gwasi area and the topographical map. The I2 airphotos formed a strip of I0 km. length and 2 km. width. The scale was I:9000. The photos were obtained from the Survey of Kenya.

The procedure which was followed was:

First the physiographic airphoto-interpretation of small area, which was checked was next day in the field. This resulted in correction of the soil boundaries and drawing of new boundaries while some boundaries found by airphoto-interpretation showed to be irrelevant. This procedure was carried out daily. The most important elements used are relief, drainage, while vegetation was important for coastal areas.

Greytone and greytone-changes proved to be very usefull.

Fieldwork was carried out with auger and pit observations.

2.I. Augerobservations:

About 700 soil profile augerings were made to ad depth of, if possible, I.20m. by means of an Edelman-auger.

The following properties of the soil and the surroundings were observed at the augering place:

- depth of solum and thickness of the horizons
- soilcolour, this was measured by comparison with the Munsell soil colour charts
- texture
- stoniness of the profile
- presence of free carbonates tested by HCl (10%)
- depth groundwatertable if present
- surface stoniness and rockiness.
- slope form and slope gradient; (Abney level)
- parent material
- landuse and/or vegetation.

2.2. Pit observations.

In every soilseries an observation was made in a soilpit for a detailed description of the soilprofile. For this purpose about 20 pits were dug to a depth of 0.5-2.00 m. A detailed description was made of every pit according to the guidelines as given in the soil Survey Manual (1952) and the F.A.O. guidelines for soildescription.

At every pit-place the following properties of the soil and surrounding were observed:

- the properties mentioned under auger-observations
- soil structure
- presence of clayskins, slickensides or pressure skins
- biopores and rootdevelopment
- cracks
- consistency
- mottles and concretions
- width and topography of soil boundaries
- presence of salt
- presence of primary minerals.

2.3. Map compilation.

A detailed soil map on scale 1: 12.500 has been produced. Firstly base map was prepared using the Arundel method (graphical radial triangulation on a strip of 12 airphotos). The soilboundaries and other data drawn on the airphotos were transferred to the base map using the Vertical Sketch master of Keuffel and Essen.

A land suitability map is produced by using the soil map. Before that, a study has been made about the suitability of the different soilseries for gravity-irrigation.

3. Description of the soils.

3.1. Explanatory legend. See appendix.2

3.2. Series, types and phases.

3.2.1. Criterions and symbols for distinction of the series:

a Seriename

Each serie has a geographical name. The first two characters of the series-code have been derived from that name.

b Parentmaterial. The first character of the parent material is the third one of the seriescode.

N- Nephelinites

M- Miocene lakebeds.

c Groundwaterlevel

A new series has been distinguished when the groundwaterlevel is within 100 cm. throughout the year.

3.2.2. Criterions and symbols for distinction of the types and phases.

Type, this is the texture class of the first 18 cm.

A - silty clay and clay,more than 40%

B - medium texture, finer than sandy loam

C - coarser than sandy loam.

Phases

a - Soildepth, i.e. the penetrability of the soil with the auger.

4 = 0 - 20 cm. very shallow

3 = 20 - 50 cm. shallow

2 = 50 -100 cm. moerately deep

1 = 100 -150 cm. deep

0 = over 150 cm. very deep

b -Slope

A = 0 - 1% level

B = 1 - 3% nearly level

C = 3 - 5% very gently sloping

D = 5 -10% gently sloping

E = 10 -20% sloping

F = 20 -30% moderately steep

G = 30 -50% steep

c - Surface stoniness

S1 = 0 - 3%
S2 = 3 - 15%
S3 =15 - 90%
S4 =90 -100%

d-- Rockiness

R1 = 0 - 2%
R2 = 2 - 10%
R3 =10 - 25%
R4 =25 - 50%
R5 =50 - 90%
R6 =90 -100%

e - Erosion

	Intensity of gullies		
Depth of gullies	length/surface<0.2	0.2-0.4	>0.4
0 - 3 m.	E 1	E 1	E 1
3 - 6 m.	E 1	E 2	E 3
>6 m.	E 2	E 3	Gullied land(GL)

f - Salinity

This has been indicated on the map by a sign '+' slightly to moderately saline.

3.3. Series, complexes, miscellaneous and their setting.

3.3.1. Series.

ViN - Victoriaseries

This series occurs in the flat coastal plain of the Lake Victoria. It includes deep, moderately well drained to well drained dark grey-brown, calcareous, layered soils. The greater part of the profile is of a sandy to loam texture, with small clayey to clayloam layers. The A-horizon is black to very dark brown and mostly shallow. The stoniness class of this series is always 0.

KsN - Kasigunga series

The Kasigunga series is mainly found on straight gentle sloping pedimentslopes and in the level alluvial plains. Surface stoniness class is mostly 0, sometimes 1. It comprises deep, poorly drained, very dark greyish

brown montmorillonitic clay soils with a thin selfmulching surface-soil overlying a prismatic subsurfacesoil with slickensides and cracks deeper than 50 cm. (in dry season). The A-horizon is very d dark brown.

GeN - Gembeseries

This series occurs on gently pedimentslopes on spots where the rock is at a shallow depth or where erosion had removed the top-soil. The series includes moderately deep and deep (then light clayloam within 50 cm), strong prismatic, very dark grey-brown montmorillonitic clay usually with a selfmulching surface layer of a few centimeters. The series is imperfectly to moderately well drained.

MiN - Migumaseries.

The Migumaseries occurs on level gently sloping alluvial plains in slight depressions. It comprises deep cracking, strong prismatic, very dark grey - brown montmorillonitic clay, with a selfmulching surfacelayer of a few centimeters. In the B-horizon contious slickensides occur. The A-horizon is usually very dark brown. The series is imperfectly drained.

OkN - Okothseries.

The Okothseries is found in the slight depressions of the gently undulating alluvial plains. It includes calcareous, cracking, strong prismatic montmorillonitic clay, overlying calcareous, moderate subangular blocky light clayloam within 50 cm. of the surface. The profile is deep moderately welldrained and sometimes slightly stony.

ChN - Chamarungaseries.

The series occurs exclusively in the coastal area of Lake Victoria in very low positions (till 1m. above lake level).It consists of deep, moderately prismatic, very dark grey, montmorillonitic claysoils with grey mottles. The A-horizon is black. The series is poorly drained and might be moderately affected by salt or alkali. Stoniness class is always 0.

AnN - Andugoseries

This series occurs in gently undulating alluvial plains downwards of outlets of erosion-gullies.It comprises deep, calcareous dark gray-brown to brown moderately subangular blocky medium textured soils. The A-horizon is very dark gray and shallow. The series is well drained.The soils at a low position near Lake Victoria might be slightly to moderately affected by salt or alkali.

MbN- Mbitaseries

The Mbitaseries occurs on gently sloping to sloping convex hill-slope of nephelinites. It consists of moderately deep, dark gray-brown moderately medium angular blocky, medium textured soils. are usually gravelly to stony. The A-horizon is very dark gray-brown and shallow. The series is well drained.

KhN - Kiaheraseries

This series is found on eroded spots and edges of hills. The surface stoniness and rockiness of this series is very high. The series comprises shallow moderately subangular blocky, stony, dark gray-brown loamy soils with lithic contact within 20 cm. A-horizon is very dark gray-brown and thin. The series is well drained.

OnM - Onyangoseries

This series is exclusively found on a small patch on a level to gently sloping top of low hill, where a small outcrop of Miocene lakebeds occurs in between of nephelinite-agglomerates. It consists of moderately deep to deep, very weak subangular, calcareous, gray-brown silty clayloam overlying a petrocalcic horizon. The A-horizon is dark-gray-brown and shallow. The stoniness class is 0 or 1. The series is well drained.

OlN - Oleleseries

This Oleleseries occurs exclusively on a limited spot on the flat top of a convex nephelinite hill.It consists of a deep to moderately deep, strong medium angular, stony, darkbrown clay to clayloam soil with patchy claycutans in the B-horizon. This series is well drained.

RuM - Rusingaseries

The series is mainly found on gently sloping convex hills of Miocene lakebeds.

It consists of moderately deep, weak medium subangular blocky calcareous gravelly, brown to reddish brown loam. Surface stoniness class is never 0, usually 1 or 2. The A-horizon is dark brown and shallow. The series is well drained. The underlying rotten rock is usually soft.

KiM - Kiangataseries

The Kiangataseries occurs on gently sloping to sloping strongly dissected pedimentslopes.

It consists of moderately deep, weak subangular blocky, calcareous, gravelly gray-brown to brown clay loam to loam soils. The A-horizon is usually dark brown and shallow. The underlying rotten rock is usually soft.

The surface of the soils is generally covered with small gravel and exposed to sheet-erosion.

LeM- Leakyseries

This series is found on excessively drained positions on edges of convex hills and on sloping convex hills of Miocene Lakebeds with noncalcareous parentmaterial.

It includes moderately deep to deep, weak subangular blocky, noncalcareous, gravelly, gray-brown to brown, medium textured soils. The A-horizon is dark brown and thin. The surface soil is exposed to sheet-erosion and often covered with many small gravel.

The series is well drained.

OgM - Ogosaseries

This series is found in the alluvial plain on a very gently sloping position near the outflows of gullies.

It includes deep, weak, medium subangular blocky, calcarous, layered soils with intermittent layers of sandy loam, clayloam and loamy sand. In the coarser layers rounded gravel can be observed. The A-horizon is brown and shallow. The series is well to somewhat excessively drained.

KaM - Kakriguseries

The Kakriguseries occurs on very gently to gently sloping concave slope in alluvial area.

It consists of deep, strong angular blocky to prismatic, calcareous dark grey-brown montmorillonitic clay soils. Often a comparable second profile can be distinguished below the above mentioned.

The depth of the top of the A-horizon varies from 80 cm. to 1.50 m. below the surface. The A-horizon of the upper profile is dark greyish brown and shallow. The surface stoniness class is 0.

The series is imperfectly drained. The soils in lower positions might be slightly affected by salinity.

NyM - Nyamugaseries

This series is mainly found in the transitionzone from the alluvial areas to the hilly area, and on spots where the rock comes near the surface. It occurs in concave, very gently sloping positions. The Nyamugaseries consists of deep to moderately deep, strong medium angular blocky, calcareous gravelly, dark grayish brown to dark brown montmorillonitic clay. The A.horizon is very dark grayish brown and moderately thick (20 - 50 cm.).The series is moderately to imperfectly drained.

3.3.2. Complexes.

Coastal complexes.

a.It occurs from from lakelevel to 3-4 meters above it. Especially very near the lake the soils have a high groundwater level (150 m) throughout the year.
The soils which are found here, are from the Victoria or Chamarunga-series.The somewhat higher situated parts are covered with the Kakriguseries and the Nyamugaseries, of which the latter occur more frequently near sloping parts.
b.Around Mbita-point:
The coastal strip is very narrow here and usually bounded by steep slopes.Because of strong windinfluence on this point causing a rather turbulent sedimentation environment the major part of the plain is covered with the more sandy soils of Victoriaseries.On more quiet places due to a reedvegetation where small gullies have carried finer sediments to the plain the finetextures Chamarungaseries are found.
Usually the groundwaterlevel is within 150 cm. of the surface.

Complexes on nephelinite agglomerate.

a.Slope complexes.
This complex is found on the remnant hills, which outcrop on some places on the pedimentslope of the Gembe hill. On the steep slopes the very shallow Kiaheraseries are found; they are usually very resistant, and with a lot of rockoutcrops covering 10 - 50% of the surface.Between rockoutcrops on the gently sloping top and in pockets the moderately deep Gembe-series is found, while on slightly eroded places the shallow Mbitaseries occurs. Both have a high surface stoniness.

b. Eroded pediment.

This occurs on the lower parts of the pediments of the Gembe hill, where a lot of erosion gullies occur. The relatively untouched positions (rembants of the gently sloping pedimentslope)are occupied by deep soils of the Kasigungaseries.

On the slightly eroded soils towards the gullies the moderately deep Gembeseries is found, while on the strongly eroded sites the shallow Mbitaseries is located. Sedimentation in the gullies takes place especially near the transitionzone towards the alluvial fans. It starts some hundreds of meters from the boundary between alluvial fan and pediment. On the valley bottom usually deep to moderately deep soils of the Kasiguraseries are found on a gentle slope.

Complexes on Miocene lakebeds.

a.Alluvial plain complexes.

A large part of the alluvial fans of Rusinga-island is covered with this complex. The uniformity of the complex is small due to different sedimentation. In the subsurface, soil textures in the horizontal plain range from heavy clay to coarse sandy loam.

The major part of this gently sloping complex consists of deep soils of the Kakriguseries. On the transitions towards the pediments but especially on places where the subsurface soil is light clay loam or coarser (even stony layers may occur) the deep to moderately deep Nyamugaseries.occurs.

b.Transitionzone pediment-alluvial plain.

This consists of a undulating area with a medium intensity of moderately deep (3-6m) gullies.

The pedimentparts which cover a large part of this complex have soils of the Kiangataseries. They have shallow profiles on a gentle slope. The surface is usually covered with a high amount of small stones, due to sheet-erosion. The lower part of the slightly concave gently sloping gullyslopes are occupied by shallow soils of the Nyamugaseries, which are gradually grading into the deep soils of the Kakriguseries which are found on the bottom.

The latter two are the results of sedimentationprocesses of colluvial/alluvial origin. Surfaces stoniness of these two are low (S1).

Complexes on materials of mixed origin.

a. Lulonge complex.

The highest part of this hill is covered with nephelinite agglomerates. This has resulted in shallow soils of the Gembeseries, which are found near the top and somewhat lower down the slope in pockets, usually on sloping land with moderately high surface stoniness (S3). The major part of the hill, however, is built up from Miocene lakebeds, which have resulted in shallow to very shallow soils on sloping to very steep positions with many rockoutcrops. The shallow soils are from the Kiangataseries and the very shallow ones from the Kiaheraseries. Surfacestoniness is high (S3).

b. Alluvial/colluvial plain near Mbita.

This gently sloping plain is mainly consisting of materials from Miocene lakebeds which are partly overwashed by eroded material from nephelinite origin.

It has resulted in shallow soils of the Rusingaseries on positions where no or few overwashing has taken place. Where the colluvial layer is thin the Okothseries occurs with shallow soils. Where thickness of the colluvial layer consisting of fine textured materials exceeds 50 cm. the Migumaseries is found with moderately deep soils on slightly concave gentle slope.

3.3.3. Miscellaneous.

MR - Miscellaneous of rock.

Some hilly parts are found with more than 90% outcrops of nephelinites on Miocene lakebeds. They occur both on steep slopes and on relatively flat hilltops.

MRS - Miscellaneous of rocks and stones.

Occurs on the same position as MR. 90% of the surface is covered by rocks and stones.

GLM - Gullied land on Miocene lakebeds.

Occurs on the straight sloping pedimentslopes. The greater part of land is occupied by deep gullies (6 m.)

Part III. Interpretation of the survey data

4. Land utilisation, actual and proposed.

4.1. Actual land utilisation types.

The land utilisation type of the Mbita area is mixed farming: grazing and cultivation of subsistence crops, which are party sold.

Key attributes to characterise the land utilisation type are:

a Nature of produce (4.1.1)
b Land tenure system(4.1.2)
c Size of the farms (4.1.3)
d Labour intensity (4.1.4)
e Level of technical know-how (4.1.5)
f Farmpower (4.1.6)
g Capital intensity (4.1.7)

4.1.1. Nature of produce.

(Subsistence) crops.

These are listed consecutively their importance:

a maize, mainly local varieties
b sorghum
c cassave
d bananas
e cabbage and other vegetables
f paw-paw
g beans
h sweet potatoes
i sugarcane
j groundnuts

Besides there is an extensive exploitation of the sisal sisal which is planted in strips along roads or as a fence around the cultivated fields.

a Maize.

This is the main staple food. Sometimes it is also used for trading. The seed is usually of local origin. Each year a part of the crop is kept back. The use of hybrid maize is limited problably because the price of the seed. It seems that the amount of hybrid maize seeds is increasing year by year.

Landpreparation starts in March and continues till after the onset of the rains. Due to the unreliability of the rains the planting date varies from year to year, but it is usually done after the onset of the rains (among others because landpreparation is not yet ready). The late plating is one of the reasons of crop failure, because the rainy season is sometimes rather short. Another reason is the occasional occurence of heavy rains causing floods, erosion and sedimentation. Approximately in one out four years the crop fails. Weeding is done 2- 4 times and is especially important when the crop is young. Wild vegetables are saved and left in between the maize. The weeding is done with the jembe. When the crop is mature (june - july)the cobs are taken and brought into a store. The stems with leaves are left on the field and serve as food for the cattle.

Because of the relative high fertility of the soils, the use of fertilizers may not be very necessary. Only availability of nitrogen and sulfates are the main nutricients that are limited, but only a few N and/or S fertilizers are applied, probably because of the high price.

The main factors of yield depressions are:

occasional - insufficient water availability
damage done by heavy rains (hailstorms)

permanent - occurence of Striga spp.
damage done by cattle
deficiency of nutricients
stalkboarers. (other deseases and pests)

On some place cattle is concentrated for some time on a small plot surrounded by hedges of thorny branches. In this way a certain concentration of cowdung is obtained in the wet season this part is used for growing maize. Generally application of cowdung is rare.

b <u>Sorghum.</u>

This is another important staple food in this area and it is used for trading on the local market. The planted area is approximately equal to that of maize. It is rather drought resistant. In year when maize fails due to drought sorghum may survive. It is more resistant to waterlogging than other cereals (apart from rice) and yields reasonably well on infertile soils. In years with sufficient rain after harvesting, sorghum can be ratooned and give a second crop.

Still maize has become relatively important in this area because it yields more, tastes better and because a lot of damage is done by birds to sorghum.

c Cassave.

This is the most important rootcrop in this area. It is found on sandy to loamy soils on somewhat higher spots near the coast. It is very drought resistant and can grow in areas with an unreliable rainfall. On infertile soils it can still give a good yield. It is planted as a stem cutting. It requires little labour and can serve as a famine reserve. Disadvantage of cassave is the low nutritive value.

h Sweet potatoes.

Next to cassave this is another rootcrop. It is also drought resistant but it requires a more regularly distributed rain as cassave does. Because of the latter, sweet potatoes are planted on small mounds in small area only. Soil and growing conditions are the same as for cassave.

d Bananas.

These are grown very near the lake. Both plantains and sweet bananas occur. They are locally consumed. A part of it is sold on the local market.

e Cabbage, paw-paw, sugarcane, beans and groundnuts.

These occur in the shambas near the lake together with one or more of the following crops: sweet potatoes, cassave and with each other. All these crops are subsistence crops, but they are also parlty sold on the local market.

The shambas are usually well-fenced with thonny branches and often a small house is built for a watchman, who has to take care that the shamba is not entered by hippos. Which crops are grown depends on the soil and the interest of the farmer. Usually the more coaser textured soils carry crops like sweet potatoes, cassave or grounnuts, while on fine textured soils one can observe paw-paw, sugarcane and cabbage.

The shambas are permenantely cultivated. In the waterrequirements is forseen partly by rainwater, partly from groundwater, while a minor part is irrigationwater, which is carried from the lake to the shambas with buckets.

The shambas are very important, because they deliver a lot of highly nutritive ingredients which diversify the meals of the people of this area.

Animal husbandry.

An important factor in raising cattle is capital-investment. Not much attention is paid to the quality of the cattle and the "grassland". The animals which are kept are: cows, bulls, oxen, sheeps, goats and chicken.

The cattle is of local bred and is roaming around through an extensive area, using all possible food. The quality of the grasses is poor and the quantity of food is limited in the dry season. This is one of the reasons why the ploughing is done when the rains have already started, because first the oxen have to get stronger, by means of the grass that started growing with the first rains. The returns of animal husbandry are low: some meatproduction (in Mbita once a week a cow or ox is slaughtered) and hardly any milk production. If there is, it is mostly used for home use, only a few litres are sold. Milk is kept by making it become sour. For that purpose it is contaminated with certain micro-organisms.

4.1.2. landtenure.

The land is owned by clans. The "grasslands"(in fact grazing area)are communal lands.

4.1.3. Size of the farm.

Within the area of a clan some scattered parts are cultivated each year. Usually each year a new clearing is made while another part is left because it is exhausted. Most parts are used for a rather long time; the cultivationtime is increasing due to increasing population. No accurate data are available on the farmsize. For one family the size of the semi-permanent cultivated part is between 5 - 10 acres, while the size of the shambas near the lake range from 1 - 3 acres, but usually they are small.

4.1.4. Labour intensity.

This is usually low. Most labour is done in the wet season. Most farmers do not need to attract labour from outside the farm. The work is done by men (clearing, ploughing), wife/wives(digging, planting, weeding,harvesting) and children (planting, weeding birdwatching). Herding of cattle is usually done by children or men. Sometimes foreign labour is attracted for this purpose.

4.1.5. Level of technical know-how.

This is very low. Preparation is done by hand by means of a jembe, or an oxplough.Usually local maize is used and no fertilizers or herbicides are applicated. Even application of cowdung is rare.

4.1.6. Capital intensity.

This is also very low. The non-recurring input requirements of development costs are limited to hand-tools and a plough while recurring production costs are only for own seedproduction and family labour.

4.1.7. Farmpower

Most work is done by manpower.Oxploughing becomes more and more important. Very rarely (in fact only once) mechanical power is seen (tractorploughing).

4.2. Relevant landqualities.

For the establishment of gravity-irrigation system a number of landqualities is selected, which are important for the use possibilities of land under this system. They concern chemical physical and environmental properties of the land. The land qualities are:

4.2.1. Major landqualities related with requirements of plantgrowth under gravity irrigation. These are:

a. Availability of water (waterholding capacity)
b. Availability of nutrients
c. Availability of oxygen for rootgrowth
d. Availability of foothold
e. Possibilities of infiltaration

4.2.2. Major landqualities related with requirements for management practises. These are:

a. Resistence against erosion.
b. Freedom of farm-layout.
c. Possibilities of tillage.

Furthermore there are some landqualities which are not strongly related to the distinguished series, but which are rather uniform for the area as a whole, or which are depending on the position in the field.

4.2.3. Non-rated landqualities. These are:

a. Availability of irrigationwater.
b. Flooding hazard.
c. Wind and storms as affecting plantgrowth and evapotranspiration.
d. Salinization and/or alkalinization at present and in future.

It should be noted that the availability of irrigation water is of decisive importance.

4.3. Rating and specification of the relevant landqualities.

Each landquality depends on certain properties of the land, concerning chemical, physical and enviromental characteristics. These landquality-factors can be determined quantitively resulting in the rating of the landquality. For a good rating a lot of laboratory-data are needed, especially those concerning the physical and chemical properties of soil. Because only few of these data are available this rating is more qualitative.

The following grades of rating are distinguished:

a. Very high grade of availability/absence of risks/possibilities.
b. High grade of availability/absence of risks/possibilities.
c. Medium grade of availability/absence of risks/possibilities.
d. Low grade of availability/absence of risks/possibilities.
e. Very low grade of availability/absence of risks/possibilities.

4.4. Landquality-factors and rating of the distinguished land-qualities.

4.4.1. Availability of water

Depending on:
- texture
- amount of organic matter
- depth of solum
- evapotranspiration
- susceptibility of sealing
- sttepness of the slope.

Not all these factors have to be taken into account, as evapotranspiration is more dependant on the crop and the position of the land in the area, while the amount of organic matter greatly depends on the depth of the solum and the texture. So the following factors have been rated; texture, depth of solum, susceptibility of sealing, thickness of montmorillonitic clay and the steepness of slope.

Rating availability of water:

a. Very high grade
- depth of solum over 120 cm.
- medium textured and less than 20 cm. of montmorillonitic clay on top of profile
- no sealing
- slope 0 - 5%

b. High grade
- depth of solum between 50 and 120 cm.
- fine textured
- no sealing
- slope 0 - 5%

c. Medium grade
- depth of solum between 50 and 120 cm.
- medium textured.
- no sealing
- slope between 5 - 10%

d. Low grade
- depth of solum less than 50 cm.
- sandy textures
- slightly sealing
- slopes steeper than 10%

e. Very low grade
- depth of solum less than 50 cm.
- sandy textures
- slightly sealing
- slopes steeper than 10%

4.4.2. Availability of nutrients.

Depending on - organic matter content
- CEC and basesaturation
- amount of weatherable minerals.

In this area with low rainfull and consequently reduced leaching montmorillonitic and illitic clay is formed giving rise to soils with a high exchange capacity, well saturated with calcium. Organic matter levels are usually rather low, because of the reduced addition of organic matter from the vegetation, pH of the top soil is usually slightly alkaline. Phosphate levels are fairly good in the soils. Because only few laboratory results are available (Appendix 3) the factors for rating are depth of solum (presence of weatherable minerals), and clay content (measure for CEC) and thickness of A-horizon (measure for organic matter content).

Rating availability of nutrients:

a. Very high grade
- depth of solum 50 cm.
- dark topsoil 25 cm.
- clay content over 40%

b. High grade
- depth of solum 50 - 120 cm.
- dark top-soil 25 cm.
- clay content over 40%

c. Medium grade
- depth of solum 50 - 120 cm.
- dark topsoil 25 cm.
- clay content 10 - 40%

d. Low grade
- depth of solum 120 cm.
- thickness of dark topsoil 25 cm.
- clay content 10 - 40%

e. Very low grade
- depth of solum 120 cm.
- no dark topsoil
- clay content 10%

4.4.3. Availability of oxygen for rootgrowth.

Depending on - depth of badly permeable layer or nephelinite rock
- permeability (depending on texture of the soil).

Rating of availability of oxygen:

a. Very high grade - no badly permeable layer or rock
- texture<40% clay

b. High grade - badly permeable layer or rock within 120 cm.
- texture<40% clay

c. Medium grade - badly permeable layer or rock between 50 - 120 cm.
- texture>40% clay

d. Low grade - badly permeable layer or rock between 50 - 25 cm.
- texture>40%

e. Very low grade - badly permeable layer or rock within 25 cm.
- texture>40%

4.4.4. Availability of footthold.

This depends mainly on - depth of solum
- hardness of rock.

Two types of rocks can be distinguished in the survey area namely nephelinites, which cannot easily be penetrated by roots and Miocene lakebeds, which are rather easy penetrated.

Rating availability of foothold:

a. Very high grade - depth of solum over 100 cm.
- Miocene lakebeds/nephelinites

b. High grade - depth of solum between 50 and 100 cm.
- Miocene lakebeds.

c. Medium grade - depth of solum between 20 - 50 cm.
- nephelinites

d. Low grade - depth of solum within 20 cm.
- Miocene lakebeds

e. Very low grade - depth of solum within 20 cm.
- nephelinites.

4.4.5. Possibilities of infiltration.

Depending on - slope
- sealing
- texture of surface soil.

Because of lack of infiltration measurements in the field for the different series the factors used for rating is the texture. The cracking montmorillonitic clays will have a fast infiltration at the beginning but as soon as the cracks are closed it will be reduced to nearly zero and the major part of the water will run over the surface.

Rating of the possibilities of infiltration:

a. Very high grade - slope 0 - 1%
- no sealing
- textures coarser than heavy clayloam

b. High grade - slopes 1 - 3%
- no sealing
- textures coarser than heavy clayloam

c. Medium grade - slopes 3 - 5%
- slightly sealing
- textures finer than 35% clay

d. Low grade - slopes 5 - 10%
- slightly sealing
- textures finer than 35% clay

e. Very low grade - slopes 10%
- slightly to moderately sealing
- textures finer than 35%

4.4.6. Resistance against water erosion.

This depends on - steepness and length of slope
- dissection
- surface sealing,

this on its turn depends gratly on the texture of the surface soil and organic matter content.

Length and steepness of the slope are important factors, as they greatly affect the amount of surface runoff. An distinction need to be made between slopes with and slopes without gullies.

Rating of the resistance against water erosion:

a. Very high grade - slopes 0 - 5%; dissected; no sealing
b. High grade - slopes 5 -10%; dissected; no sealing
c. Medium grade - slopes 10 - 30%; non-dissected;
- slightly sealing
d. Low grade - slopes 30 - 50%; non-dissected;
- slightly sealing
e. Very low grade - slopes over 50%; non-dissected;
- slightly to moderately sealing.

4.4.7. Freedom of farm layout.

Depending on - number and depth of gullies; slope and affecting irrigation system; micro-relief; rockiness of the surface; extent of the series.

The farmsize might be restricted because of a high intensity of gullies, especially when these are deep. These gullies also influence the accessibility of the farm. The choice of a suitable gravity irrigation system depends partly on the slope. On steeper slopes a furrow irrigation-scheme is more suitable, while bith furrow and border irrigation may occur in gently sloping positions. Series covering only a small area are less suitable.

Rating of freedom of farmlayout:

a. Very high grade - non-dissected; slope 0 - 1%; smooth surface; no rockoutcrops

b. High grade - few, shallow gullies; slope 1 - 5%; few low undulations; no rockoutcrops

c. Medium grade - less than 20% deeply gullied land; slopes 5 - 10%; few low undulations less than 25% rockoutcrops;

d. Low grade - 20 - 50% deeply gullied land; slope 10 - 20%; common undulations;
- rocks covering 25 - 50% of the surface

e. Very low grade - more than 50% deeply gullied land; slope over 20%; undulating; rocks covering more than 50% of the surface.

4.4.8. Possibilities of tillage.

These depend on - stoniness (% and size of gravel and stones); compactness of the surface layer.

The compactness of the surface layer depends on the texture organic matter content, porosity and rooting intensity of the vegetation. As texture is the main factor, this is used for rating. Another important factor is the presence or absence of a selfmulching montmorillonitic clay soils.

Rating of the possibilities of tillage:

a. Very high grade - 3% stones or gravel; texture coarser than 40%; selfmulching layer;

b. High grade - 3 - 15% stoniness; texture finer than 40%; selfmulching layer

c. Medium grade - 15 - 90% stoniness; texture finer than 40%; selfmulching layer

d. Low grade - 90% stoniness, stones and gravel;
- texture finer than 40%; no selfmulching layer

e. Very low grade- 90% stoniness; texture finer than 40%;
- no selfmulching layer

4.5. Other landqualities which have not been rated.

4.5.I. Availability of irrigationwater.

This is depending on - distance from the source (lake Victoria); height above the source (lake); possibilities of development of a waterconveyance system; possibilities of water storage.

The costs of water will increase with increasing distance of the lake and increasing height above the lakelevel. Especially when the water has to be pumped up to some height, the costs will greatly increase.
On the priciple of costs of a m^3 of water one can say that the costs of bringing I m^3 to a height of 1 m. equals the costs for 1 m^3 at a horizontal distance of I00 m. (for a long-term project of I0 - 20 year), with high non-recurring development costs - mill, pipelines, storage capacity etc.-- and low running costs).
Another factor which has to be taken into account is the fact that pipelines or ditches may have to pass over land of different owners. To avoid difficulties it will be necessary to consolidate the land. Another problem is the crossing of roads and gullies, while also attention should be paid to the damage done to open channels by cattle,while the ditches also may be a source of accelerated erosion. From these points of view but also because of waterlosses by evaporation and to the subsoil it seems wise to use pipes. Storage can be created in gullies or slight depressions.

The lowlying valleys show the best opportunities, especially when the land is owned by only one clan and where the land is not divided by roads and no or where a high intensity gullies are present.

4.5.2. Flooding hazard.

As the area has a subhumid climate with a pronounced dry season and occassionally heavy rains, large floods may occur causing a lot of damage.

Slopes will become eroded, while a big load of sediments is brought into the lowlying valleys, which may be flooded for some time. Roads can be eroded causing stagnation of the transport. All these points should be taken into account before establishing a scheme and counter measures should be taken to avoid flooding. (See paragraph 4.8)

As the flooding hazard is not strongly bound to the mapping units, no rating is made for this landquality. Generally it can be said tha all lowlying valleys are susceptible for flooding, as well as the coastal plain.

4.5.3. Winds and storms affecting plantgrowth.

Winds and storms are not constant throughout the area. Some parts of the area are sheltered by hills and vegetation.

Winds and storms have two effectsviz:

Firstly they cause damage to the crops by blowing them down. Susceptible are especially maize, sunflower, bananas and sorghum.

Secondly the wind has a strong influence on the evapotranspiration. Protected positions may have a potential evaporation which is I.5-2 mm/day less than spots which are exposed to the wind. The establishing of wind-breaks is advised for every major plot.

4.5.4. Salinity and/or sodication.

This factor is not especially bound to a certain series however salinity is found in nearly all the soils of the Victoria- and Chamarunga series and in some soils of the Okoth-, Andugo-, Miguna-, Kasigunga-, Kakrigu- and Myamuga series which are found near the Lake.

Severe sodic soils are found exclusively on a few isolated lowlying spots in the coastal plain usually consiting of the Victoriaseries. Usually the saline soils are only very slightly or not sodic.

Salinity and/or alkalinity depends on the depth of the groundwaterlevel and partly on the texture of the soil, as finer textured soils have a higher capillairy rise than coarse-textured soils, while on the other hand the permeability of coarse-textured soils is higher, so that salt is more easily washed down by rainwater.
This factors are also important for salinization hazard under irrigation and the possibilities of salt leaching (see 4.8. improvements). Without improvements the crops should be adapted to the present day salinity as represented by the ECe (millimhos/cm)
Relative salt tolerance of crops to salt.

High	Medium	Low
ECe x 10^3= 16')	ECe x 10^3=10')	ECe x 10^3= 4')
Cotton	Tomato	Maize
	Sorghum	Beans
	Cabbage	Groundnuts
	Sunflower	
	ECe x 10^3= 6'	

I) The numbers following ECe x 10^3 are the electrical conductivity values of the Saturation extract in millimhos per cm. at 25°C associated with 50% decrease of yield.

4.6. Proposed land utilisation alternatives.

In the basic assumption that economic and social structures does not alter much in the futural decades, the following assumptions are made to determine the structure of the proposed land utilisation types.

- employment has to be maintained and extended and a reasonable income must be possible.
- the farmer will not give up growing subsistence crops.
- the farmer will not give up cattle keeping.
- the demand for certain agricultural products may change in the future.

To meet these assumptions the overall structure of the proposed land utilisation type will be: mixed farming, using irrigation, with subsistence crops, cash crops and cattle keeping.

Here in the intensitivity of agriculture will be distinguished, so that finally two land utilisation types are considered:

1. extensive mixed farming using irrigation with:
   - subsistence crops
   - cash crops (low intensive level)
   - cattle keeping.
2. intensive mixed farming using irrigation with:
   - subsistence crops
   - cash crops (high intensive level)

The difference between them is the rate of intensity with which the different kinds of crops has to be looked after. This may be labour intensity (e.g.seedbed preparation, frequent weeding)or capital intensity (e.g. fertilizer, pesticides, special tools) or both.

Subsistence crops will be the same in both types and thus with the same intensity rate. So the difference between the two types is mainly found in the differences of the cash crops.In this report a rating is done to the suitability of the soilseries for growing subsistence crops, low intensity cash crops and high intensity cash crops under irrigation.If not suited for one these uses it is mentioned what is the best to do on this series.

4.6.1. Key attributes for both utilisation types.

The most important factors to characterise the proposed utilisation types are:
- produce
- landtenure
- size of farm
- farm management and labour intensity
- capital intensity
- level of technical know-how
- farmpower.

These will be discussed below.

Produce. (see also appendix 6),

Products of the area will be:

1. staple food (e.g. maize, cassave)
2. vegetables (e.g. cabbage, beans, bananas)
3. cash crops (e.g. cotton, sunflower)

Crops of the first and second group are both subsistence crops and cash crops.

In comparison with the actual situation, improvements of yield can be reached by more intensively weeding. Especially the control of Striga Spp (Kayongo) in crops of Gramineae as maize, sorghum and sugarcane is very important. Striga germinates on the roots of Gramineae, using these roots as a basisi for food. So in this way it diminishes the yield of the crop very much. To get a lasting success in the control of this weed it is necessary to remove these weeds before they set seeds, year after year. The seeds remain viable for about 5 - IO year. So after this period of a good control of them one may aspect that the amount of the crop will rise. If the farmer allows a fall after some years of tillage, he should also remove this "Kayongo" in the temporarely abondoned field.
Even a more direct improvement is reached by restricting birddamage This may be done by chasing them away continuously when the crops start setting fruits. A usefull method amy be: tying debbes together with long ropes and then pulling on them, or throwing soil. All of these measurements are very labourous.
The prevention of damage due to insects will improve the yield of the crops too. The main insects in subsistence crops are stalkboarrs (in Gramineae), lice (in vegetables) and storage insects. Adequate measurements are possible. Applying in time of the different treatments to the crop as weedcontrol, water- and fertilizer-supply is also necessary to avoid yield depressions. Especially in the "learning" phase it will be difficult to have a good insight into the stages to apply the right treatments. Therefore yield will raise more after getting more experience.
The improvements for crop husbandry as mentioned above is not conclusive. Attention has to be given to other pests and diseases too.
Up till now the cashcrops consisted mainly of the part of the subsistence crops, not necessary for own consumption. For these and other crops as cotton, sisal, groundnuts, vegetables a.s.o. ther is already a certain market. For other crops as oil-seeds and a considerably raised production of vegetables possibilities to sell them have to be found. One may think of delivery to the National Board of Maize and Products, delivery to markets in big towns or to factories for conserving (canning, oil substracting). It is advisable to make contracts for delivery before introducing new crops on a large scale.

With respect to the agricultural production it is necessary to take into account a long time lag to reach a reasonable production, because time is necessary to introduce and adapt new systems of farmmanagement (e.g. irrigation, pests and disease control) and new crops. Nothing is still known of the specific problems in this area with the newly introduced methods and crops. It can be stated that with respect to the farmmanagement it is advisable not to have crops on the field during the months of January and February to prevent losses by heavy storms, (see further: farmmanagement). Cattle keeping will be necessary to provide farmpower, milk and meat. If necessary production of these can be raised by paying more attention to the conditions of cattle keeping and also bearing in mind that a small cattle of well fed cows is a better capital investment than a big cattle of meagre animals. Further improvements in foddering may be reached by interplanting crops with fodder/crops. After harvesting the main crops the fodder crops remain on the field to be eaten by the cattle. This interplanting may be done some weeks after germination of the main crop. Suitable for this purpose may be:
Puerari spp, Esmodium spp, centrosema spp, but also grasses that can withstand some shade.

Farmtenure.

In this area the quality of the soils differs very much, while the soils suitable for crop growing are scattered throughout the area. To avoid difficulties, which will come by dividing up the land and giving one farmer a part well-suited for crop growing and another farmer only a poor part, it is better to consolidate the land first. After that the needed improvementworks are to be carried out and at last the irrigation-works can be carried out.

Farmsize.

The farmsize mainly depends upon the yields needed by the farmer and also by the rate of intensity with which is worked on the farm. Afarm with a poor soil must be larger than one with a rich soil to give the same yields. And because of the great differences in soilquality it is impossible to give guidelines for the farm sizes. More research has to be done to the actual productivity and the possibilities of the soils in this area.

Farmmanagement and labour intensity. (See also Appendix 6).
Much of what is said in the previous part also deals with farmmanagent. Using irrigation it is possible to reach two crops a year, but then it is necessary for the farmer to work according a more accurate planting sceme. A base of such a sceme may be: 1st crop: land preparation and sowing before the onset of the rains, so that harvesting can find place in the months of June or July. In the meantime suitable control of weeds, pests and diseases has to be done in the right time and eventually additional irrigation has to be applied.
2nd crop: land preparation to be done in July or August. After that sowing and looking after crops so that harvesting is done in November or December, before the storms in January or February may crash the plants. For crops with remarkable longer growing period (e.g. cassave, sugarcane, sweet potatoes) adaptions are necessary.
The amount of labour inputs depends mainly on the choice of the crops and also on the workability of the land. The farm lay out, especially the length of the fields has its influence on the time to spend on irrigation.
If the farmer is not able or he does not like so, to have a high labour intensity (e.g. members of family, paid labourers), his choice of crops will be restricted to those, that do not need much labour. Of course the choice of crops should be such that the yields will cover labour (and other) costs. Skilled labour will increase the yields and reduce the working time. On the other hand skilled labour is more expensive.
Capital Intensity. Much of the improvements which were mentioned in previous parts, need some rate of capital investment.
Capital is necessary directly or indirectly for:
1 permanent investments: a) - soil concervation and erosion control
- drainage
- establishment of irrigation works
b) - sheds and stores
- machine (plough, wagon for transport
- traction (strong oxen, donkeys, tractor).

- small/tools
- windbreaks.

2 direct yielding investments

- improved seeds
- improvement of grassland
- manure and fertilizer
- materials for control of pests and diseases
- landpreparation
- skilled labour.

In this list only the most importnat investments are mentioned. For the development of the whole area or a valley it will be necessary that a newly found authority or cooperation bears the main permanents investments as mentioned under 1a. Other investments (1 b and 2) may be done by the farmers or family clan. Of course the investments have to supplement each other. The rate in which capital investments are necessary depends mainly on the choise of crops and the yields to get out of it. Especially in the beginning it is not advisable to spend much money in investments. It is better to find out first with small trials what will be the optimal capital intensity to reach a reasobable yield. Also the effect windbreaks to reduce the water use of plants has to be measured. These windbreaks may be made of sugarcane, pigeonpea (cajanus cajan), shrubs or trees of which the products are also usefull.

Level of technical know-how.

All improvements become only effective under good farmmanagement This requires a reasonable level of technical know-how. For instance applying fertilizer in the wrong time or killing stalkboarers after they have attacked maize and sorghum plants is useless. The level should be raised by training the farmers in farming with irrigation. Also getting experience in using new methods and materials is of utmost importance for the farmers. For this purpose the farmers should be supported by experts giving them advise and leading nucleus farms. After a well established irrigation sytem also experts are necessary for the maintanace of the irrigationworks.

Farmpower.

To provide sufficient farmpower it is necessary to keep the oxen for traction well fed. To improve their forces it may be usefull to cross local cow with big strong races. This will give stronger oxen, provided the husbandry is goos. Also donkeys may be used for traction and trasport.

On the longer term it may be advisable to establish some specialized serices to do the heavy work. These services have to be paid by the farmers for work that is done. This may give a more effective use of the available farmpower.

4.7. General outline for institutional provisions.

Before starting project is advised to establish a good organisation to provide a good running of the project. In the Mbita-area the land is owned by different clans. These clans will have to work together and for that purpose good arrangements will have to be made.

These provisions include.

a. Consolidation of the land of the different clans.

b. Organisation of a cooperation of the landowners, which will prepare, execute, manage and control the investments (pipelines, windmills, waterreservoirs, drainageditches etc.)
   A fixed/price of the irrigationwater will have to be settled, which is not dependant on the distance from the lake. This will require a control of the delivered water to each farm.

c. Organisations concerning transfer of knowledge to the farmers. This includes the establishment of a nucleusfarm, which can, serve as an example, but which has a second purpose namely trialstation.
   Another aspect of the information is how to establish an irrigationplot, when application is necessary and how much water is required.

d. Organisations for disposal of "inputs", (credit organisations, purchase organisations).

e. Organisations for selling or processing the product;(sales organisations).

For the establishment of all these organisations it will be necessary that the government supplies both experts and the capital at start with. The experts should only have an advising and an instructing task.It should be pursued that the project becomes independant after some years.

4.8. Environments.

Futher improvements are needed to reach the highest possible landquality. These are:

4.8.1. Environmental improvements.

Forestation of the upper pediment slopes and hill slopes from this area resulting in better infiltration of the soils under these forests so that with heavy rains the surface runoff is limited and the water comes available more gradual. Drainage of the area: improvement is needed to prevent flooding of the lower parts.
The gullies coming from the pediment will have to be extended to the lake or measurements will have to be taken to reduce the speed of the water in the gullies by construction of walls in the gullies.
Futhermore an area-drainage system is needed to discharge the excess of irrigation water.
Trafficability of the area will have to be improved by roadconstruction works. Good roads are necessary for the transport of materials needed for the irrigation and crop-growing into the area and the transport of the cashcrops from the area.

4.8.2. Landimprovement.

The following improvements are considered:
-Artificial drainage, this is needed for the removal of the excess irrigation water that is used for the leaching of the salts from the soil at the beginning of the cropping and the excess water given during cropping to prevent salinization.
The level of drainage is depending on:
- texture of the soil
- hydraulic conductivity of substratum
- depth of groundwater.
For very low lying soils good drainage will only be possible by pumping the water from the drainage ditch into the lake.

Rating of improvements of drainage;

(dr) - low level - very permeable soils, deep groundwatertable

dr - moerate level - permeable to modetately permeable soils with groundwater between 100 - 150 cm.

DR - high level - slowly permeable soils with groundwater between 100-150 cm.

DR - very high level - very slowly permeable soil with groundwater into 100 cm.

When a soil has a very low permeability this might be improved by planting a very intensively rooting crop or scrub (cotton, Sesbania sesban, Carthamus tinctorius) to improve the porosity of the soil.

Another measurement, which might be advantegeous is ploughing till about 35 cm depth.

- Salinity control.

In fact this is strongly related with drainage. The groundwater must be controlled at a rather deep level, so that no capillary supply of any amount reaches the rootzone. Secondly the subsoil runoff must cope with an additional percolation. This additional quantity can be applied at each irrigation turn or in one special application after harvest, or just before sowing.

As the quality of the water of Lake Victoria is very good it is probably not necessary to apply excess irrigationwater on non-saline soils with good drainage. On soils which are all-ready slightly to moderately affected by salt it is needed firstly to leach this salts through a good drainage system. If salts are leached not very much additional water is needed, provided the groundwater is controlled at a rather deep level. So a rating of salinity control can be made according to the present day salinity as expressed by the ECe values.

Rating of salinity control (in fact costs of irrigation water needed for leaching).

(sa) low level - ECe 0 - 4 mmho/cm.
sa medium level - ECe 4 - 8 mmho/cm.
SA high level - ECe 8 -12 mmho/cm.
SA very high level - ECe12 -16 mmho/cm.

A proposal for a field layout for salt affected parts may be:

a. ploughing
b. application of leaching water
c. cropping period with application of excess water at each irrigation turn.

The crops should be salttolerant and if possible intensively rooting e.g. cotton or Garthamus tinctorius.

d. after harvesting again application of leaching water.

Depending on the present ECe value this might be repeated one or more time.

- Cypsum should be applied before leaching sodic soils.

Severe sodication is found exclusively on some lowlying spots in the coastal plain, where the exchangeble sodium can be 8 meq/100 grams of soil. (CEC = 24 meq/100 gr).

The amount of gypsum needed depends on the percentage or sodium and on the cation exchange capacity of the soil.

According to handbook 60 (p.49) the amounts of gypsum required to replace indicated amounts of exchangeble sodium are:

Exhangeble sodium (Meq/100 g. soil)	Tons of Gypsum per acre
1	1.7
4	6.9
8	13.7
10	17.2

No accurate rating can be given no accurate data are available on sodication and because the costs of gypsum are unknown.

Thin layers of gypsum are known in pleistocene sediments near Homa mount (Geology and mineral resources of Kenya - Pulfrey). If these layers are of economic value the costs will not be too high, but if not the gypsum has to come from North-Eastern province and this would make the leaching operations very costly.

- Terracing:

This may improve the possibilities of gravity-irrigation. An important factor is the slope; the steeper the slopes, the more soil-material has to be replaced and the narrower the terraces become. On slopes over 10% terracing becomes very difficult.

Rating of terracing:

(te) - low level - slopes 1 - 3%

te - medium level - slopes 3 - 5%

TE - high level - slopes 5 - 10%

TE - very high level - slopes over 10%.

Leveling:

On parts with an irregualar micro-relief (termite hills, shallow gullies) the possibilities of gravity-irrigation are limited. Leveling may considerably improve these possibilities.

The level of leveling depends on the above mentioned micro-relief. In this area only few termite hills are found but on some places the area is very gently undulating due to shallow wide erosion gullies.
It should be noted that these gullies cannot be filled up without further measurements to discharge the water that used to stream through these gullies.

Rating of leveling:

(le) - low level - few termite hills or low undulations
le - medium level - common low undulations
LE - high level - common moderately high undulations
LE - very high level-many moderately high undulations.

- Stonepicking:

This can generally be done together with terracing, as stones can serve as building materials for small terrace walls.
Rating of stonepicking:

(st) - low level - stoniness 0 - 3%
st - medium level - stoniness 3 -I5%
ST - high level - stoniness I5-90%
ST - very high level- stoniness 90-I00%

4.9. Actual suitability of the landunits for gravity irrigation-improvements and potential suitability.

For reference see Table I (page 56 and further).
For the explanation of the landunits see the legend (page 23)
The explanation of the abbreviations for the landqualities are:

W - availability of water
N - " of nutrients
O - " of oxygen for rootgowth
F - " of foothold
I - possibilities of infiltration.
E - resistance against erosion
L - possibilities of farmlayout
T - possibilities of tillage.

Suitability classes (actual and proposed)

I - very high suitable
II - highly suitable
III - medium suitable
IV - marginally suitable
V - unsuitable
A - epecial cropchoice, due to salt (I) 1 or texture (2)

B - special irrigation system.e.g. tied ridging on slow permeable soils on a gentle slope.

C - Attention should be given to the nutrient status of the soil.

Improvement requirements

Level	artificial drainage	salinity control	levelling	Terracing	Stonepicking.
low	(dr)	(sa)	(le)	(te)	(st)
moderate	dr	sa	le	te	st
hig	DR	SA	LE	TE	ST
very high	DR	SA	LE	TE	ST

Gypsum was not rated due to the fact that prices and availability were not known while also no accurate data on sodication are available. For the relevant landunits a distinction is made between actual suitabilityclasses with and without taking into account salinity/sodication.

Actual suitability class s1 gives suitability of the landunit when it is slightly saline and/or alkaline. While s2 gives the suitability when moderately saline and/or alkaline.

Some landunits ($\frac{ViN\text{-}C_2}{A}$, $\frac{ViN\text{-}B_1}{B}$, $\frac{ChN\text{-}B_1}{B}$, $\frac{ChN\text{-}A1}{A}$) are salt-affected as a whole, but others (some landunits of the KsN, CKN, MiN, KaM and NyM series) are only partly affected in fact only the parts near the lake.

For the first case the actual suitability is given for two salinity classes, which are also mentioned under s1 and s2.For the latter case a distinction is made between non saline parts, whose actual suitability is given in the first column, and saline parts from which the suitability- if necessary- is given under s, or s2.

X Note:

A_1 see 4.5.4.

A_2 In fact there is only indicated when crops need to be chosen which are more suitable for or restricted to loamy to sandy soils. These crops are groundnuts, cassave and sweet potatoes.

Table 1: The landunits, their landqualities and their actual suitability

landunits			landqualities					landunits			landquality		Actual suitability
Soil		0-5						Ston.	Rock.	Eros.			
series		cl.	W	N	O	F	I	cl.	cl.	cl.	E.	L	T	classs
ViN	1	B	3	4-5	1	1	2	0-1	-	-	1-2	2	1	IIIA IVA
	2	A	3-4	4	1	2	1	-	-	-	1	1	1	IIIA
	3	C	4	3-4	1	3	2	-	-	-	2-3	2	1	IVAC
KsN	1	A	2	2	2-3	1	1-2	0-1	-	-	1	1	1-2	II
		B	2	2	2-3	1	2-3	0-1	-	-	1-2	1-2	1-2	IIB
								0-1		1	1-2	2	1-2	IIB
	2	A	2-3	1-2	2-3	1	1-2	0-1	-	-	1	1	1-2	II
		B	2-3	1-2	2-3	1	2-3	0-1	-	-	1-2	1-2	1-2	IIIB
								2	-	-	1-2	1-2	2	IIIB
		C	2-3	1-2	2-3	1	3	0-1	-	-	2-3	1-2	1-2	IIIB
GeN	1	A	1-2	2	2	1	1-2	-	-	-	1	1	1-2	II
		B	1-2	2	2	1	2-3	2	-	-	1-2	1-2	2	IIB
	2	A	2	1-2	2	2	1-2	0-1	-	-	1	1	1-2	II
		B	2	1-2	2	2	2-3	-	-	-	1-2	1-2	1-2	III
		C	2	1-2	2	2	3	0-1	-	-	2-3	2	1-2	IIIB
								2-3	-	-	2-3	2-3	2-3	IV
	3	B	3	1	3	2-3	2-3	0-1	-	-	1-2	1-2	1-2	IV
								3	-	1	1	2	3	V
		C	3-4	1	3	2-3	3	0-1	-	-	2-3	2	1-2	IV
								2	-	-	2-3	2	2	V
MiN	1	A	2	2	2-3	1	1-2	-	-	-	1	1	1-2	II
		B	2	2	2-3	1	2-3	-	-	-	1-2	1-2	1-2	IIB
	2	A	2-3	1-2	2-3	1	1-2	-	-	-	1	1	1-2	II
ChN	1	A	2	2	3	1	1-2	-	-	-	1	1	1-2	IIA-IIIA,
		B	2	2	3	1	2-3	-	-	-	1-2	1-2	1-2	IIAB-IIIAB
	2	A	2-3	1-2	3	1	1-2	-	-	-	1	1	1-2	IIA-IIIA
OkN	2	A	2	1-2	2	2	1-2	-	-	-	1	1	1-2	II
		B	2	1-2	2	2	2-3	-	-	-	1-2	1-2	1-2	III
		D	2	1-2	2	2	3	0-1	-	-	2-3	2	1-2	IVB
AnN	1	A	1	2-3	1	1	1	-	-	-	1	1	1	I
	2	A	1-2	2	1	1	1	-	-	-	1	1	1	I
		B	1-2	2	1	1	2	-	-	-	1-2	1-2	1	I
		D	2	2	1	1	2-3	-	-	-	2-3	2	1	III
MbN	2	B	2-3	3	1-2	1-2	2	0-1	-	-	1-2	1-2	1	III
								0-1	1	1	1-2	3	1	IV
	3	A	3-4	2-3	2-3	3	1	0-1	-	-	1	1	1	IV
		B	3-4	2-3	2-3	3	2	0-1	-	-	1-2	1-2	1	IV
								2	-	-	1-2	1-2	2	IV
								2	2	-	1-2	2	2	V
								3	2	-	1-2	2	3	V
		C	4	2-3	2-3	3	3	0-1	-	-	2-3	2	1	IV
								2	0-1	-	2-3	2-3	2	V
								3	0-2	-	2-3	2-3	3	V

For explanation of abbreviation see page 54 a.o.

Table 1: continued---

Landunits

Soil-series	Depth class	Slope class	improvement requirements Dr	Sa	Gy	Le	Te	St	Potential suitability
ViN	1	B	dr	(sa)/sa		(le)			III
	2	A	dr	(sa)		(le)			III
	3	C					te		IV
KsN	1	A	dr	(sa)					II
		B	dr	(sa)			(te)		II
						(le)	(te)		
	2	A							II
		B	(dr)				(te)		II
			(dr)				(te)	st	II
		C	(dr)				te		II
GeN	1	A				(le)	(te)		I
		B				(le)	(te)	st	I
	2	A				(le)			II
		B				(le)	(te)		II
		C				(le)	te		II
						(le)	te	st	II
	3	B					(te)		III
							(te)	ST	III
		C					te		III
							te	st	III
MiN	1	A	dr	(sa)					II
		B	(dr)				(te)		II
	2	A							
ChN	1	A	DR	sa					II
		B	DR	sa			(te)		II
	2	A	DR	sa					II
OkN	2	A	dr	(sa)/sa					II
		B	dr	(sa)/sa			(te)		II
		D					TE		II
AnN	1	A							
	2	A							
		B							
		D					TE		I
MbN	2	B					(te)	(st)	II
						le	(te)	(st)	II/III
	3	A				(le)		(st)	III
		B					(te)	(st)	III
							(te)	st	III
							(te)	st	IV
							(te)	ST	IV
		C					te	(st)	III
							te	st	III
							te	ST	IV

Table 1 continued

Landunits			Landqualities					Landunits						Actual
Soil-series	Depth class	slope class	W	N	O	F	I	Ston. class	Rock class	Eros. cla.	E	L	T	suitability class
KhN	4	C	5	1-2	2	4-5	3	3	3	-	2-3	4	3	V
		D	5	1-2	2	4-5	3-4	3	3	-	3	5	3	V
		E	5	1-2	2	4-5	4-5	3	3	-	3-4	5	3	V
		F/G	5	1-2	2	4-5	5	3	3	-	4-5	5	3	V
OlN	3	B	3-4	2-3	2-3	3	2-3	0-1	-	-	1-2	1-2	1-2	IV
OnM	2	B	2	3-4	1	1-2	2-3	-	-	-	3	1-2	1	IIIC
	3	B	3	2-3	1	2-3	2-3	-	-	-	3	1-2	1	IV
RuM	2	B	3	2	1	2	2-3	2	-	-	2	2	2	III
		C	3	2	1	2	3	2	-	-	3	2	2	IV
LeM	3	C	4	2	1	3	3	1	-	-	3	2	1	V
								1	-	1	3	2-3	1	V
KiM	1	B	2	2-3	2-3	2-3	2-3	2	-	-	2	2	2	III
	2	B	3	2	1	2	2-3	0-1	-	-	2	2	1	IV
								2	-	-	2	2	2	IV
		C	3	2	1	2	3	3	-	-	3	3	3	IV
		D	4	2	1	2	3-4	3	-	-	4	3	3	V
	3	B	4	1	2	3	2-3	2	-	-	2	2	2	V
								3	1	-	2	2	3	V
		C	4	2	1	3	3	2	-	-	3	3	2	V
								2	-	2	3	3-4	2	V
								3	-	-	3	3	3	V
								3	-	1	3	3-4	3	V
		D	4	2	1	3	3-4	3	-	-	4	3	3	V
								3	2	-	4	3-4	4	V
		E	5	2	1	3	4-5	3	2	3	4	5	3	V
								3	-	3	4	5	3	V
								3	2	-	4	5	3	V
		F/G	5	2	1	3	5	3	2	-	5	5	3	V
OgM	1	B	3	3-4	1	1	2	0-1	-	-	2	2	1	IIIC
		D	3-4	3-4	1	1	3	2	-	-	2	2	2	IVC
KaM	1	B	2	2	3-4	1	2-3	0-1	-	-	1	1	1-2	IIB
		C	2	2	3-4	1	3	0-1	-	-	2	2	1-2	IIB
	2	A	3	2	3-4	2	2	0-1	-	-	1	1	1-2	II
		B	3	2	3-4	2	2-3	0-1	-	-	2	2	1-2	III
NyM	1	B	2	2	3	1	2-3	0-1	-	-	2	2	1-2	II
		C	2	2	3	1	3	0-1	-	-	3	2	1-2	IIB
	2	B	3	2	3	2	2-3	0-1	-	-	2	2	1-2	III
								2	-	-	2	2	2	III
		C	3	2	3	2	3	2-3	-	-	3	2	2	IIIB
		D	3	2	3	2	4	3	-	-	4	3	3	IV
	3	B	3-4	1-2	3	3	2-3	2	-	-	2	2	2	IV
								2	-	1	2	2-3	2	IV
		C	3-4	1-2	3	3	3	2	-	-	3	2	2	V

For abbreviations see page 54 a.o.

Table 1: continued---

Soil-serie	Depth class	Slope class	Landunits	Improvements					Potential suitability
			Dr	Sa	Gy	Le	Te	St	
KhN	4	C							
		D							
		E							
		F/G							
OlN	3	B					(te)	(st)	III
OnM	2	B					(te)		II
	3	B					(te)		III
RuM	2	B					(te)	st	II
		C					te	st	II
LeM	3	C					te	(st)	III
						le	te	(st)	III
KiM	1	B					(te)	st	II
	2	B					(te)	(st)	III
							(te)	st	III
		C					te	ST	III
		D					TE	ST	III
	3	B					(te)	st	IV
							(te)	ST	IV
		C					te	st	IV
						LE	te	st	IV
							TE	ST	IV
		D				le	TE	ST	IV
							TE	ST	IV
		E					TE	ST	IV/V
OgM	1	B					(te)	(st)	III
		D					TE	st	III
KaM	1	B	dr/DR	(sa)/sa		(le)			II
		C	dr				te		II
	2	A	dr						II
		B	dr				(te)		II
NyM	1	B	dr	(sa)			(te)		I
		C	(dr)				te		I
	2	B	dr	(sa)			(te)		II
							(te)	st	II
		C					te	st	II
		D					TE	ST	II
	3	B					(te)	st	III
						le	(te)	st	III
		C					te	st	III

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Appendix no 1

Detailed descriptions of the soil units

Final seriesname and symbol. Preliminary seriessymbol.

Victoriaseries	- ViN	D
Kasigungaseries	- KsN	L
Gembeseries	- GeN	B
Migumaseries	- MiN	Lk
Okothseries	- OkN	Bk
Andugoseries	- AnN	M
Chamarungaseries	- ChN	LH
Mbitaseries	- MbN	G
Kiaheraseries	- KhN	H
Onyangoseries	- OnM	F
Oleleseries	- OlN	R
Rusingaseries	- RuM	A
Leakyseries	- LeM	Au
Kiangataseries	- KiM	Ap + C
Ogosaseries	- OgM	Q
Kakriguseries	- KaM	T + To
Nyamugaseries	- NyM	S + So

Appendix 1

Detailed description of the soil units

Profile nr. 1 : Kasigunga series (KsN)

Classification : Soil Taxonomy 1970: Typic Cromustert.
F.A.O. 1970 : Chromic Vertisol

Location : Mbita area sheet 115/3/ Rusinga,

Coordinates : 6375 E., 99505 N.

Elevation : 1170 m.

Described by : D. Noordam and H.v.d. Ham on 30-8-1974.

Landform- physiographic position: pedimentslope
- surrounding landform : dissected slope
- micro relief : flat

Slope gradient : 2 - 3%, pit is the middle of the slope.

Parent material : mela-nephelinite/phonolites.

Surface stoniness : 5%

Drainage : moderately well-drained.

Effective soildepth : 70 cm.

Surface soil : self mulching.

Erosion : some sheet erosion

Rootdistribution : 0 - 15 cm 50%
:15 - 40 cm 35%
: 40- 70 cm 15%

Vegetation type : trees 5%
shrubs 5% (Acacia seyal);
herbs 5% (aloe, sisal);
grasses 85%.

Landuse : arable land with maize / sorghum.

Profile description:

A1 0 - 2 cm: Very dark brown (10 YR 2/2, dry and moist) clay, moderately very fine subangular blocky; slightly hard, firm, slightly sticky and plastic; slightly calcareous; few fine, common very fine pores; glimmers and a few gravels mulched toplayer; clear and smooth boundary.

Ap 2 - 8 cm: Very dark brown (10 YR 2/2, dry and moist) clay; moderately coarse subangular blocky; slightly hard, firm, slightly sticky and plastic; slightly calcareous common very fine pores; glimmers and little gravel; clear and smooth boundary; Sample nr. Mb. 1

B21 8 -38 cm: Very dark gray (10 YR 3/1 dry and moist) with few medium distinct strong brown (7.5 YR 5/6) mottles and few large distinct pale brown (10 YR 6/3) mottles; clay strong medium prismatic breaking up into strong caorse angular blocky; very hard, very firm, slightly sticky and plastic; slickensides on all elements, slightly calcareous, many very fine pores; little gravel; clear and wavy boundary; Sample nr. Mb. 2. Organic matter 10 - 15 cm. nr. 71.

B22 38-70 cm: Very dark grayish brown (10 YR 3/2, dry and moist), with few medium distinct pale brown (10 YR 6/3) mottles; clay strong caorse prismatic breaking up into strong coarse angular blocky; very hard, firm, sticky slightly plastic; slightly calcareous; common very fine pores, slickensides on all elenents; glimmers and a few gravel; gradual and wavy boundary;
Sample nr. Mb. 3. Ring sample Mb. 60 - 65 cm.

C 70- cm: Dark grayish brown (10 YR 4/2, dry) Very dark grayish brown (10 YR 3/2, moist); silty clay loam; massive; hard, friable, slightly sticky and plastic; very calcareous; few very fine pores, much gravel and glimmers;
Sample nr. Mb. 4.

Range of characteristics:

Profile characteristics:

The A-horizon is usually very dark, but also lighter colours occur. The thickness ranges from 10-20 cm, and this horizon is non-calcareous. The texture of the upper 50 cm is always finer than 35%, and is mainly between 40-50%. Below 50 cm textures may be light clayloam and the soil may be calcareous. But usually the soils consist of deep clay-soils which are slightly calcareous in the subsoil.
The selfmulching surfacelayer is always present and thickness ranges between 2-5 cm.

Environmental characteristics:

The profiles occur on the pediments on straight, gentle slopes (3-5%) In the very gentle sloping alluvial plains they are found on slopes of 1-2%. Surface stoniness is mainly 0, but on the pediments a few stones may be observed. In some parts of the series there is a low density of shallow gullies, which become deeper going up the slope.

Profile no. 2	: Migumaseries (MiN)
Classification	: Soil Taxonomy 1970: Udic Chromustert
	F.A.O. 1970 : Chromic Vertisol
Location	: Mbita area, sheet no. 115/3, Rusinga
Coordinates	: 6378 E, 99512 N, along road Mbita-Homa Bay, 6 km from Mbita.
Elevation	: 1160 m.
Described by	: H.v.d. Ham on 31-8- 1974
Slope gradient	: 1-2%
Parent material	: Kiangata nephelinite agglomerate.
Surface run-off	: moderate
Drainage	: moderately well drained.
Effective soildepth	: 60 cm.
Vegetation type	: trees 30% (acacia seyal a.o.); shrubs 30% (id.); herbs 10% (sisal, Leonotis sp) grasses 30%.
Landuse	: extensive grassland.
Soil surface	: selfmulching
Root distribution	: 0 - 17 cm. 65% 17- 60 cm. 30% 60- 75 cm. 5%

Soil profile:

A11 0 - 7 cm : Very dark grey to black (10 YR 25/1, dry and moist); clay, strong, medium breaking into very fine subangular blocky; very hard, very firm, slightly sticky and plastic; non-calcareous; common fine, few medium pores, clear and smooth boundary.

A12 8 -17 cm : Very dark gray to black (10 YR 25/1 dry), very dark grayish brown (10 YR 3/2 moist), light clay moderate medium, columnar prismatic, breaking up into moderately strong, medium angular / subangular blocky; very hard, friable, slightly sticky and plastic, calcareous; common fine pores, few medium pores, very few, very small lime continuous pressure skin concretions; clear and smooth boundary.

Sample no. Mb. 6.

B1 17 - 40 cm: Dark gray brown (10 YR 4/2, dry), dark brown (7.5 YR 4/2, moist), silty clay, strong coarse prismatic, breaking up into moderate medium angular blocky; very hard, very firm, sticky and plastic; calcareous; few fine, few medium pores; few very small gravels (?); few small lime concretions; continuous pressure skins. gradual and smooth boundary. Sample no. Mb. 7A.

B2 40 - 60 cm: Very dark (10 YR 3/1, dry and moist); clay; strong coarse prismatic breaking up into moderate medium angular blocky; very hard, very firm, sticky and plastic; slightly calcareous; few fine, few medium pores; few very small gravels; few small lime concretions; continuous pressure skins; gradual and smooth boundary. Sample no. Mb. 7B.

B3 60 - 75 cm: Brown (10 YR 5/3, dry) and dark gray brown (10 YR 4/2, moist); loam, weak, coarse, angular blocky, hard, friable, non sticky and slightly plastic; very calcareous; few fine, few medium pores; common medium gravels; many medium lime concretions; gradual and smooth boundary. Sample no. MN 8.

C 75 -125+cm : Pale brown (10 YR 6/3) when dry and dark brown (10 YR 4/3) when moist, sandy loam, massive; slightly hard, friable, slightly sticky and non- plastic, very calcareous; few fine, few medium pores; common small gravels; many medium lime concretions. Sample no. Mb. 9.

Range of characteristics:

Profile characteristics.

Texture of A horizon is always clay, while the colours is usually very dark brown, but sometimes very dark grayish brown.

The profiles are usually deep clayey and they are calcareous throughout. Toplayer may be slightly or non- calcareous.

Profile no. 4 : Chamarunga series (ChM)
Classification : Soil Taxonomy 1970: Typic Tropaquent
F.A.O. 1970 : Eutric Fluvisols
Location : Mbita location / South - Nyanza district, along the coast of Lake Victoria, 5 km east of Mbita.
Coordinates : 6375 E, 99545 N, sheet no, 115/3 Rusinga
Elevation : 1145 m.
Described by : H.v.d. Ham on 4-9-1974
Landform : flat alluvial plain
Slopegradient : 0%.
Landuse : shamba, with cultivation of bananas, paw-paw, cassave cabbage, sugar-cane and maize.
Vegetation : The shamba is surrounded by trees (Acacia Seyal) at the far side from the lake, while nearer to the lake many grasses and reeds occur.
Parentmaterial : nephelinites.
Drainage : poorly drained.
Rootdevelopment : half of the roots occurs in the first 30 cm, while the other half is found mainly between 30-70 cm; only few roots of reeds are found below 70 cm
Effective soildepth: 70 cm.
Groundwaterlevel : 150 cm.
Salinity and /or alkalinity: probably slightly effected.

Soil profile.

A11 0 - 3 cm: Black (2.5 YR 2/0, dry and moist); clay; moderate very fine subangular blocky; hard, firm, sticky and very plastic; slightly calcareous; common medium and many fine and very fine pores; very few shell; clear and smooth boundary.

A12 3- 10 cm: Black (10 YR 2.5/1, dry) and very dark gray brown (10 YR 3/2, moist); clay; strong, coarse subangular blocky breaking into moderate fine to very fine angular blocky; hard, firm, sticky and very plastic; slightly calcareous; clear to gradual and smooth boundary.

A/C 10 - 49 cm: Very dark gray (10 YR 3/12, dry and moist); clay; with few thin, prominent, yellowish brown (10 YR 5/6) lines along rootpores; strong medium prismatic, breaking into moderate medium angular blocky; hard, friable, slightly sticky and plastic; few coarse and medium, common fine and very fine pores; slightly calcareous; gradual and wavy boundary.

C11 49 - 74 cm: Very dark grayish brown (10 YR 3/2, dry and moist); clay; moderate medium angular blocky; hard, friable, slightly sticky and plastic; calcareous; few coarse, common fine and very fine pores; few shells; clear and wavy boundary.

C12 74 -120 cm: Very dark grayish brown (10 YR 3/2, dry and moist); clayloam; weak medium angular blocky; very friable, slightly sticky and slightly plastic; calcareous; few medium, common fine and very fine pores; some thin sandy layers occur in this horizon.

Range of characteristics:

Profile characteristics:

The colour of the A-horizon ranges from black to very dark brown. Textures of the profiles varies between heavy clayloam, but it is mostly light clay. Below 50 cm lighter textures may occur, even thin sandy layers are found. But the majority of the soils of the chamarungaseries are deep clayey. They are usually calcareous and under influence of groundwater that is found at depths of 50 - 150 cm.
The soils are slightly saline to moderately saline in the subsoil.

Environmental characteristics.

The Chamarungaseries is exclusively found in the flat coastal plain. The slope never exceeds 3% and is usually 1.5%. Most parts have no stones on the surface but little gravels may occur locally.
The vegetation mainly consists of reeds and other swamp plants.
Parts of the series is cleared and now used for a permanent cultivation of vegetables.

Profile nr. 5	: Okoth series (OkN)
Classification	: Soil Taxonomy 1970: Udic Haplustol
	FAO 1970 : Haplic Phaeozems
Location	: Mbita area, sheet nr. 115/3 Rusinga, north of road Mbita
Coordinates	: Homa Bay, about 5 km. from Mbita, near Lake Victoria.
Elevetion	: 1145 m.
Described by	: D. Noordam on 5-9-1974
Physiography	: coastal plain
Surrounding	: gently undulating
Micro-relief	: nearly flat.
Slope gradient	: 0%
Parent material	: Kiangata nephelinite agglomerate.
Soil surface	: cracking.
Effective soildepth	: 120 cm.
Rootdistribution	: 0 - 10 cm 6%
	10- 20 cm 10%
	20- 90 cm 25%
	90 cm 5%
Drainage	: moderately well drained
Groundwater level	: 180 cm.
Vegetation type	: shrubs and herbs 15%, grasses 70%, reeds 25%.
Landuse	: pasture land.

Profile description:

A11 0 - 9 cm: Dark grayish brown (10 YR 4/2, dry) and very dark gray (10 YR 3/1, moist); clay loam;, moderate, medium sub-angular blocky; hard, firm, sticky and plastic; non-calcareous; many very fine pores; few gravels; clear and wavy boundary; precipitation of salts along cracks; ECe 5.5 mmho/cm^2; Sample nr. Mb 27.

A12 9 - 20 cm: Very dark grayish brown (10 YR 3/2, dry and moist) with common distinct brownish yellow (10 YR 6/6) mottles; clayloam; moderately medium angular blocky; very hard, very firm, sticky and plastic; calcareous; many very fine pores; common gravel, clear and wavy boundary; ECe 11.6 mmho/cm^2; Sample nr. Mb 28. Ring samples 11 - 16cm nrs. 53 - 54 Org. matter nr. 68.

$B2_{sa}$ 20 - 30 cm: Very dark grayish brown (10 YR 3/2, dry and moist), with precipitation of salt (10 YR 8/2) clay loam, moderately weak medium subangular blocky; hard, firm, sticky and slightly plastic; very calcareous; many very fine pores; diffuse and irregular boundary; ECe 10.2 mmho/cm^2; Sample nr. Mb 39.

B3gsa 30- 54 cm: Dark brown (10 YR 3/3, dry and moist), with few medium faint very gray (10 YR 3/1) mottles (along roots), few medium prominent white (10 YR 8/1) mottles and many coarse prominent white (10 YR 8/2) mottles; silt loam; weak fine to medium subangular blocky; friable, sticky and slightly plastic; few distinct skins of organic matter; many very fine pores; very calcareous; diffuse and irregular boundary; ECe 9.5 mmho/cm^2; Sample nr. Mb 30. Ring samples 48 - 53 cm. (55 + 57). Org. matter nr. 67.

C1g 54 - 74 cm: Very dark grayish brown (10 YR 3/2, dry and moist); silt loam; weak fine to medium subangular blocky; very friable, slightly sticky and slightly plastic, very calcareous; many very fine pores, clear and wavy boundary; ECe, 9.8 mmho/cm^2; Sample nr. Mb 31.

C29 74 - 94 cm: Blacck (10 YR 2/1, dry and moist); silt loam; weak fine to medium subangular blocky; friable to loose; slightly sticky and slightly plastic; very calcareous, common very fine pores; layer to sandy sediments; clear and broken boundary; ECe 9.0 mmho/cm^2; Sample nr. Mb 32, Ring sample nrs. 58 + 59 (75 - 80 cm). Org. matter nr. 65.

C39 94 -130+cm: Very dark grayish (10 YR 3/2, moist); siltloam; weak fine to medium subangular blocky; firm, slightly sticky and slightly plastic; very calcareous; many very fine pores; ECe 7.6 mmho/cm^2 Sample nr. Mb 33.

Range in characteristics:

Profile characteristics:

The colour of the A-horizon of this profile is mostly very dark brown, but sometimes very dark grayish brown. The texture of the A-horizon is heavy clayloam to clay, but texture becomes light clay-loam or coarser within 50 cm. of the surface.

The profiles are usually moderately deep (80 cm). They are calcareous throughout.

Environmental characteristics:

The profiles occur on slopes of 0 - 3%. The surface stoniness class is laways 0. They are usually dry for more than 3 months a year.

Profile nr. 6 : Onyango series (OnM)

Classification : Soil Taxonomy 1970: Petrocalcic typic Ustropept

FAO 1970 : Petrocalcic Calcic Cambisol.

Location : Mbita area, sheet nr. 115/3, East of Homa Bay.

Elevation : 1170 m.

Description : D. Noordam on 5-9-1974.

Landform -physiographic position: pediment slope.

-surrounding landform : undulation

- microtopography : flat

Slope gradient : 2-3%, in middle of slope.

Parent material : Kiangata nephelinite agglomerate

Erosion : strong

Surface stoniness: 1%

Drainage : moderately well drained.

Surface runoff : moderate.

Soil surface : sealed

Effective soildepth: 30 - 50 cm.

Vegetation : herbs 10% (aloe, solanum spp);

Rootdistribution: 0 - 10 cm. 60%

10- 40 cm. 40%

Landuse : arable land (sorghum, maize) and extensive grass-land.

Profile description:

A1 0 - 10 cm: Grayish brown (10 YR 5/2, dry) and very dark brown (10 YR 2/2, moist); silt loam; very weak very fine subangular blocky; soft, friable, slightly sticky and slightly plastic; calcareous; many very fine pores;few gravel; glimmers; clear and wavy boundary; Sample nr. Mb. 34.

B/C 10- 40 cm: Dark grayish brown (10 YR 4/2, dry) and very dark gray (10 YR 3/1, moist); light silt loam; weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; slightly calcareous; many very fine pores; few gravel; few small lime concretions; clear and wavy boundary; Sample nr. Mb. 35.

B3 40 - 80+cm: Petrocalcic horizon.

Range of characteristics:

Profile characteristics:

The depth of the profiles ranges from shallow to moderately deep. This is the distance to the top of the petrocalcic horizon, which is found on most places in this series. The weakly developed A-horizon is graybrown and thin. The texture range from silty clayloam to siltloam.The soils are always very calcareous throughout.

Environmental characteristics:

The series is found on one place in the very gentle sloping of top of a nephelinite hill. The surface soil is more or less sealing and susceptible to erosion. On some places termites have formed low mounds. The surface stoniness class is 0 or 1.

Profile nr. 7 : Mbita series (MbN)
Classification : Soil Taxonomy 1970: Udic Haplustoll
FAO 1970 : Haplic Phaeozem
Location : Mbita area/South Nyanza, along road from Mbita to Homa Bay. Sheet nr. 115/3 Rusinga.
Coordinates : 6375 E, 99514 N.
Elevation : 1170 m.
Described by : D. Noordam, 5-9-1974
Landform- physiographic position: pedimentslope
- surrounding landform : undulating
- microtopography : nihil.
Slope gradient : 3%, on middle of slope.
Parent material: nephelinite agglomerate.
Drainage : moderately well-drained
Surface stoniness: 5%
Surface runoff : medium
Soil surface : crusting crumbling
Rockoutcrops : 1%
Effective soildepth: 40 cm.
Rootdistribution : 0 - 20 cm. 75%
20- 40 cm. 25%
Vegetation type: herbs 10% (aloe, sisal); grases 80%, bare ground 10%.
Landuse : extensive grassland.

Soil profile:

A11 0 - 10 cm: Very dark brown (10 YR 2/2, dry) and black (10 YR 2/1, moist); loam; moderate fine subangular blocky; hard, very friable, slightly sticky and slightly plastic; non-calcareous; few fine, many very fine pores; few gravels; common fine roots; glimmers; clear and wavy boundary; Sample nr. Mb. 36.

A12 10 - 20 cm: Very dark grayish brown (10 YR 3/2, dry and moist); loam; strong caorse subangular blocky; hard, very friable, slightly sticky and plastic; non-calcareous, few fine, common very fine pores; few gravels; glimmers; clear and wavy boundary, Sample nr. Mb 37.

C 20 - 40 cm: Very dark grayish brown (10 YR 3/2, dry and moist); sandy loam; weak fine subangular blocky; non-plastic; non- calcareous; few fine, common very fine pores; very many calcareous, weathering stones; glimmers; clear and wavy boundary; Sample nr. Mb 38.

R 40 - 60+cm: Strongly calcareous rock, white (10 YR 8/1).

Range of characteristics:

Profile characteristics:

The profiles of the Mbita series are all shallow (paralithic contact within 50 cm) The colour of the A-horizon is mostly very dark grayish brown (10 YR 3/2), but also dark gray brown (10 YR 4/2) colours occur. Thin horizon is usually non-calcareous. The texture of these profiles ranges from light clayloam to heavy loam. The stoniness is usually high (about 20% of the profile in the subsoil).

Environmental characteristics

The surface stoniness is usually in class 1 or 2. The series occurs on slopes of 1 - 10%. Also rockoutcrops may occur in this series.

Profile nr. 8 : Kiahera series (KhN)
Classification : Soil Taxonomy 1970: Lithic Haplustolls
FAO 1970 : Lithic Haplic Phaeozems.
Location : Mbita area/South Nyanza, along road Mbita- Homa - Bay, about 4.5 km for Mbita on low hill. Sheet nr. 115/3, Rusinga.
Coordinates :
Elevation : 1170 m.
Described by : D. Noordam on 5-9-1974.
Landform- physiographic position: rocky pediment slope
- surrounding landform : sloping, length 50 cm
- micro-topography : irregular sloping
Slope gradient : 6%
Parent material : Kiangata nephelinite agglomerate.
Drainage : imperfectly drained.
Soil surface : sealed.
Surface runoff : much.
Surface stoniness: 10%
Rockoutcrops : 50%
Effective soildepth: 20 cm.
Rootdistribution : 0 - 8 cm. 70%
8 -20 cm. 30%
Vegetation type : herbs 25% (aloe, Solanum sp.); grasses 25%, bare ground 50%.
Landuse : very extensive grassland, plant- growth at location is bad.

Soil profile:

A1 0 - 10 cm: Very dark grayish brown (10 YR 3/2, dry and moist); loam; moderate fine subangular blocky; hard, friable, slightly sticky, slightly plastic; non- calcareous; few fine, common very fine pores; few gravels; glimmers; clear irregular boundary; Sample nr. Mb 39.

A/C 10- 20 cm: Very dark grayish brown (10 YR 3/2, dry and moist); coarse sandy loam; moderate fine subangular blocky; hard, friable, non sticky, non plastic; non- calcareous; few fine, common very fine pores, many gravels (rotten rock; glimmers; clear and wavy boundary; Sample nr. Mb. 40.

Range of characteristics:

Profile characteristics;

The profile of this series are always very shallow (20 cm.). The colour of the A-horizon ranges from very dark grayish brown to dark gray brown (10 YR 3/2- 10 YR 4/2). The A-horizon is usually thin (5 - 10 cm.). The soil may be concalcareous to calcareous. The texture ranges from loam to clayloam (25% - 35%).

Environmental characteristics:

The profiles are usually found in stony, rocky positions (total less than 90% of the surface). The slope ranges from 3-20%, but is usually sloping.

Profile nr. 11 : Rusinga series (RuM)
Classification : Soil Taxonomy 1970: Typic Ustropept
FAO 1970 : Calcaric Cambisol
Location : Mbita area, sheet no 115/3,
Coordinates : 6358 E, 99517 N, in guly on the lake side of the road Mbita-Luanda.
Elevation : 1180 m.
Described by : H.v.d. Ham. on 20-9-1974
Landform - physiographic position: Eroded pedimentslope
- surrounding landform : pedimentslope
- micro topography : irregula.
Slope gradient : 10%
Parent material : Miocene lakebeds
Erosion : strong
Rockoutcrops : 20%
Surface stoniness : 60%
Surface runoff : Moderate to severe
Drainage : moderate well-drained
Effective soildepth: 40 cm.
Vegetationtype : Trees 20% (Acacia seyal a.o.); shrubs 10% (Acacia seyal a.o.); herbs 20% (Aloe, Sisal a.o.); grasses 40%; 10.
Landuse : Extensive grassland, sometimes digged.
Soil surface : sealed.

Soilprofile:

A1 0 - 7 cm: Dark brown (7.5 YR 4/2, dry), dark brown (7,5 YR 3/2, moist); siltloam; weak very fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; very calcareous; few very fine pores; few rounded gravels, few fine roots; clear and smooth boundary; very few small soft lime, concretions. Sample nr. Mb. 48.

B2 7 -34 cm: Dark brown (7.5 YR 4/2, dry), dark brown(7.5 YR 3/2, moist); silty clayloam; moderate medium subangular blocky; hard, friable, sticky and slightly plastic; very calcareous; common fine, common medium, very few coarse pores; few rounded gravels; many small soft lime concretions; few fine roots; clear and wavy boundary; Sample no. Mb. 49.

B3 34 - 70 cm: Dark brown (7.5 YR 4/5, dry), reddish brown (2.5 YR 4/4, moist); loam; moderate medium platy; hard; very friable, non- sticky and slightly plastic; very calcareous; few fine pores; few rotten stones; few small soft lime concretions; very few fine roots; glimmers; gradual and wavy boundary. Sample nr. Mb.50

C 70 - 90+ cm: Reddish brown (2.5 YR 4/4), dark grayish brown (2.5 YR (4/2), black (2.5 YR 2.0), white (2.5 YR 8/0, dry), reddish brown (2.5 YR 5/4), grayish brown (2.5 YR 5/2), very dark gray (2.5 YR 3/0), white (2.5 YR 8/0, moist); loam; massive weathering material; slightly calcareous; few small soft lime concretions; very few very fine roots. Sample nr. 51.

Range of characteristics:

Profile characteristics:

The profiles are usually moderately deep (70 cm) overlying reddish brown soft rotten rock and rock. Also shallow profiles occur locally. The stoniness of the profiles is mostly common, mainly consisting of small rotten gravels. The thickness of the A-horizon is usually 20 cm and colours of it are varying from dark brown to brown.
Texture is ranging from light clayloam to loam. Often the layer from 40 - 70 cm is very gravelly and stony. The profiles are calcareous throughout, at some profiles of this series a horizon with soft small lime concretions are found.

Environmental characteristics:

The Rusinga series occurs on slightly concave gently sloping peneplain. (slopes 1-5%). Surface stoniness ranges between 3 - 15% and consisting mainly of small gravels. Some sheet erosion may occur in the series, but is not common.

Profile no. 12 : Victoria series (ViN)
Classification : Soil Taxonomy 1970: Aeric Tropaquents.
FAO 1970 : Calcaric Fluvisols
Location : Mbita point, approximately 500 m SE of Mbita market, South-Nyanza
Coordinates : 6345 E. 99535 N, sheet no. 115/3 Rusinga
Elevation : 1145 m.
Described by : H.v.d. Ham on 21-9-1974
Landform-physiographic position: very gentle sloping coastal plain
-surrounding landform : slightly concave colluvial slope towards steep, stony hillslope.
-microtopography : somewhat irregular due to human activity.
Slopegradient :1%
Parent material :Nephelinites.
Erosion :slight sheeterosion
Surface runoff : moderate
Drainage (internal): imperfectly drained
Rootdevelopment :the major part of the roots is found in the upper 20 cm. a minor part of mainly fine roots is found between 20 - 50 cm, while only few fine roots occur from 50-80 cm.
Effective soildepth: 50 cm.
Groundwaterlevel : 150 cm.
Salinity/alkalinity: Probably slightly to moderately affected.

Profile description:

A11 0 - 3 cm: Very dark gray brown (10 YR 3/2, moist); loam; weak fine crumb; friable,slightly sticky and plastic; calcareous; common fine and very fine pores; very few small gravels; abrupt and smooth boundary; Sample no. Mb. 59.

A12 3 -16 cm: Very dark gray brown (10 YR 3/2, moist), light clay-loam, with common dark brown coarse, faint mottles; moderate medium subangular to angular blocky% hard, friable, slightly sticky and plastic; calcareous; few fine and common very fine pores; few small gravels; clear and wavy boundary; sample no. Mb 60.

A/C 16-35 cm: Dark brown (10 YR 3/3, moist), sandy clayloam; moderate fine to medium angular blocky; very firbale, slightly sticky and slightly plastic; very calcareous with a few very small lime concretions;few fine and very fine pores common gravels; abrupt and wavy boundary;sample no. Mb 61.

C11 35 - 63 cm: Very dark gray brown (10 YR 3/2, moist); sandy loam; with common faint brown medium mottles; weak fine to medium angular blocky; very friable, slightly sticky and slightly plastic; very calcareous, with very few very small lime concretions; few fine and very fine pores; few gravels; clear and wavy boundary; sample no. Mb 62.

C12 63 - 80 cm: Very dark gray to very dark gray brown (10 YR 3/1.5, moist); sand; with a few fine distinct brown and a few fine prominent yellowish brown mottles; massive structure; loose, non-sticky and non-plastic; very calcareous; common small gravels; clear and smooth boundary; sample no. Mb 63.

C12 80 -120+cm: Dark gray brown (10 YR 4/2, moist); sandy clayloam; with a few, medium, faint, brown mottles; massive structure; friable, slightly sticky and slightly plastic; very calcareous; sample no. Mb 64.

Profile no. 14 : Gembe series (GeN)

Classification : Soil Taxonomy 1970: Vertic Haplustolls
FAO 1970: : Haplic Phaeozems.

Location : Mbita area / South Nyanza, sheet nr. 115/3, Rusinga on Mbita point, near D.O. Office.

Elevation : 1160 m.

Landform : physiographic position: alluvial slope
- surrounding landform : convex slope, nearly flat
- microtopography : nil

Slope gradient : 1%, to top of slope

Parent material : alluvial gravel and clay

Drainage : well drained

Surface runoff : low

Soil surface : self mulching

Surface stoniness: 5%

Vegetation : shrubs 5% (Acia seyal a.o.); herbs 35% (sisal, aloe, Solanum sp; grasses 65%; bare ground 5%.

Landuse : extensive pasture.

Soil profile:

A11 0 - 8 cm: Very dark gray to very dark grayish brown (10 YR 3/1.5, dry) and very dark grayish brown (10 YR 3/2, moist); clay loam; moderate, coarse, subangular blocky; hard, friable; slightly sticky and plastic; non- calcareous; few fine, few very fine pores; few gravels and small stones; clear and smooth boundary; Sample nr. Mb 65.

A12 8 -28 cm: Very dark gray (10 YR 3/1, dry) and very dark grayish brown (10 YR 3/2, moist); clay; strong medium to coarse prismatic breaking up into strong, medium to coarse angular blocky; very hard, very friable, very sticky and very plastic, non- calcareous; few fine, few very fine pores; broken, moderately thick clay skins; common gravels; gradual and smooth boundary; Sample nr. Mb 66.

B/C 28-40 cm: Very dark (10 YR 3/1, dry) and very dark grayish brown (10 YR 3/2, moist); sandy loam, moderate, medium angular blocky; very hard, firm, slightly sticky and slightly plastic; non- calcareous; pores hardly visable; very many gravels (rotten); gradual and smooth boundary; Sample Mb 67.

C 40-60+cm : Dark brown (7,5 YR 3/2,dry and moist); sandy loam; massive; very hard, firm, slightly sticky and slightly plastic; calcareous; no pores visable; very many gravels (rotten); Sample nr. Mb (

Range of characteristics

Profile characteristics:

The profiles of this series are usually gravelly in the subsoil. The texture of the A-horizon is laways finer than 35%. Within 50 cm. the texture becomes light clayloam or coarser. The colour of the A-horizon is mostly very dark brown, but sometimes very dark grayish brown and is non-calcareous. The B-horizon may be calcareous.

Environmental characteristics

The profiles occur on slopes of 1 - 5%. The surface stoniness is usually low (class 1), but sometimes class 2 occurs.
They are usually dry for more than 3 months a year.

Profile nr. 15 : Olele series (OlN)
Classification : Soil Taxonomy (1970: Udic Haplustolls
FAO 1970 : Haplic Phaeozems.
Location : Mbita area/ South Nyanza, sheet 115/3, Rusinga, on Mbita point, near D.O.Office.
Coordinates : 6343 E, 99534 N.
Elevation 1180 m.
Described by : H.v.d. Ham on 21-9-1974
Physiographic position: hill top
Surrounding landform : convex slope, nearly flat, 200 m.
Microtopography : nil.
Slope gradient : 1%
Parent material : nephelinites and mela-nephelinites with subordinates melitites.
Drainage : well drained.
Surface : low
Soil surface : crumbling.
Surface stoniness : 6%
Effective soildepth: 50 cm.
Root distribution : 0 - 20 cm. 50%
20 - 45 cm. 30%
45 - 60 cm. 20%
Vegetation : trees 10% (Acacia seyal, Cassia spp); shrubs 40%; herbs 15% (solanum sp, sisal, aloe); grasses 35%.
Landuse : extensive pasture; plantgrowth is rather poor.

Soil profile

A1 0 - 7 cm: Dark brpwn (7.5 YR 3/2, dry and moist); clay loam; moderate to weak medium subangular blocky; hard, friable, sticky and plastic, non-calcareous; common fine, common very fine pores, clear and smooth boundary; sample nr. Mb 69% organic matter Mb 15 (1 - 6 cm).

B1 7 -32 cm: Dark brown (7.5 YR 3/2 dry and moist); clay; strong medium prismatic; breaking into strong medium angular blocky; very hard, very firm, sticky and plastic; non-calcareous, few medium, common fine, common very fine pores; few

gravels; gradual and smooth boundary; Sample nr. Mb 70; organic matter 15 - 20 cm.

B2 32 - 50 cm : Dark brown (7.5 YR 3/2, dry and moist); clayloam; strong medium prismatic, breaking up into moderate, medium angular blocky; very hard, friable, sticky and slightly plastic; few medium faint brown (7,5 YR 5/3) mottles; common fine, common very fine pores; common gravels; clear and wavy boundary; sample nr. Mb 71.

C 50 - cm: Brown (5 YR 3/4 dry and moist); loam; massive; very hard, very friable, sticky and slightly plastic; very calcareous; common very fine pores; very many gravels and stones; sample nr. Mb 72.

Profile characteristics:

The depth of the profile ranges from shallow to moderately deep (40 - 80 cm.) and it is stony and gravelly. The A-horizon is darkbrown and moderately thick: 15 - 25 cm. Texture ranges from light clay to light clayloam.

Environmental characteristics

This unit is exclusively found on the gently sloping top of a hill of nephelinites near Mbita. Surface stoniness is usually class 1, sometimes 2.

Profile nr. 16 : Victoria series (D)
Classification : Soil Taxonomy 1970: Mollic Psammaquent
FAO 1970 : Eutric Arenosol
Location : Mbita point, about 500 m. South of Mbita, near Lake Victoria, sheet nr. 115/3 Rusinga.
Elevation : 1145 m.
Described by : D. Noordam on 11/10/74
Landform : coastal plain, gently undulating to flat.
Slope gradient : 4%
Vegetation : at the moment of examination fallow arable land,
Landuse : in the wet season used for growing of maize, millet, beans and groundnuts.
Parent material : nephelinites.
Internal drainage: moderately well-drained.
Groundwater level: ranging between 60 and 120 cm, now 120 cm.
Presence of salt : probably slightly saline.

Profile description:

Ap 0 - 20 cm: Black (10 YR 2/1, moist and dry); sandy clayloam; with common brown (7,5 YR 4/4) fine distinct mottles; moderate medium subangular blocky; hard, firm, slightly sticky and plastic, non fine, pores; clear and wavy boundary; sample no. Mb 73, organic matter Mb 16 15 - 20 cm, rings 49 - 50.

AC 20 - 35cm: Very dark grayish brown (10 YR 3/2, moist and dry); coarse sand; common white (10 YR 8/1) coarse to medium, distinct and many black (10 YR 2/1) coarse prominent mottles; structureless single grain; soft; loose, non-sticky, non-plastic; con-calcareous; few medium, common fine, many very fine pores; clear and smooth boundary;(74)

C11 35 - 52 cm: Brown (10 YR 5/3,dry) and very dark grayish brown (10 YR 3/2, moist); sand, common white (10 YR 8/1) medium distinct mottles and common black (10 YR 2/1) coarse prominent mottles; structural single grain; soft, loose, non-sticky, non-plastic; non-calcareous; few medium, common fine, many very fine pores; clear and smooth boundary; sample hr. Mb 75, organic matter Mb 16 40 - 45 cm. rings 51 - 52.

C12 52 - 63 cm: Very dark grayish brown (10 YR 3/2, dry and moist); coarse loamy sand common medium, distinct, white mottles; structureless, single grain; soft, very friable non-

sticky and non-plastic; non-calcareous; common fine pores; clear and smooth boundary; sample no. Mb. 76

C13 63 - 95 cm: Dark gray brown (10 YR 4/2, dry and moist); coarse loamy sand; with few, white (10 YR 8/1), medium distinct mottles; structureless, single grain; soft, loose non-sticky and non-plastic; slightly calcareous; common fine pores; clear and smooth boundary; sample no. Mb 77

C14 95 -105 cm: Dark gray brown (10 YR 4/2, moist); coarse loamy sand; structureless, single grain; soft, very friable, non-sticky and non-plastic; non-calcareous; common fine pores.

Range in characteristics

Profile characteristics:

The profiles of the Victoria series contain a considerable amount of coarse sand. Texture range from coarse loamy sand to coarse sandy clay-loam. Usually different textural classes occur in one profile. The colour of the A-horizon in the more sandy profiles is mostly black to very dark brown, while the one in the finer textured soils is mainly very dark grayish brown. The coarse textured profiles are mostly non- to slightly calcareous and the finer textured soils are calcareous at least below the A-horizon. Usually the soils are affected by salt (slightly in the surface soil and moderately in the subsoil).The groundwaterlevel is mainly between 100 - 150 cm, sometimes deeper.

Environmental characteristics

The series occurs mainly in the coastal plains on very gently sloping positions (slopes 0-3%) However it may also occur on slightly concave gently sloping footslopes of hills towards the coastal plain (slopes 3-5%). Often the micro-relief is irregular due to human activity A part of the profile is overwashed with sand. Stones are absent or very few small gravels are present.

Profile no. 17 : Andugo series (M) (AnN)
Classification : Soil Taxonomy 1970: Typic Torrifluvent
FAO 1970 : Calcaric Fluvisol
Location : Mbita area/South Nyanza, 4km east of Mbita,
Coordinates : 6368 E, 99514 N, sheet no. 115/3 Rusinga.
Elevation : 1160 m.
Physiographic position: aluvial fan

Surrounding landform: gentle undulating
Slope gradient : 2 - 3%
Landuse : pastureland.
Vegetation : 20% trees (A. Seyal), 20% shrubs(A.Seyal), 20% herbs (Solanum incanum, Leonotis) and 40% grasses (Cynodon dactylon)
Parent material : nephelinites
Drainage well drained
Effective soldepth : 150 cm.
Surface runoff : slow

Profile description:

A11 0 - 9 cm: Very dark gray (10 YR 4/1.5,dry) and very dark (10 YR 2/1, moist); clayloam; moderate medium subangular blocky; hard firm, slightly sticky and plastic; non calcareous; many medium, fine and very fine pores; few rounded gravels; abrupt and wavy boundary.

A12 9 - 14 cm: Very dark gray (10 YR 4/1.,dry) and very dark grayish brown (10 YR 3/2, moist); coarse sandy loam; single grain; slightly hard, friable, sticky and non-plastic; calcareous common lime concretions; common medium and fine pores; many gravels; few primary minerals (pyroxenes); abrupt, wavy boundary.

B21 14 - 40 cm: Dark brown (10 YR 3/3, dry and moist)clayloam; moderate medium prismatic breaking into moderate medium subangular blocky; hard, very firm, sticky and plastic; very calcareous; few medium, many fine and very fine pores; organic matter cutans along pores and on peds: very few rounded gravels; abrupt, wavy boundary.

B22 40 - 46 cm: Dark brown (10 YR 3/3, dry amd moist); loamy sand; songle grain; slightly hard, loose, non sticky and non plastic; few lime concretions; few fine, common very fine pores; few primary minerals (pyroxenes); many gravels; abrupt and wavy boundary.

B23 46 - 86 cm: Dark grayish brown (10 YR 4/2, dry and moist); very fine sandy loam; weak moderate subangular blocky; soft, friable, sticky and slightly plastic; very calcareous; common fine and very fine pores; common gravels; gradual wavy boundary.

A1b 86 -105 cm: Dark brown (10 YR 4/3, dry and moist); clayloam; moderate medium subangular blocky; hard, friable, sticky and plastic;

calcareous to very calcareous; few medium and common fine and very fine pores; organic matter cutans along pores and on peds.

Augering:

105 - 150 cm Very calcareous dark brown (10 YR 3/2.5) clayloam.
150 - 175 cm Very calcareous dark brown (10 YR 4/3) clayloam.
175 - 210 cm Slightly calcareous dark brown (10 YR 3/2.5) clay.

Range of characteristics:

Profile characteristics:

The moderately thick (10-20) A-horizon is usually very dark gray brown (10 YR 3/2), but also darker (10 YR 2/2) and lighter (10 YR 4/2) colours occur. Usually the series is layered, the main texture being light clayloam alternating with more or less thick sandy loam and clayey layers. Sometimes a layer of rounded gravels is found. The soils are usually calcareous throughout, but sometimes the topsoil is only slightly calcareous. Depth of the profile is mostly below 120 cm, but also moderately deep profiles are found.

Environmental characteristics:

The series are usually found on slopes 1-2%, but is found on steeper parts 2-5%. Surface stoniness is low, mainly class 0, sometimes class 2.

Profile no. 19 : Ogosa series (OgM)
Classification : Soil Taxonomy 1970: Typic Torrifluvents
FAO 1970 : Calcaric Fluvisols
Location : Rusinga island, Wariga, South Nyanza,
Coordinates : 6325 E, 99545 N, sheet no. 115/3 Rusinga.
Described by : D. Noordam on 18-12-1974
Elevation : 1170 m.
Physiographic position: alluvial plain
Surrounding landform : gently undulating to flat.
Slopegradient : 0 - 1%
Landuse : Forest plantation (firewood and poles) on a small area the rest is used for grazing.
Vegetation : 20% trees, 20% shrubs, 30% herbs, and 30% grasses.
Parentmaterial : stratified fuffs, boulder breccias, but mainly tuffaceous sandstones.
Drainage : well drained
Effective soildepth: 60 - 100 cm.
Surface runoff : slow

Surface soil : slightly sealed.

Profile description:

A1 0 - 20 cm: Brown (10 YR 5/3 dry) and dark grayish brown (10 YR 4/2 moist); silty clayloam; moderate medium to fine subangular blocky; slighlty hard, friable, nonsticky and slightly plastic; very calcareous; few coarse and medium common fine and very fine pores; few small gravels; clear and wavy boundary.

C11 20- 38 cm: Brown (10 YR 5/3, dry); loamy sand; single grain; slighly hard, very friable, non sticky and non plastic; very calcareous many rounded gravels; common fine and very fine pores; few shells; clear and wavy boundary.

C12 38- 56 cm: Brown (10 YR 5/3, dry); silt loam; weak medium subangular blocky; slighlly hard, very friable, slightly sticky and nonplastic; very calcareous; few coarse and medium pores, common fine and very fine pores; few gravels; clear and wavy boundary.

C13 56- 76 cm: Brown (10 YR 5/3, dry); sand; single grain; loose, very friable, nonsticky and nonplastic; very calcareous; few fine and very fine pores; very many gravels; clear and wavy boundary.

C14 76-120 cm: Brown (10 YR 5/3, dry); loamy sand; single grain; soft, very friable, nonsticky and nonplastic; very calcareous; few medium, common fine and very fine pores; few gravels.

Range of characteristics:

Profile characteristics:

Soils of this series are always deep to very deep.
The A-horizon is thin (10 - 20 cm) and weakly developed. The colours range from dark gray brown to brown, but are mostly brown. Below the A-horizon different layers are found ranging in texture from sand to fine loam, with thinner layers of clayloam, light clay or rounded gravels. These layers may be absent. The soils are always very calcareous.

Environmental characteristics:

The series occurs on slightly convex, very gently sloping alluvial fans, but also on remants of fans. These consists of sloping round hills, with a concave footslope. Few stones may be present.

Profile no. 25 : Kakrigu series (KaM)
Classification : Soil Taxonomy 1970: Udic Chromusterts
: FAO 1970 : Chromic Vertisols
Location : Mbita area South Nyanza district, 1 km west of Mbita on Rusinga island,
Coordinates : 6327 E, 99545 N, sheet no. 115/3, Rusinga
Elevation : 1155 m.
Desctibed by : D.Noordam on 31-10-1974
Physiographic position: alluvial plain
Surrounding landform : slightly concave, gently sloping alluvial plain.
Micro relief : the slope is slightly terraced, because low (20 cm) walls of stones are built to catch the erosion materal coming from the higher parts. The distance between the walls is approximately 100 m.
Slopegradient : 2%.
Landuse : At the moment of examination the land was used for extensive grazing. In the wet season it is arable land.
Vegetation : A part is bare, the rest is covered with grass and herbs (mainly Ipomoea kituiensis), while also some shrubs occur (Balanites aegyptica and Euphorbia tirucalli).
Parent material : stratified tuffs, boulder, and tuffaceous sandstones.
Drainage : moderately
Erosion : slight sheeterosion.
Pootdevelopment : The majority of the roots is found in the upper 20 cm. From 20 - 60 cm a small of fine roots is found. Effective soildepth: 60 cm.
Cracking : few cracks starting below 50 cm running to the lower part of the A-horizon.

Profile description:

A11 0 - 8 cm: Dark grayish brown (10 YR 4/2, dry and moist); clayloam moderate, medium subangular blocky; hard, friable, sticky and plastic; very calcareous; common coarse, many medium and fine pores; clear and wavy boundary.

A12 8 -28 cm: Dark brown (10 YR 3/3, dry and moist); clay loam; moderate coarse prismatic breaking into moderate medium angular blocky; hard, firm, slightly sticky and plastic; very calcareous few coarse and medium, common fine and very fine pores; clear and wavy boundary;

B2 28 - 66 cm: Very dark brown (10 YR 2/2, dry and moist); clay; strong coarse prismatic breaking into strong medium angular blocky; extremely hard, extremely firm, very sticky and very plastic; contineous slickensides; calcareous; few coarse cracks, common medium and few fine fine and very fine pores; clear and wavy boundary;

C 66 - 80+ cm: Very dark brown (10 YR 2/2, dry); heavy clay; structureless massive; extremely hard; very calcareous; very many many stones and gravel.

Profile no. 26: Leaky series (LeM)
Classification : Soil Taxonomy 1970: Udic Haplustoll
FAO 1970 : Haplic Phaeozems
Location : Rusinga island, South Nyanza,
Coordinates : 6335 E, 99542 N. sheet no. 115/3 Rusinga.
Elevation : 1160 m.
Physiographic position: edges of hillslopes.
Surrounding landform: undulating.
Slope gradient : 4.5%
Landuse : extensive pasture land.
Described by : D.Noordam on 18-12-1974
Vegetation : 30% herbs (Solanum incanum, Ipomoa kituiensis)
30% grasses, 40% bare.
Erosion : some sheeterosion.
Parentmaterial : stratified tuffs, boulder breccias and tuffaceous sandstones.
Drainage : well drained.
Rockoutcrops : 1%
Surface stoniness: 20%
Effective soildepth: 40 cm.
Surface runoff : moderate fast.

Profile description:

A1 0 - 12 cm: Dark brown (10 YR 4.5/2, dry and moist); light clayloam; very weak, medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; noncalcareous; common fine and very fine pores; common weathering gravels; clear and wavy boundary.

A/C 12-24 cm: Dark brown (10 YR 3.5/2, dry and moist); light clayloam; very weak medium subangular blocky; slightly hard, friable,

slightly sticky and slightly plastic; noncalcareous; common fine and very fine pores; many weathering gravels; clear and boundary.

C 24 - 40+cm: Horizon with very many weathering gravels and stones non-calcareous.

Range of characteristics:

Profile characteristics:

The soils of this series are shallow and stony. Depth ranging from 40-50 cm and stoniness of the profile between 20-50% stones and gravels. The A-horizon is thin (10 - 20 cm) and has colours ranging from dark gray brown to dark brown. Texture is light clayloam to heavy loam, but mostly the latter. The soils are usually non-calcareous, but some are slightly calcareous below the A-horizon.

Environmental characteristics:

This series is found on slightly convex, gently sloping edges of hills (slopes 3-5%) and on moderately steep solitairy hills (slopes 10-20%). The series is surraunded by an undulating landform, exept for the solitary hills. On the edges of hills the stoniness is usually low, and mainly consisting of small gravels. Some shallow gullies may occur here. The hills have a high surface stoniness, 15 - 90% is covered with many small gravels and a few stones.

Profile no. 27 : Kiangata series (KiM)
Claasification : Soil Taxomy 1970: Haplustolls
FAO 1970 : Calcaric Phaeozems
Location : Rusinga island, South Nyanza
Coordinates : 6335 E, 99542 N, sheet no. 115/3 Rusinga.
Elevation : 1170 m.
Physiographic position: lower part of long, straight pedimentslope.
Surrounding landform: gently undulating.
Described by : D.Noordam on 18-12-1974
Slopegradient : 4-5%
Landuse : pastural land and arable land
Vegetation : 10% shrubs (euphorbia tirucalli), 30% herbs and 60% grasses.
Erosion : some sheeterosion.
Parentmaterial : stratified tuffs, boulder breccias and tuffaceous sandsones.
Drainage : well drained

Stoniness : 4 %, mainly small stones
Soildepth : 40 cm.
Surface ronoff : moderate.

Profile description:

A1 0 - 20 cm: Dark grayish brown (10 YR 4.5/1, dry) and 10 YR 3.5/2, moist); clayloam; very weak fine subangular blocky; slightly hard, friable, slightly sticky and slighlty plastic; very calcareous; common fine and very fine pores; common weathering gravels and stones; clear wavy boundary.

A/C 20- 25 cm: Grayish brown (10 YR 5/2, dry) and dark grayish brown (10 YR 4/2,moist); clayloam; massive slightly hard, friable, slightly sticky and slightly plastic; very calcareous; few fine and very fine pores; many wethering gravels and stones; clear, wavy boundary.

C 25 - 40 +cm: As A/C, but with very many soft rotten rock.

Range of characteristics:

Profile characteristics:

The depth of the profiles may range between 120 - 40 cm, but is mainly below 30 cm. The A-horizon is very dark gray brown to gray brown, mostly the latter. Thickness of the A-horizon is between 10-20 cm in the shallow profiles, but somewhat thicker in deeper profiles. All soils are medium texture, usually light clay loam. The C-horizon contains always multi-colcured rotten rock. The soils are always calcareous throughout.

Environmental characteristics:

The series is found on different slopes.
Firstly on sloping to very steep hillslopes with many rockoutcrops and a high surface stoniness. The profile are shallow on these positions. Further it occurs on sloping pediments. Here rockoutcrops are found seldom, but surface stoniness is high, mainly consisting of small gravels. Some part are severely eroded and have a high intensity of deep to very deep gullies. Other parts are less affected, but sheet erosion is found everywhere.
At last the series is found on gently sloping peneplains. No rockoutcrops are found here and surface stoniness is low to common, but mainly the surface is covered for 10-30% with small gravels.

Profile no. 28 : Kakrigu series (KaM)
Classification : Soil Taxonomy 1970: Thapto Udic Chromustertic Typic Haplustolls:
Location : Rusinga island, near Kakrigu school, South Nyanza,
Coordinates : 6320 E, 99541 N, sheet no. 115/3 Rusinga.
Elevation : 1150 m.
Described by : D.Noordam on 31-10-1974
Physiography : alluvial plain
Surrounding : gently undulating
Slopegradient : 2%
Landuse : arable land and pastureland in wet season.
Vegetation : shrubs (10; (E.tirucalli), 20% herbs (I.kituiensis), 70% grasses.
Erosion : some sheeterosion of selfmulching toplayer in wet season.
Parent material: stratified tuffs, boulder breccias and tuffaceous sandstones and nephelinites.
Drainage : moderately well drained.
Surface stoniness: 1%
Soildepth : 130 cm.
Runoff : slow
Groundwaterlevel: 260 cm below surface.
Salinity-Sodic : probably slightly affected.

Profile description:

A11 0 - 10 cm: Dark grayish brown (10 YR 4/2, dry) and very dark grayish brown (10 YR 3/2, moist); clayloam; moderate, medium subangular blocky; hard, firm, slightly sticky and plastic; calcareous; common medium and fine pores clear and wavy boundary;

A3 10 - 30 cm: Dark grayish brown (10 YR 4/2, dry)and very dark grayish brown (10 YR 3/2, moist); clayloam moderate medium prismatic breaking into moderate medium angular blocky; hard, firm, slightly sticky and plastic; calcareous; common medium and fine pores; few gravels; clear and wavy boundary.

B1 30 - 50 cm: Dark brown (10 YR 3/3, dry) and very dark grayish brown (10 YR 3/2, moist); clayloam; strong medium angular blocky; hard, firm, sticky and plastic, calcareous; few medium and fine pores; clear and wavy boundary.

B22 50 - 60 cm: Very dark grayish brown (10 YR 3/2, dry and moist); clay; weak medium prismatic breaking into strong medium angular blocky; hard, very firm, sticky and plastic; calcareous; patchy slickensides; few medium fine and very fine pores; few gravels; clear and wavy boundary.

C1 60 - 77 cm: Very dark grayish brown (10 YR 3/2, dry and moist); sandy loam; weak medium angular blocky; hard, very friable, slightly sticky and slightly plastic; calcareous; few medium and fine pores; few gravels; clear and wavy boundary.

A10 77 -130 cm: Very dark grayish brown (10 YR 3/2, dry and moist);heavy clay; strong coarse prismatic breaking into coarse angular blocky; extremely hard; extremely firm, very sticky and very plastic; very calcareous; patchy slickensides (between 110-130 cm continous) few medium pores; few gravels.

Range of characteristics:

Profile characteristics:

This series contains mainly deep to very deep soils, but also some moderately deep profiles are found. The soils have often a selfmulching layer, but sometimes this has disappeared. The A-horizon is 10-30 cm and has colours ranging from very dark brown to dark gray brown, but usually very dark gray brown colours are found. The texture varies from heavy clayloam to clay. Very often a second, buried profile is found, mainly between 60-120 cm. Small gravels may occur locally in the profiles. Usually the soils are calcareous throughout, sometimes the topsoil is only slightly calcareous.

Environmental characteristics:

The Kakrigu series is found on slightly concave, nearly flat to gently sloping alluvial plain. A few small gravels may occur.

Profile no. 30 : Nyamuga series (NyM)

Classification : Soil Taxonomy 1970: Udic Haplustolls

FAO 1970 : Calcaric Phaeozems

Location : Rusinga island, 250 m South of Mbita market near the coast of Lake Victoria, South Nyanza district,

Coordinates : 6368 E, 99543 N, sheet no. 115/3 Rusinga
Elevation : 1143 m.
Described by : D.Noordam on 31-10-1974
Physiography : transitionzone from hillslope towards coastal plain, lower part of concave slope
Landform : nearly flat.
Slopegradient : 4%
Landuse : In wet season cultivation of maize and sorghum; in dry season used for extensive grazing.
Vegetation : Major part occupied by water coming from gullies on higher situated slope.
Parentmaterial : stratified tuffs, boulderbreccias and tuffaceous sandstone.
Drainage : moderately well drained.
Stoniness : 1%
Soildepth : 80 cm.

Profile description:

A1 0 - 15 cm: Dark brown (10 YR 3/3, dry and moist); light clay; moderate medium subangular blocky; hard, firm, slightly sticky and plastic; calcareous, common medium and fine pores; clear and wavy boundary.

A3 15 - 40 cm: Dark brown (10 YR 3/3, dry and moist); heavy clayloam; strong medium angular blocky; hard, firm, slightly sticky and plastic; calcareous; common medium and fine pores; very few very small gravels; clear and wavy boundary,

B1 40 - 70 cm: Dark grayish brown (10 YR 4/2, dry); loam; moderate,medium to fine angular blocky; slightly hard, friable, slightly sticky and slightly plastic; very calcareous; few medium and common fine pores; common small gravels; clear and wavy boundary,

C11 70 - 80 cm: Dark grayish brwon (10 YR 4/2, dry); clayloam; moderate medium angular blocky; hard, firm, sticky and plastic; calcareous; common fine pores; common gravels, gradual and wavy boundary,

C12 80 -100+cm: Rotten rock with weathered soil in between.

Range of characteristics:

Profile characteristics:

The soil depth range from deep via moderately deep to shallow. The deeper ones are found in the alluvial plains, together with soils of the Kakrigu

series. They generally have a moderately thick A-horizon. The moderately deep and shallow profiles occur in the transitionzone of alluvium and hills. They often consist of colluvial material. The A-horizon is less thick than the ones of deeper profiles. Colour of the A-horizon varies between dark grayish brown and very dark grayish brown of which the latter occurs more frequent in the alluvial profiles.
The texture of the upper 30-50 cm has to be finer than 35%, but becomes light clayloam or coarser before 50 cm. Generally the texture of the subsoil is heavy loam, with common stones and gravels. Usually the soil are calcareous throughout, but sometimes the upper part is slightly or non-calcareous.

Environmental characteristics:

Mostly the series occurs on slightly concave gently sloping foot-slopes and straight very gently sloping alluvial slopes. Surface-stoniness is low, class 1-2 or absent. Sometimes the series occurs on moderately sloping colluvial slopes. Stoniness is higher than 20-50% of the surface is covered with small gravels.

Appendix 2: Explanatory legend

Taxonomic unit	Series code and name	Textural family
Ruptic-vollic Psammaquent	ViN-Victoria Series	coarse sandy loam
Aeric Tropaquents / Typic Chromusterts	KsN-Kasigunga series	clay
Udic Haplustolls	GeN-Gembe series	clayey over clay-loamy or loamy.
Typic Chromusterts	MiN-Miguna series	clay
Typic Tropaquents	ChN-Chamarunga series	clay
Udic Haplustolls	OkN-Okoth series	clayey over clay-loamy or loamy
Typic Torrifluvents	AnN-Andugo	clayloam over sandy loamy
Udic Haplustolls	MbN-Mbita series	clayloam or loamy
Lithic Haplustolls	KhN-Kiahera series	clayloam or loamy
Udic Haplustolls	OlN-Olele series	clayloam
Typic Ustropepts	OnM-Onyango series	silt loam to silty clayloam
Ruptic-typic Ustropepts / Udic Haplustolls	RuM-Rusinga series	loamy-skeletal to loamy
Udic Haplustolls	LeM-Leaky series	loamy-skeletal to loamy
Udic Haplustolls	KiM-Kiangata series	loamy-skeletal to loamy
Typic Torrifluvents	OgM-Ogosa series	silty clayloam over loamy sand
Ruptic-thapto-udic-Haplustolls	KaM-Kakrigu series	clay
Ustollic-typic-Chromusterts / Udic Haplustolls	NyM-Nyamuga series	clayey over clay-loamy or loamy or loamy-skeletal

Series	Drainage	Physiographic	Slope
ViN·	well	Coastal plains	Nearly flat to gently sloping
KsN	poorly	Straight pediment and alluvial fanslopes	Nearly flat to gently sloping
GeN	somewhat poorly	Transitionzone pediment or alluvial plain towards hilly parts	Nearly flat to ge gently sloping
MiN	poorly	Slight depressions in alluvial plains	Nearly flat to very gently sloping
ChN	poorly	Coastal plain	Nearly flat to very gently sloping
OkN	somewhat	Slight depressions in alluvial plain near hills	Nearly flat to very gently sloping
AnN	well	Slight convex alluvial fans	Nearly flat to sloping
MbN	well	Low hills and eroded pediments	Nearly flat to sloping
KhN	well	Steep hillslopes and rocky parts of low hills	Nearly flat to gently sloping
ClN·	well	Flat top of low hills	Very gently sloping
OnM	well	Flat top of low hills	Very gently sloping
RuM	well	Non-dissected pediment	gently sloping
LeM	well	Convex edges of hills and along gullied	Gently sloping to moderately steep
KiM	well	Straight strongly dissected pedimentslopes	Gently sloping to very steep
OgM	somewhat excessive	Slightly convex alluvial fans and remnants of fans	Very gently sloping to sloping
KaM	poorly	Alluvial fans and on gully-bottons	Nearly flat to gently sloping
NyM	somewhat	Alluvial fans and lower slightly concave pedimentslopes	Gently sloping

Series	Surface-stoniness	Rockoutcrops	Genetic horizons	Color below A-horizon
ViN	No or few	No	A-C	Dark gray brown
KsN	No or few	No	A-B-C	Very dark brown to very dark gray brown
GeN	Usually no or few sometimes common	No	A-B-C-(R)	Very dark gray brown to dark brown
MiN	No	No	A-B-C	Very dark gray brown
ChN	No	No	A-(B)-C	Very dark gray to black
OkN	No or few	No	A-B-C-(R)	Very dark gray brown
AnN	No	No	A-C	Dark gray brown to brown
MbN	Few to many	Occasionally few	A-C-R	Very dark gray brown to dark gray brown
KhN	Abundant	Very many	A-C-R	Very dark gray brown
OlN	No or few	No	A-(B)-C-R	Dark brown
OnM	No	No	A-B-R	Dark gray brown to gray brown
RuM	Few gravels	No	A-C-R	Reddish brown to brown
LeM	Few to many gravels	No	A-C-R	Gray brown to brown
KiM	Many gravels	Occasionally few	A-C-R	Gray brown to brown
OgM	No or few gravels	No	A-C	Brown to gray brown
KaM	No or few gravels	No	A-B-C-(A_b-C)	Very dark gray brown to dark brown
NyM	Few to common	No	A-B-C-(R)	Very dark gray brown to dark brown

Series	Depth of solum	Structure	Soil-reaction	Other characteristics
ViN	50-80 cm	moderate-weak	0/+	Slightly to moderate saline and/or alkaline
KsN	75-100cm	strong	0/-	Selfmulching toplayer
GeN	50-80 cm	strong	0/-	" "
MiN	75-100 cm	strong	+	" "
ChN	50-100 cm	strong-moderate	+	Slightly to moderate saline and/or alkaline
OkN	50-80 cm	strong	+	Selfmulching toplayer
AnN	80 cm	moderate	+	Sometimes soft lime present
MbN	40-50 cm	moderate	0/-/+	Usually little stony and rotten rock
KhN	< 20 cm	moderate	-/+	Very stony, rotten rock within 20 cm
ClN	50 cm	moderate-strong	0	Usually stony
OnM	40-60 cm	weak	+	Petrocalcic horizon, sealing surface
RuM	50-60 cm	moderate	+	Red gravels (soft) throughout
LeM	50-60 cm	moderate	0	Gravels throughout
KiM	50-60 cm	moderate	+	Gravels throughout, moderate sheeterosion
OgM	80 cm	moderate-weak	+	Layers of rounded gravels, soft limeconcretion.
KaM	50-100 cm	strong	+	Thin selmulching toplayer may occur
NyM	50-80 cm	strong	+	" "

Appendix 3:

Some data on the fertility of the soils of the Mbita area:

Mixed surface soil samples (0 - 10 cm.) were taken on some places on the compound of the catholic parish at Mbita.
These places include both, higher hilly parts and the coastal plain.
Determined were pH, and the following minerals: Ca, Mg,K, Na and P.
The results for the different positions were:
- upper parts with moderately deep to shallow soils of the Mbita (and partly of the Gembe) series on a slope of 3-5%.

Sample no.	pH	Na me%	K me%	Ca me%	Mg me%	P ppm	Soilseries
R9	8.30	0.50	0.25	96.0	0.08	140	Gembeseries
R10	8.20	0.48	0.47	48.0	0.15	310	Mbitaseries
R11	8.90	1.18	0.60	58.8	0.11	325	Mbitaseries

-very gently undulating coastal plain, with deep soils of the Victoria-series a-somewhat higher part (2m, above lakelevel).

R4	7.70	1.08	1.70	20.3	0.11	325	Victoriaseries
R8	8.55	0.60	0.74	36.0	0.15	310	"

b-slight depression with sealing surface layer.

R5	7.50	8.80	1.06	14.0	0.12	315	Victoriaseries
R6	10.15	9.20	0.70	15.6	1.32	310	"
R7	9.60	2.16	0.74	17.2	0.32	310	"

Appendix 4:

List of crops that can be grown in the Mbita area.

1. Under "remarks" mainly notes are pointed which deal with labour and capital requirement.
2. All crops need well drained and fertile soils otherwise manuring is necessary; except if the notes mention other conditions.
3. Conditions mentioned in this list are necessary to get a reasonable yield.

Crop	Water-requirements	soil-requirements
maize	600 - 1200 mm.	well aerated
sorghum	400 - 700 mm.	all soils, even rather poor imperfectly drained
wimbi	500 - 900 mm.	
rice	1500- 2000 mm.	water lodged soils
sugar cane	1500 mm/year	heavier soils
beans	800- 1000 mm.	
soy beans	800- 1000 mm.	best on loamy soils
groundnuts	1000 mm.	lighter soils
cowpeas	600- 1000 mm.	
greengrams	600- 850 mm.	best on loamy soils
pigeonpeas	625 mm.	
cabbage	700- 1000 mm.	best on loamy soils
carrots		
tomatoes		best on loamy soils
cocoyams	1250 mm.	water lodged soils
bananas	1500 - 2500 mm.	best on loamy soils
paw paw	1250 mm.	
citrus		well aerated
mango	650 - 900 mm.	deep poorer soils
yellow passion fruits	750 - 1250 mm.	best on lighter soils
cassava	500 - 2000 mm.	poorer soils
sweet potatoes	750 - 1500 mm.	
sisal	625 - 1250	
cotton	750 - 1000 mm.	
sunflower	750 - 1000 mm.	
cucumber		
melon		
watermelon		loamy soils
etc,		

remarks

weeding(Striga sp, kanyango); manuring; stalkboarers.
bird-damage; weeding; somewhat tolerant to salts; stalkboarers.
seedbedpreparation; weeding; bird-damage; stalkboarers.
landpreparation; manuring; bird- and insectdamage.
manuring.
some weed control.
seedbed preparation; manuring.
weeding; manuring.
in drier areas insect resistant.
drought resistant; tillage.
drought resistant; deep rooting.
manuring; insects and diseases.

landpreparation; organic manuring.

manuring, also with organic matter.

manuring, diseases.

climber.

very drought resistant.
drought resistant; manuring; insectdamage.

weed control; deeprooting; salt tolerant.
drought resistant; birddamage; deeprooting.
drought resistant; weeding; deeprooting; resistant to birddamage

manuring; damage by insects and diseases.

Appendix 5

Salt analysis. (samples taken November 1974)

Description		Depth (cm)	pH puddle	ECe mmho/cm^2	Cations Na
Profile Mb 5.		0 - 10		5.5	23.32
		10 - 20		11.6	63.78
		20 - 30		10.2	59.64
		30 - 40		10.2	56.11
		40 - 50		7.9	24.00
		50 - 60	7.62	9.4	55.80
		60 - 70	7.67	10.8	61.14
		70 - 80	7.60	9.9	59.64
		80 - 90	7.67	9.0	59.64
		90 -100		7.7	54.81
Trial Francis B		10 - 20	7.60	5555	
		90 -100	7.82	640	
Groundwater trial Fr. B		180 -		2050	22.00
Trial plot Mbita mission I		0 - 30	7.40	1.36	6.71
		30 - 60	8.18	1.48	17.6
		60 - 90	8.60	4.2	54.25
		90 -120	8.65	5.5	67.2
	VII	0 - 30	7.74	0.44	
		30 - 60	7.87	0.5	
	IX	0 - 30	7.99	4.2	38.01
		30 - 60	8.20	8.8	91.56
		60 - 90	8.43	9.4	104.16
		90 -120	8.77	9.4	108.50
	III	0 - 30	7.32	0.57	
		30 - 60	7.50	.57	
		60 - 90	7.78	.32	
		90 -120	7.99	.30	
Water Lake Victoria				0.1	0.51

meq/1				Anions meq/1		
K	Ca	Mg	total	HCO_3	Cl	total
5.28	18.3	19.8	66.7	3.97	37.0	40.97
11.44	51.2	39.8	166.22	3.70	105.0	108.7
9.24	35.0	31.5	135.38	0.68	83.9	84.58
13.64	35.0	27.5	132.25	0.74	80.2	80.94
7.50	36.5	35.0	103.00	1.30	90.0	91.30
6.30	27.0	25.0	114.10	0.72	84.8	85.52
7.13	33.9	32.0	134.17	0.42	92.5	92.92
3.78	33.1	31.0	127.52	0.46	75.-	75.46
3.88	29.2	27.6	120.32	0.63	63.1	63.73
1.18	21.6	22.4	99.99	0.52	57.6	58.12
1.38	4.05	3.10	30.53	16.11	4.15	20.26
0.26	2.00	0.80	3.77	1.57	1.9	3.47
0.20	1.30	0.70	19.80	1.92	4.4	6.32
2.31	0.40	1.60	58.56	1.92	8.6	10.52
0.09	1.20	0.80	69.29	2.81	16.7	19.51
0.38	1.90	1.30	41.59	1.82	27.6	29.42
0.35	3.80	1.00	96.71	1.70	68.8	70.50
0.78	2.00	1.30	108.24	1.92	65.9	67.82
2.02	0.80	1.00	112.32	3.80	66.4	70.20
0.29	0.35	0.35	1.50	0.59	0.61	1.20

Appendix 5: continued

Salt analysis of samples taken in april 1975.

Location	depth	pH puddle	ECe	mmho/cm^2
Trial plot	0 - 20	7.6	0.53	
Mbita Mission	20 - 40	7.7	0.35	
Nr. I (R20)	40 - 60	7.9	0.29	
	60 - 80	7.8	0.268	
	80 -100	8.1	0.73	
	100 -120	8.5	1.29	
id.				
Nr. III(R23)	0 - 20	7.9	0.76	
	20 - 40	7.9	0.59	
	40 - 60	8.4	2.49	
	60 - 80	8.8	3.30	
	80 -100	9.1	3.00	
	100 -120	9.2	2.74	
id.				
Nr.VII (R21)	0 - 20	7.8	0.32	
	20 - 40	7.8	0.28	
	40 - 60	7.7	0.46	
	60 - 80	7.8	0.31	
	80 -100	7.8	3.30	
	100 -120	7.9	0.42	
id.				
Nr.IX (R22)	0 - 20	7.6	0.35	
	20 - 40	7.9	0.31	
	40 - 60	8.0	0.53	
	60 - 80	8.3	1.71	
	80 -100	8.6	0.295	
	100 -120	8.7	2.98	

Na^+	K^+	Ca	Mg	total	HCO	Cl	total	meg/
0.72	0.35	2.4	2.3	5.77	2.7	1.14	3.84	
0.55	0.14	1.8	1.7	4.19	3.7	0.65	4.35	
0.52	0.18	1.6	1.6	3.90	2.4	0.54	2.94	
2.40	0.04	1.05	0.9	4.39	2.0	0.36	2.36	
6.36	0.04	0.85	0.95	8.20	4.2	0.96	5.16	
11.68	1.42	3.8	0.5	16.95	6.2	1.02	7.22	
2.55	0.24	4.43	2.57	9.79	4.7	2.0	6.7	
4.44	0.04	0.70	1.6	6.78	3.9	0.9	4.8	
					4.1			
34.86	0.36	2.1	-0.15		4.8	15.91	20.71	
33.60	0.16	0.75	0.5	35.01	6.7	12.72	19.42	
24.80	0.23	0.7	0.35	26.08	7.9	9.04	16.94	
0.56	0.13	1.6	1.15	3.44	2.4	0.63	3.03	
0.66	0.09	1.25	1.00	3.00	2.0	2.75	4.75	
0.99	0.09	1.6	0.95	3.63	2.6	0.96	3.56	
0.44	0.06	2.0	0.80	3.30	2.4	0.70	3.10	
21.12	0.52	1.3	1.7	24.64	4.3	7.76	12.06	
0.80	0.18	2.8	2.0	5.78	2.8	1.23	.03	
0.94	0.33	1.5	0.9	3.67	1.7	0.84	2.54	
0.50	0.19	1.6	0.8	3.09	2.4	0.6	3.00	
1.20	0.05	0.9	1.5	3.65	4.5	0.3	4.8	
14.28	0.08	0.6	0.8	15.76	3.7	7.74	11.44	
0.70	0.10	1.7	0.6	3.10	2.1	0.56	2.66	
28.56	0.10	0.51	0.4	29.57	4.5	12.19	16.69	

Appendix 6: Soil moisture data:

From 3 profiles pF curves are determined for different depths with different textures.
From these pF curves the wateravailability of the profiles is determined.
As available water is taken the volume % of water kept between pF 2.0 (field capacity) and pF 4.2 (permanent wilting point).

Total Available Water = $\frac{Fc-Wp}{100}$ x Dr .
(mm)

Fc= volume % of water at fieldcapacity
Wp= " " " " permanent wiltingpoint.
Dr=depth of rootingzone. (mm).
As the depth of the rootingzone was taken the depth till which the roots were observed in the field, but this may differ from one crop to another.
Only 3 profile were used for the determination of the availability of water however, some estimations can be made about the other soilseries:

- profile 1 (Kasigunga series) can be compared with: Miguma series, Chamarunga series, Kakrigu series.
- profile 5 (Okoth series) comparable with: Nyamuga series and Gembe series.
- profile 16 (Victoria series) can be compared with the Ogosa-series,

Factors which influence the wateravailability of these profiles are depth and stoniness; less deep and more stony profiles will have a lower amount of total available water.

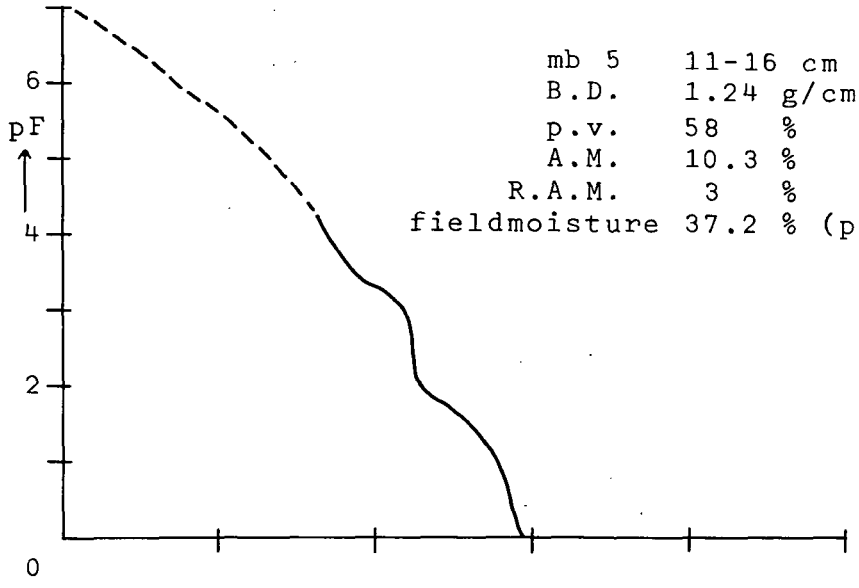
erratum

page 113 follows directly

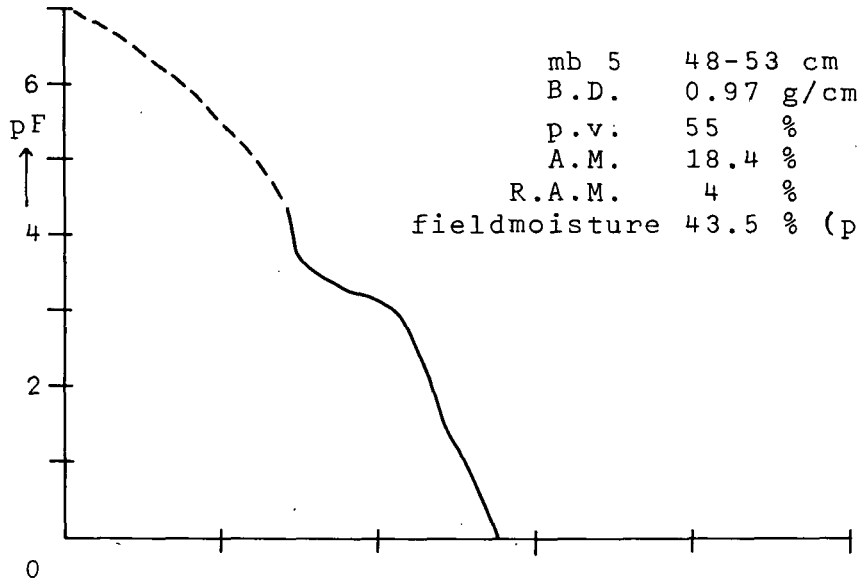
on page 107

Okoth series

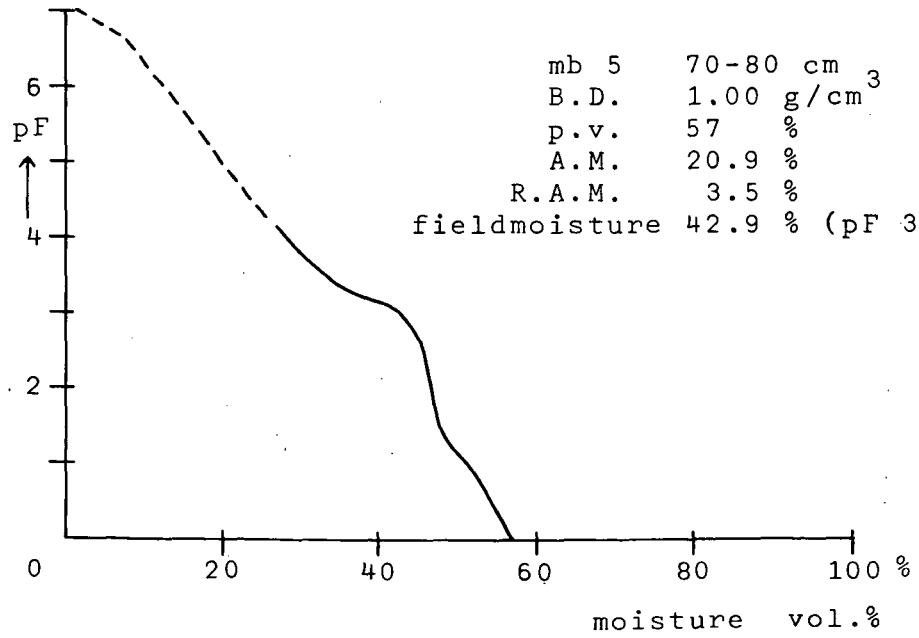
pF-curves:



mb 5 11-16 cm
B.D. 1.24 g/cm^3
p.v. 58 %
A.M. 10.3 %
R.A.M. 3 %
fieldmoisture 37.2 % (pF 3.4)



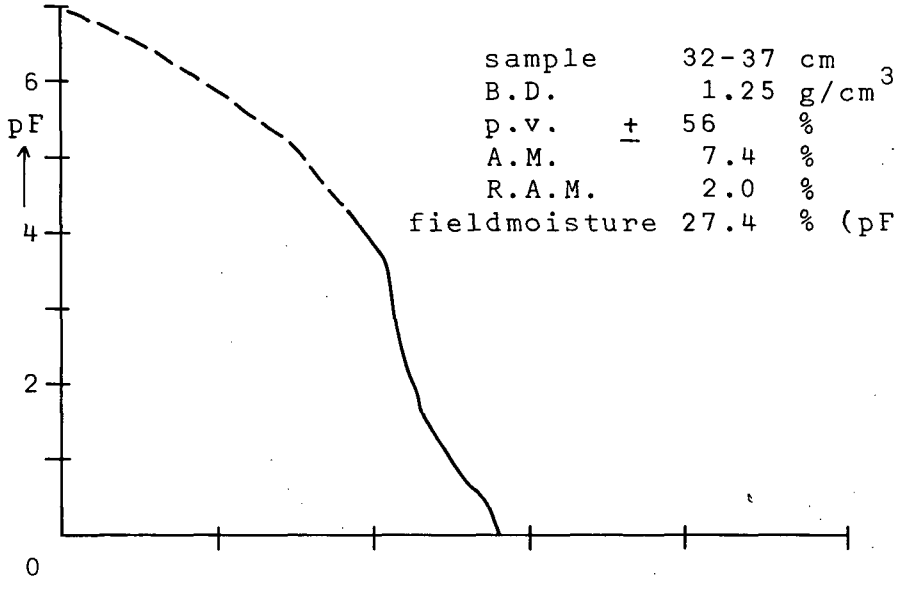
mb 5 48-53 cm
B.D. 0.97 g/cm^3
p.v. 55 %
A.M. 18.4 %
R.A.M. 4 %
fieldmoisture 43.5 % (pF 2.8)



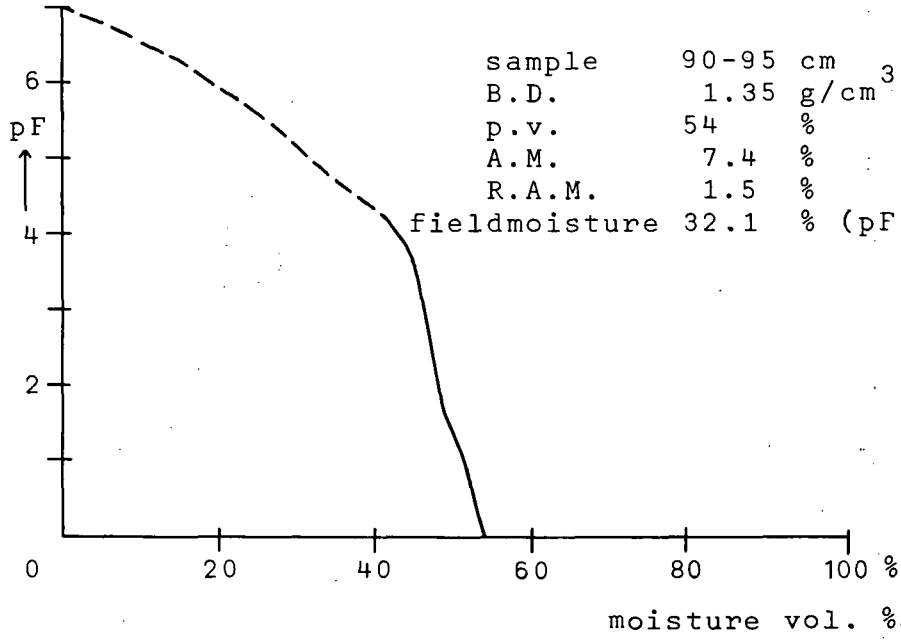
mb 5 70-80 cm
B.D. 1.00 g/cm^3
p.v. 57 %
A.M. 20.9 %
R.A.M. 3.5 %
fieldmoisture 42.9 % (pF 3.0)

Kasigimga series

pF-curves:



sample	32-37	cm
B.D.	1.25	g/cm^3
p.v. ±	56	%
A.M.	7.4	%
R.A.M.	2.0	%
fieldmoisture	27.4	% (pF 5.3)

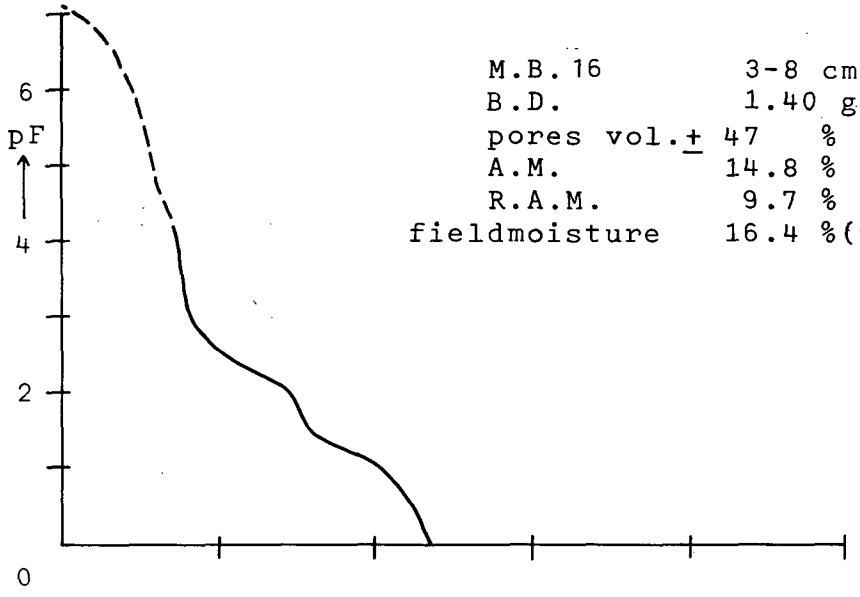


sample	90-95	cm
B.D.	1.35	g/cm^3
p.v.	54	%
A.M.	7.4	%
R.A.M.	1.5	%
fieldmoisture	32.1	% (pF 4.9)

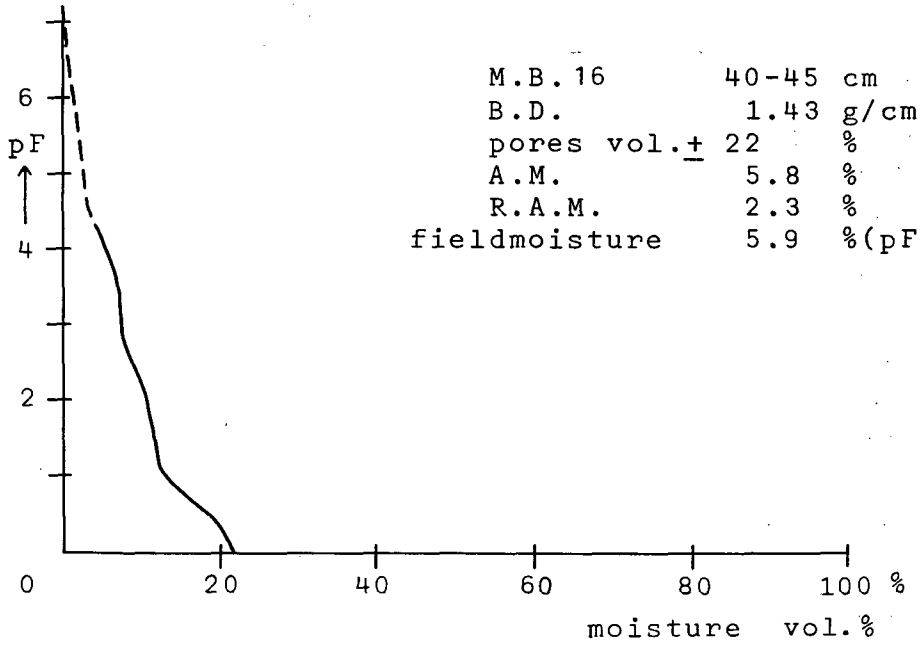
B.D. = bulkdensity (g/cm^3)
A.M. = available moisture (pF 2.0 - pF 4.2)
R.A.M. = readily available moisture (pF 2.2 - pF 3.0)
fieldmoisture % = moisture % (vol. %) at the moment of sampling

Pit no. Mb 16 Victoria series

pF-curves:



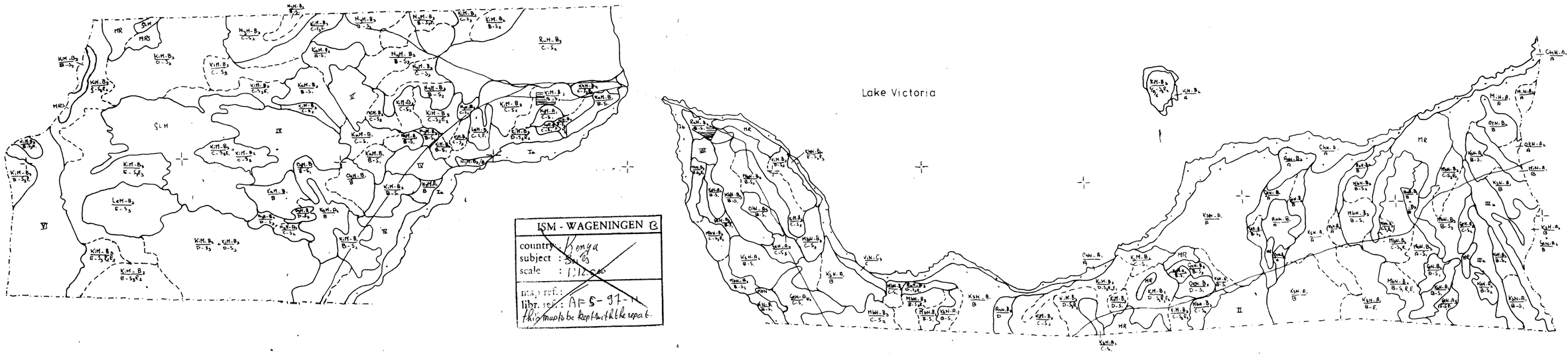
M.B. 16	3-8 cm
B.D.	1.40 g/cm^3
pores vol. ±	47 %
A.M.	14.8 %
R.A.M.	9.7 %
fieldmoisture	16.4 %(pF 3.0)



M.B. 16	40-45 cm
B.D.	1.43 g/cm^3
pores vol. ±	22 %
A.M.	5.8 %
R.A.M.	2.3 %
fieldmoisture	5.9 %(pF 3.8)

APPENDIX 7. Preliminary Report no 11.

DETAILED SOILMAP OF THE MBITA-AREA



LEGEND OF THE DETAILED SOILSURVEY OF THE MBITA-AREA.

Soils developed on alluvial and colluvial materials of nephelinite agglomerate.

ViN Victoriaseries — ruptic-mollic Psammaquents ic aeric Tropaquents
Deep, moderately welldrained, dark gray brown, calcareous or noncalcareous, layered soils, generally with loamy to sandy texture, with or without thin clayey layers. Groundwater within 150 cm throughout the year, saltaffected.

KsN Kasigungaseries — typic Chromusterts
Deep, poorly drained, very dark brown to very dark gray brown, montmorillonitic clay, with a selfmulching surface layer.

GeN Gembeseries — udic Haplustolls
Deep to moderately deep, somewhat poorly drained, very dark gray brown, montmorillonitic clay over light clayloam; with a selfmulching surfacelayer.

Soils developed on alluvial materials of nephelinite agglomerate

MiN Migumaseries — udic Chromusterts
Deep, poorly drained, very dark gray brown, calcareous montmorillonitic clay, with a selfmulching surfacelayer.

ChN Chamarungaseries — typic Tropaquents
Deep, poorly drained, very dark gray to black, montmorillonitic clay. Groundwater within 150 cm throughout the year, saltaffected.

OkN Okotheseries — udic Haplustolls
Deep to moderately deep, somewhat poorly drained, very dark gray brown, calcareous, gravelly, montmorillonitic clay over light clayloam; with a selfmulching surface layer.

AnN Deep, welldrained, dark gray brown to brown, calcareous clayloam to loam, sometimes with soft limeconcretions. Andugoseries — typic Torrifluvents

Soils developed on hills of nepnelinite agglomerate.

MbN Mbitaseries — udic Haplustolls
Shallow to moderately deep, welldrained, very dark gray brown to dark gray brown clayloam to loam

KhN Kianeraseries — lithic Haplustolls
Very shallow, welldrained, stony, very dark gray brown loam.

OlN Oleleseries — udic Haplustolls
Shallow to moderately deep, welldrained, dark brown stony clayloam to light clay.

Soils developed on Miocene lakebeds consisting of stratified tuffs, boulderbreccias and tuffaceous sandstone.

OnM Onyangoseries — typic Ustropepts
Shallow to moderately deep, welldrained, dark gray brown to gray brown, calcareous silty clayloam to silt loam, with a petrocalcic horizon.

RuM Rusingaseries — ruptic-typic Ustropepts ic udic Haplustolls
Shallow to moderately deep, welldrained, brown to reddish brown, gravelly, calcareous, loam.

Soils developed on alluvial materials from Miocene lakebeds.

LeM Leakyseries — udic Haplustolls
Shallow to moderately deep, welldrained, gray brown to brown, noncalcareous, gravelly clayloam to loam.

KiM Kiangataseries — udic Haplustolls
Shallow to moderately deep, welldrained, gray brown to brown, calcareous, gravelly, clayloam to loam.

OgM Ogongaseries — typic Torrifluvents
Deep, somewhat excessive drained, brown to gray brown calcareous, loam to light silty clayloam, with thin layers of sand androunded gravels.

KaM Kakrigueries — ruptic-thapto-udic-Haplustollsic typic Chromusterts
Deep, poorly drained, very dark gray brown to dark brown, calcareous montmorillonitic clay, with a few gravelly layers.

NyM Nyamugaseries — udic Haplustolls
Deep to moderately deep, somewhat poorly drained, very dark gray brown to dark brown, calcareous montmorillonitic clay over light gravelly clayloam.

complexes of soils

Coastal complexes

Ia Kuringa-island: 40% ChN-B_2 + 20% ViN-C_2 + 20% KaM-A_1 + 20% NyM-B_2

Ib Mbita point: 30% ChN-B_1 + 70% ViN-B_1

Complexes on nephelinite agglomerate

II Slopecomplex: 60% KhN-B_4 C,D,E,F-S_2R_3,4 + 20% GeN-A_2 + C-S_3 + 20% MbN-B_2 B-S_3

IIIa Eroded pediment: 20% KsN-A_1 B-S_1 + 60% GeN-A_2 C-S_2 + 20% MbN-B_2 C-S_3
Erosionphase E_2

IIIb Ibid: 10% KsN-A_1 B + 45% GeN-B_2 B + 45% MbN-B_2 B
Erosionphase E_3

Complexes on Miocene lakebeds

IV Alluvial plain: 80% KaM-B_1 B-S_1 + 20% NyM-B_1 B-S_1

V Transition pediment-alluvial plain, erosionphase E_2: 80% KiM-B_3 B-S_2 + 15% KaM-A_1 C-S_1 + 5% NyM-A_2 B-S_1

Complexes on materials of mixed origine

VI Lulongecomplex: 10% GeN-B_2 D-S_2 + 60% KiM-B_3 D,E,F,G-S_2R_3 + 10% KhN-B_4 + 20% MRS.

VII Alluvial plain near Mbita: 60% RuM-B_2 C-S_1 + 20% OkN-A_2 C + 20% MiN-B_2 C-S_1

EXPLANATION OF THE SERIESCODE

Soiltype: first 18cm.
A: Silty clay and clay > 40%
B: Medium texture, finer than sandy loam
C: Coarser than sandy loam.

Seriesname — KiM-B_3 — E-$S_3R_2E_2$

Depth of the profile
4: 0 _ 20 cm
3: 20 _ 50 cm
2: 50 _ 100 cm
1: 100 _ 150 cm

Slope:
A: 0 _ 1 %
B: 1 _ 3 %
C: 3 _ 5 %
D: 5 _ 10 %
E: 10 _ 20 %
F: 20 _ 30 %
G: 30 _ 50 %

Surface stoniness
S1: 0 _ 3 %
S2: 3 _ 15 %
S3: 15 _ 90 %
S4: 90 _ 100 %

Rockoutcrops
R1: 0 _ 2%
R2: 2 _ 10 %
R3: 10 _ 25%
R4: 25 _ 50%
R5: 50 _ 90%
R6: 90 _ 100%

Erosion:

Depth of gullies \ Intensity of gullies: length / surf.		< 0.2	0.2 - 0.4	> 0.4
0 - 3 m	----------	E1.	E1.	E2.
3 - 6 m	- - - - - -	E1.	E2.	E3.
> 6 m	--------	E2.	E3.	GL.

Parentmaterial:
N: Nephelinites.
M: Stratified tuffs, boulderbreccias and tuffaceous sandstone.

Legend of symbols:
- Boundery of the survey-area
- Bounderies of series
- Bounderies of phases
- Principal points
- KiM-B_3 / E-$S_3R_2E_2$ — Seriescode
- Presence of salinity and/or alkalinity (slightly affected topsoil or mod. affected subsoil)
- Roads
- Villages
- Ferry

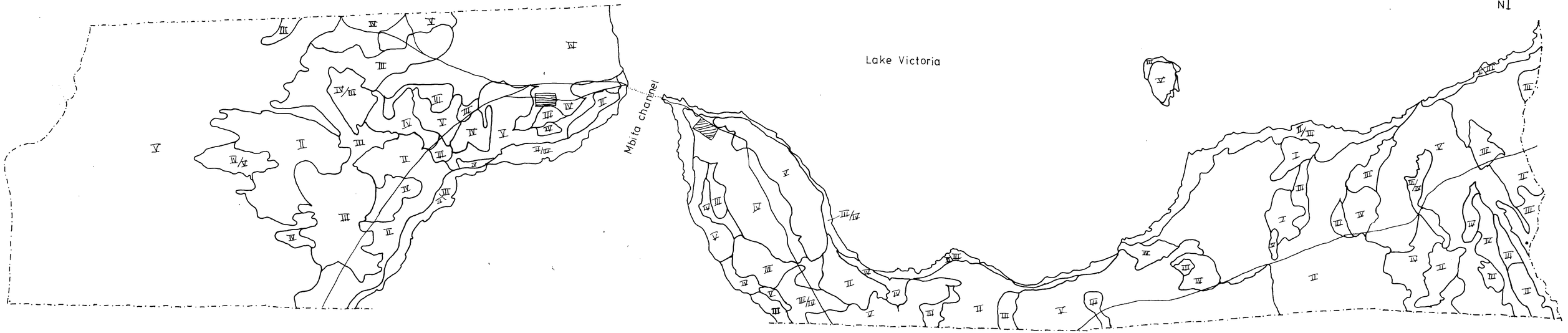
0 250 500 750 1000 m

Scale: 1: 12.500
Surveyed: august-november 1974

APPENDIX 8. Preliminary Report no 11.

6349 a

ACTUAL SUITABILITY MAP



I	Very highly suitable
II	Highly suitable
III	Medium suitable
IV	Marginally suitable
V	Unsuitable

Boundery of the suitability classes.

Boundery of the survey-area.

Roads.

Village.

Ferry.

0 250 500 750 1000 m.

Scale : 1:12,500